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.

1st Year		
Fall	**Winter**	**Spring**
ENGR 110	ENGR 111	ENGR 112
CHEM 124	CHEM 125	*Life science ge*
Area A ge	*Area A ge*	*Area A ge*
MATH 141	MATH 142	MATH 143
	PHYS 131	PHYS 132
2nd Year		
Fall	**Winter**	**Spring**
EE 201	CE 204	MATE 210
ME 211	ME 212	MATE 215
Area D ge	*Area D ge*	CSC 101
MATH 241	MATH 244	STAT 350*
PHYS 133	CHEM 305*	
3rd Year		
Fall	**Winter**	**Spring**
ME 302	ME 313	ME 341
IME 314	ME 328 tech	MATE 424 *tech*
MATE 230 *tech*	CHEM 328 *elec*	CSC 342 *tech*
CHEM 326 *elec*	*Area C ge*	*Area C ge*
4th Year		
Fall	**Winter**	**Spring (**
MATE 440 *tech*	CSC 480 *tech*	IME 319 *tech*
MATE 425 *tech*	ENGR 581 *tech**	EE 321 *tech*
CSC 103 *tech*	*Area C ge*	MATE 570 *tech**
Area D ge	*Area C ge*	*Area D ge*
5th Year		
Fall	**Winter**	**Spring**
STAT 512	ENGR 590	ENGR 591
ENGR 582	EE 500-level	MATE 400-level
MATE 530		
Thesis 599 *tech**	Thesis 599 *tech**	Thesis 599 *tech**
		Total Units = 231

ge	General Education
*	Math & Science Elective
elec	Elective
tech	Technical Elective
*tech**	Shared BS and MS Technical Elective

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)
  - ENVE 421 Mass Transfer Operations (3)
  - ENGR 581, 582, 583 Biochemical Engr I, II, III (4,4,4)

Approved Electives 8

45

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

45

MS Engineering, Specialization in BIOMEDICAL ENGINEERING

Required Courses 32
- MATE/CHEM 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

45

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

47/48

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

45

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

45

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 (includes comprehensive examination)	8
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
	97

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

90

Aerospace Engineering

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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)	
	30

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 Aerospace 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
	50

Sophomore

AERO 215 Introduction to Aerospace Design	2
AERO 300 Aerospace Engineering 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
	51

Junior

AERO 301, 302 Aerothermodynamics	5,5
AERO 303, 304 Aerothermodynamics	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
	47

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 Anlys	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
	47
	195

BS AEROSPACE ENGINEERING

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

MAJOR COURSES

AERO 121 Aerospace Fundamentals	2
AERO 215 Introduction to Aerospace Design	2
AERO 300 Aerospace Engineering Analysis	5
AERO 301, 302 Aerothermodynamics	5,5
AERO 303, 304 Aerothermodynamics	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 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
	90

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 149 Technical Writing for Engineers (A3)*	4
IME 144 Intro 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

PHYS 131 General Physics (Add'l Area B)*	4
PHYS 132, 133 General Physics	4,4
STAT 312 Statistical Methods for Engineers (B6)*	4
	65

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	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
	22

Astronautics Concentration

AERO 451 Orbital Mechanics I	4
AERO 447, 448, 449 Spacecraft Design	2,4,4
Astronautics electives	8
	22

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 Missile/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

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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 Engineer-ing 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

CE 111 Introduction to Civil Engineering.....	1
CE 114 Intro CAD in Civil/Environ Engr.	4
CHEM 124 Gen Chem for Engineering (B3/B4)* ..	4
CHEM 125 Gen Chem for Engineering	4
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
CSC 231 Fortran *or* CSC 234 C/UNIX	2/3
[1] Political economy elective (D2)*	4
	51

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
Literature elective (C1)*	4
	52

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 Analys *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
	51

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
[2] Advisor approved emphasis area to be selected from: general civil, geotechnical, structural, transportation, or water resources engineering	14
[2,3,4] Advisor approved technical electives	14
	48
	202

BS CIVIL ENGINEERING

☐ *60 units upper division* ☐ *GWR*
☐ *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
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
CE 461, 462 Senior Project *or* CE 466, 467 Senior Project Design Lab	2,2
[2] Advisor approved emphasis area to be selected from: general civil, geotechnical, structural, transportation, or water resources engineering	14
[2,3,4] Advisor approved technical electives	14
	75

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
CSC 341 Numerical Analys *or* IME 314 Engr Econ	4/3
EE 201 Electric Circuits Theory	3
ENGL 149 Technical Writing for Engineers (A3)*	4
ENVE 331 Intro to Environmental Engineering	4
GEOL 201 Physical Geology	3
MATE 210 Materials Engineering	3
MATE 215 Materials Engineering Laboratory	1
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

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[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.