The Mission of the College of Engineering is to serve the State of California, the nation, and society at large, by graduating well-prepared professionals, who are provided with excellent education and training in the fundamentals of their discipline through a combination of theory and laboratory practice, and who are provided with the ability and skills to expand knowledge and transform complex ideas into working systems.

The College of Engineering offers four-year curricula leading to Bachelor of Science degrees in the disciplines of Engineering, Computer Science, and Engineering Technology. The B.S. programs provide broad education and training for entry to the professions and for continuing academic work toward advanced degrees. The graduate programs in the college include Master of Science degrees in Aerospace, Civil, Computer, Electrical and Mechanical Engineering, and in Computer Science. The Master of Science in Engineering is also offered in interdisciplinary areas. The Ph.D. in Engineering and Industrial Applied Mathematics is offered jointly with The Claremont Graduate University. These programs provide opportunities to specialize in the areas of Aerospace, Biomedical, Chemical, Civil, Computer, Electrical, Construction Management.

Accreditation

The Bachelor of Science programs in Aerospace, Chemical, Civil, Computer, Electrical and Mechanical Engineering are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The Bachelor of Science in Computer Science is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

Programs at a Glance

The following is a list of degree programs offered by the college. Details about each program is described in the respective sections of the catalog.

Bachelor of Arts:

Engineering Systems

Bachelor of Science:

Aerospace Engineering
Chemical Engineering
Civil Engineering
Computer Engineering
Computer Engineering Technology
Computer Science
Construction Engineering Management
Electrical Engineering
Electronics Engineering Technology
Engineering
  Option in Audio Engineering
  Not accepting new students as of Fall 2012
  Option in Biomedical and Clinical Engineering
  Not accepting new students as of Fall 2012
  Option in Industrial-Management Engineering
  Not accepting new students as of Fall 2012
Mechanical Engineering

Minor:

Computer Science Applications

Environmental Engineering

Web Technologies and Applications

Single Subject Teaching Credential:

Industrial and Technology Education

Master of Science:

Aerospace Engineering
Civil Engineering
  Option in Computer Engineering
  Not accepting new students as of Fall 2012
  Option in Computer Science
  Not accepting new students as of Fall 2012
Electrical Engineering
Engineering (Interdisciplinary)
Mechanical Engineering

Ph.D. in Engineering and Industrial Applied Mathematics
(jointly with The Claremont Graduate University)

Certificates:

Heating, Ventilating & Air-Conditioning Engineering (MAE)
Not accepting new students as of Fall 2012
Waste Engineering and Management (CECEM)
Not accepting new students as of Fall 2012
Energy Conversion and Power Systems Engineering (MAE and EE)
   Not accepting new students as of Fall 2012
Industrial Plastics Processing and Design (MAE and ChE)
   Not accepting new students as of Fall 2012
Facilities Operations (CECEM)
   Not accepting new students as of Fall 2012
Safety Operations (Che)
   Not accepting new students as of Fall 2012
Aerospace Manufacturing (MAE)
   Not accepting new students as of Fall 2012
Systems Engineering (COE)
   Not accepting new students as of Fall 2012
Web Technologies and Applications (CECS)

Academic Standards

Preparation for Admission

High school students planning to enter engineering, engineering technology, or computer science are advised to pursue a program with courses in biology, physics, chemistry, advanced algebra, and trigonometry. The general requirements for admission to the University must be satisfied. Deficiencies in any of these areas may result in an extension of the time required to complete the program. Full-time students can complete any baccalaureate degree in engineering, engineering technology, or computer science in four years.

The curricula are also designed to accommodate students transferring from other colleges or universities. Full-time students who complete two years at a community college can complete the B.S. degrees in two additional years. Transfer students should note and follow, where possible, the appropriate curriculum as outlined in later sections. None of the COE programs are impacted.

Most required courses are offered in multiple sections every semester. In addition, many required courses are also offered during Summer Sessions.

General Academic Requirements

The College of Engineering values good communication skills which are achieved through the General Education courses and are measured by the Graduation Writing Assessment Requirement (GWAR). A student must fulfill the GWAR before qualifying for any degree. Students are advised that, while specific course requirements vary depending on the nature of the subject, most College of Engineering courses require not only detailed analysis, and competent design, but also clear and concise written and oral reports and presentations. ENGL 100 or equivalent is a prerequisite to upper division laboratory courses.

Letter Grade Policy

A grade of "C" or better must be achieved in prerequisites for courses required of Engineering, Computer Science, and Engineering Technology majors.

Required Foundation courses must be taken for a Letter grade only, not Credit/No Credit.

Concurrent and/or Summer Enrollment in Another College

Students who wish to take coursework in a community college or another college or university to meet curricular requirements while enrolled as an undergraduate in the College of Engineering must petition the appropriate department for prior approval to enroll in specific courses. This policy is for either concurrent enrollment or summer enrollment. University policy must also be complied with; see "Concurrent Enrollment" and "Transfer of Undergraduate Credit" in this Catalog. Courses not receiving prior approval may not be accepted for credit by the department.

The Engineering Student Success Center (ESSC)
Interim Coordinator of Academic Advising
   Jason Deutschman (562) 985-2729
Director of Leadership and Diversity
   Emmit Clark (562) 985-1719
Director of Outreach and Recruitment
   Saba Yohannes-Reda (562) 985-1463
Engineering Education Research Associate
   Lily Gossage (562) 985-2498

The Engineering Student Success Center provides key services to students in an inclusive environment that fosters collaboration, community building and academic success skills. The center provides outreach and recruitment activities, first-year experience programs for freshmen and incoming transfer students, mandatory academic advising by professional and peer advisors, tutoring resources, professional development and practice services, and career and graduate school guidance. As a one-stop shop, the center encourages students to visit for help from professional advising staff. The center focuses its full efforts on informing, engaging and encouraging students to be self-directed in their educational planning process and overall academic success.

Undergraduate Programs

Bachelor of Science in Engineering

Option in Audio Engineering (127 units)

Not accepting new students as of Fall 2012

This option is designed to train students for work in the audio engineering industry. The curriculum in the College of the Arts will show students in the program how the arts and entertainment industry uses modern technology in the recording, processing and creation of sound. The curriculum in the College of Engineering will teach students in the program how to analyze and design the electronic and computer components used in the arts and entertainment industry.

As this option is not ABET accredited, students are urged to either take a second major in Computer Engineering (follow the Computer Engineering Track) or Electrical Engineering (follow the Electrical Engineering Track)

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.
First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Computer Engineering Track

Lower Division:
Take the following courses:

- BIOL 207 Human Physiology (4)
  Prerequisites: GE Foundation requirements.

- CECS 174 Intro to Programming & Problem Solving (3)
  Prerequisite: CECS 100 and MATH 113 (or equivalent) with a grade of "C" or better.

- CECS 201 Computer Logic Design I (3)
  Prerequisite: MATH 113 or equivalent with a grade of "C" or better.

- CECS 228 Discrete Structures with Computing Applications I (3)
  Prerequisites: CECS 174 and MATH 113 or equivalent with a grade of "C" or better.

- CECS 274 Object Oriented Programming and Data Structures (3)
  Prerequisite: CECS 174 with a grade of "C" or better.

- EE 210 Electro-Magnetic Foundations in EE (3)
  Prerequisite: PHYS 151 with a grade of "C" or better.

Corequisites: MATH 123, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)

- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

MATH 222 Intermediate Calculus (3)
Prerequisite: A grade of "C" or better in MATH 122.

MUS 190 Listener's Approach to Music (3)
Prerequisites/Corequisites: ENGL 100 or another GE Foundation course.

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 122.

Upper Division:
Take the following courses:

- CECS 301 Computer Logic Design II (3)
  Prerequisites: CECS 174, 201 with a grade of "C" or better.

- CECS 311 Principles of Computer Engineering II (3)
  Prerequisites: CECS 201 and CECS 211 with a grade of "C" or better.

- CECS 326 Operating Systems (3)
  Prerequisites: CECS 282 and either 285 or 346 with a grade of "C" or better.

- CECS 346 Microprocessors and Controllers I (3)
  Prerequisites: CECS 211 and 262 with a grade of "C" or better.

- CECS 347 Microprocessors and Controllers II (3)
  Prerequisites: CECS 301, 311, and 346 with a grade of "C" or better.

- CECS 360 Integrated Circuit Design Software (3)
  Prerequisites: CECS 301, 346, MATH 123 or 222 with a grade of "C" or better.

- CECS 447 Microprocessors and Controllers III (3)
  Prerequisite: CECS 347 with a grade of "C" or better.

- CECS 460 System on Chip Design (3)
  Prerequisite: CECS 360 with a grade of "C" or better.

CECS 497 Directed Studies (3)
Prerequisite: Consent of instructor.

E E 386 Digital Signal Processing (3)
Prerequisites: EE 310 or CECS 301 with a grade of "C" or better.

E E 486 Digital Signal Processing for Multimedia Communications (3)
Prerequisite: EE 386 with a grade of "C" or better or graduate standing.

ENGR 340 Guitar Electronics: Engineering Sound (3)
Prerequisites: Upper division standing, GE Foundation requirements, one course from GE category B.1b.

MATH 323 Introduction to Numerical Analysis (3)
Prerequisites: MATH 222 or 224, and a course in computer programming.

MATH 370A Applied Mathematics (3)
Prerequisite: MATH 123. Not open to Freshmen.

MATH 380 Probability and Statistics (3)
Prerequisite: MATH 222 or 224.

Take three courses from the following:

- FEA 307, THEA 449, EE 428, MUS 370, 455, 456

Take an approved technical elective.

Electrical Engineering Track

Lower Division:
Take the following courses:

- BIOL 207 Human Physiology (4)
  Prerequisites: GE Foundation requirements.

- CECS 100 Critical Thinking in the Digital Information Age (3)
  Prerequisite/Corequisite: ENGL 100 or its equivalent.

- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.

- MATH 224 Calculus III (4)
  Prerequisite: A grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.

- E E 201 Digital Logic Design (4)
  Prerequisite: MATH 117 (or equivalent) with a grade of "C" or better.

- E E 202 Computer Methods in Engineering (3)
  Prerequisites/Corequisites: ENGL 100 or another GE Foundation course.

- E E 210 Electric Circuits Laboratory (1)

- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 122.

Upper Division:
Take the following courses:

- CECS 301 Computer Logic Design II (3)
  Prerequisites: CECS 174, 201 with a grade of "C" or better.

- CECS 311 Principles of Computer Engineering II (3)
  Prerequisites: CECS 201 and CECS 211 with a grade of "C" or better.

- CECS 326 Operating Systems (3)
  Prerequisites: CECS 282 and either 285 or 346 with a grade of "C" or better.

- CECS 346 Microprocessors and Controllers I (3)
  Prerequisites: CECS 211 and 262 with a grade of "C" or better.

- CECS 347 Microprocessors and Controllers II (3)
  Prerequisites: CECS 301, 311, and 346 with a grade of "C" or better.

- CECS 360 Integrated Circuit Design Software (3)
  Prerequisites: CECS 301, 346, MATH 123 or 222 with a grade of "C" or better.

- CECS 447 Microprocessors and Controllers III (3)
  Prerequisite: CECS 347 with a grade of "C" or better.

- CECS 460 System on Chip Design (3)
  Prerequisite: CECS 360 with a grade of "C" or better.

- CECS 497 Directed Studies (3)
  Prerequisite: Consent of instructor.

- E E 386 Digital Signal Processing (3)
  Prerequisites: EE 310 or CECS 301 with a grade of "C" or better.

- E E 486 Digital Signal Processing for Multimedia Communications (3)
  Prerequisite: EE 386 with a grade of "C" or better or graduate standing.

- ENGR 340 Guitar Electronics: Engineering Sound (3)
  Prerequisites: Upper division standing, GE Foundation requirements, one course from GE category B.1b.

- MATH 323 Introduction to Numerical Analysis (3)
  Prerequisites: MATH 222 or 224, and a course in computer programming.

- MATH 370A Applied Mathematics (3)
  Prerequisite: MATH 123. Not open to Freshmen.

- MATH 380 Probability and Statistics (3)
  Prerequisite: MATH 222 or 224.

Take three courses from the following:

- FEA 307, THEA 449, EE 428, MUS 370, 455, 456

Take an approved technical elective.
Bachelor of Arts in Engineering Systems (120 units)

Program Director: Tracy Bradley Maples

The Bachelor of Arts in Engineering Systems provides students with an opportunity to study engineering in an interdisciplinary environment. This program combines a core engineering program with two options and course work and programs in business, communications, design, economics, or language.

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of “C” or better must be achieved in MATH 111 and 113 within one calendar year.
Transfer Students: A grade of “C” or better must be achieved in MATH 122 within one calendar year.

Requirements

Core

Thirty-one units required. Take all of the following:

CECS 100 Critical Thinking in the Digital Information Age (3)
Prerequisite/Corequisite: ENGL 100 or equivalent.

CECS 174 Introduction to Programming and Problem Solving (3)
Prerequisite: CECS 100 and MATH 113 (or equivalent) with a grade of “C” or better.

CECS 202 The Digital Information Age (3)
Prerequisite: GE Foundation requirements.

CECS 312 Introduction to Distributed Operating Systems (3)
Prerequisite: CECS 174 with a grade of “C” or better.

CECS 414 Introduction to Network and System Security Issues (3)
Prerequisites: CECS 174 with a grade of “C” or better.

ENGR 203 Engineering Problems and Analysis (3)
Prerequisite: MATH 122 with a grade of “C” or better; Corequisite: ENGR 203L.

ENGR 310 Business Communications in Engineering Profession (3)
Prerequisites: ENGL 100, COMM 110 with a grade of “C” or better.

ENGR 498 Engineering Systems Senior Project (3)
Prerequisite: Senior Standing.

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of “C” or better in MATH 111 and 113, or a grade of “C” or better in MATH 117.

Take one of the following:

EE 403 Systems Engineering (3)
Prerequisites: ENGR 203 or EE 202 with a grade of “C” or better, or graduate standing.

EE 380 Probability, Statistics & Stochastic Modeling (3)
Prerequisites: MATH 122; (CECS 100 or equivalent) with a grade of “C” or better.

Select one of the following emphases (31 units)

Emphasis in Systems and Security
Take all of the following:

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 122.

CECS 110 Web Design I (3)
Prerequisites: None.

CECS 200 Web Design II (3)
Prerequisite: CECS 110 with a grade of “C” or better.

CECS 410 Computers and Networks (3)
Prerequisite: Course design assumes familiarity with computers.

CECS 412 Introduction to Computer Network Architectures (3)
Prerequisite: Familiarity with computers.

Upper Division:
Take the following courses:

CE 370 Analytical Mechanics (3)
Prerequisites: PHYS 151 with a grade of "C" or better; Prerequisite/Corequisite: MATH 123.

EE 310 Signals and Systems (3)
Prerequisites: EE211; and MATH 370A or equivalent with a grade of “C” or better.

EE 330 Analog Electronic Circuits I (4)
Prerequisite: EE 211 with a grade of “C” or better.

EE 346 Microprocessor Principles and Application (3)
Prerequisites: EE 201, (CECS 100 or equivalent) with a grade of “C” or better.

EE 360 Electromagnetic Fields (3)
Prerequisites: MATH 224, EE 310 with a grade of “C” or better.

EE 370 Control Systems (3)
Prerequisite: EE 310 with a grade of “C” or better.

EE 370L Control Systems Laboratory (1)
Prerequisite/Corequisite: EE 370.

EE 382 Communications Systems I (3)
Prerequisite: EE 310 with a grade of “C” or better.

EE 386 Digital Signal Processing (3)
Prerequisites: EE 310 or CECS 301 with a grade of “C” or better.

EE 430 Analog Electronic Circuits II (3)
Prerequisites: EE 330 and 370 with a grade of “C” or better, or graduate standing.

EE 444 Microprocessor Based System Design (3)
Prerequisites: EE 346 with a grade of “C” or better or graduate standing.

EE 486 Digital Signal Processing for Multimedia Communications (3)
Prerequisite: EE 386 with a grade of “C” or better or graduate standing.

ENGR 340 Guitar Electronics: Engineering Sound (3)
Prerequisites: Upper division standing, GE Foundation requirements, one course from G.E. category B1b.

MATH 370A Applied Mathematics I (3)
Prerequisites: MATH 123. Not open to Freshmen.

Take one of the following courses:

EE 489 Digital Signal Processing Design (3)
Prerequisites/Corequisites: (EE 400D and 486) or graduate standing.

EE 490 Special Problems (3)
Prerequisites: Minimum G.P.A. of 2.5 and consent of instructor.

Take three courses from the following:

FEA 307, THEA 449, EE 428, MUS 370, 455, 456
Take an approved technical elective.
ENGR 302I Energy and Environment: A Global Perspective (3)
Prerequisites: G.E. Foundation requirements, one or more Exploration courses, and upper-division standing.

ENGR 350 Computers, Ethics and Society (3)
Prerequisites: 3 units from GE Category A.1 (Writing) and 3 units from GE Category D (Social and Behavioral Science).

Take 9 units of approved engineering and non-engineering courses (see program advisor for a detailed list of courses)

Emphasis in Systems Engineering
Take all of the following:
MATH 123 Calculus II (4)
Prerequisite: A grade of "C" or better in MATH 122.
CECS 271 Introduction to Numerical Methods (3)
Prerequisites: CECS 174 and MATH 123 with a grade of "C" or better.
CECS 345 Fundamentals of Embedded Systems (3)
Prerequisite: CECS 202 with a grade of "C" or better.
ENGR 432 Logistics Systems Engineering (3)
Prerequisite: Consent of instructor.
CE 406 Cost Engineering and Analysis (3)
Prerequisite: GE Foundation requirements.
EE 402 Engineering Modeling and Simulation (3)
Prerequisite: EE 380 with a grade of "C" or better.

Take one of the following:
EE 380 Probability, Statistics & Stochastic Modeling (3)
Prerequisites: MATH 122; (CECS 100 or equivalent) with a grade of "C" or better.
EE 403 Systems Engineering (3)
Prerequisites: ENGR 203 or EE 202 with a grade of "C" or better, or graduate standing.

Take 9 units of approved engineering and non-engineering courses (see program advisor for detailed list of courses)

Take 24 units of non-engineering courses with advisor's consent:
- Business (e.g., Finance, Information Systems, Operations Management)
- Communication Studies
- Design
- Economics
- Foreign language

Take approved engineering and non-engineering courses to reach a total of 120 units including 40 upper division units (see program advisor for a detailed list of courses)

Minor in Environmental Engineering
This 18-unit interdisciplinary minor is designed for undergraduates from various engineering and science backgrounds who are interested in applying engineering approaches to environmental issues.

Requirements
A minimum of 6 units selected from the following core:
Take one of the following courses:
C E 364 Environmental Engineering I: Fundamentals (3)
Prerequisites: CHEM 111A, BIOL 200/MICR 200 with a grade of "C" or better,
Prerequisite/Corequisite: CE 335.

CH E 475 Environmental Pollution (3)
Prerequisite: CHEM 320A or 327 with a grade of "C" or better, or consent of instructor.

Take the following course:
CH E 455 Environmental Compliance (3)
Prerequisite: CHEM 327 with a grade of "C" or better or consent of instructor.

Take 12 units from the following:
CH E 415, 445, 465, 485; C E 466; E T 409F, 476

Most of the courses in the minor require some background in engineering and/or chemistry. Upper division students majoring in Biology, Chemistry, Chemical Engineering, Civil Engineering, or Mechanical Engineering may have sufficient background to select from the above choices without needing additional prerequisites. Those majoring in other branches of science and engineering may need several additional courses in engineering and/or chemistry to meet prerequisite requirements of courses in this minor.

All prerequisites to the courses in the minor must be completed with a grade of "C" or better.

Graduate Programs

Master of Science in Engineering
Program Director: Burkhard Englert

Typical tasks and responsibilities undertaken by students in the curriculum for this program would not fall within one of the traditional specialties in engineering, e.g. aerospace, chemical, civil, electrical and mechanical engineering, or computer science and engineering. The student may pursue an interdisciplinary program, approved by a graduate advisor, by selecting courses from the various departments of engineering. For information concerning the programs, special facilities, laboratories and research possibilities, contact the College of Engineering.

Prerequisites
1. A bachelor’s degree in an ABET accredited curriculum in engineering with a minimum GPA of 2.7; or
2. A bachelor’s degree with a minimum GPA of 2.7 in engineering, mathematics, natural science or other discipline with the requirement that essential undergraduate prerequisites in engineering are satisfied.
3. The general Graduate Record Examination (GRE) is required.
4. Graduate students must consult with a graduate advisor, with whom they will be working, for information concerning procedures and requirements for appropriate approval of their courses of study prior to enrolling in their graduate programs.
5. The Graduation Writing Assessment Requirement (GWAR) must be met during the first semester in residence. Failure to attempt to fulfill the GWAR during the first semester will prevent registration in engineering courses in subsequent semesters.

Requirements
1. Completion of a minimum of 30 units beyond the bachelor’s degree in upper division and approved graduate courses, including:
   A. A minimum of 18 units of 500- and/or 600-level courses in engineering;
B. Six units of electives selected from approved upper division (400-level) or graduate courses from appropriate areas;

C. Completion of an acceptable thesis or project and/or comprehensive examination.

Note: Students are strongly advised to read and be familiar with the campus regulations described under “Graduate Programs” elsewhere in this catalog.

**Advancement to Candidacy**

Students applying for advancement to candidacy must have:

1. completed all undergraduate deficiencies with grades of “C” or better;
2. attained an overall grade point average of (GPA) or 3.0;
3. completed at least 12 units applicable to the degree with a GPA of at least 3.0;
4. fulfilled the Graduation Writing Assessment Requirement (GWAR). This requirement can also be met by presenting evidence that the student met the requirement while an undergraduate at CSULB or at certain CSU campuses;
5. program of studies approved by the program’s graduate advisor.

**Graduate Certificate in Systems Engineering**

Not accepting new students as of Fall 2012. This 18-unit post-baccalaureate certificate is focused toward development and management of complex systems. Each such complex system requires a clear Systems Engineering Master Plan, a set of methodologies, appropriate tools, a rigorous requirements flow-down technique, and a comprehensive Project Management Plan to enable system design and project management for effective and efficient human interaction.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirement**

1. Completion of an accredited baccalaureate degree in engineering or equivalent;
2. Satisfactory completion of 18 units listed below;
3. File a program application card with Admissions and Records, and file for the Certificate at least one semester prior to completion;
4. The Certificate may be awarded concurrently or subsequently to baccalaureate degree.

**Required Courses**

The Certificate Program requires a minimum of 18 semester units, as indicated below.

1. System Engineering Core Courses, 6 units of the following:
   - EE 503 Advanced Systems Engineering (3)
     Prerequisite: EE 411 or equivalent mathematical maturity with a grade of "C" or better.
   - MAE 508 Systems Engineering and Integration (3)
     Prerequisite: Senior standing with a grade of "C" or better or consent of instructor.

2. Engineering Management Courses, 6 units from the following:
   - CECS 521 Database Architecture (3)
     Prerequisites: CECS 328 and 323 or 421 with a grade of "C" or better.

   - MAE 506 Management of Engineering Technology and Innovation (3)
     Prerequisite: Graduate engineering standing.
   - MAE 507 Engineering Project Management (3)
     Prerequisite: Graduate engineering standing.

3. Manufacturing Courses, 3 units of the following:
   - MAE 574 Computer-Aided Manufacturing (3)
     Prerequisites: MAE 322, 490A with a grade of "C" or better.

4. Advanced Engineering Mathematics/Analysis Courses, 3 units from the following:
   - EE 502 Engineering Modeling and Simulation (3)
     Prerequisite: EE 380 with a grade of "C" or better.
   - EE 505 Advanced Engineering Mathematics for Electrical Engineers (3)
     Prerequisites: Consent of instructor.
   - EE 508 Probability Theory & Random Processes (3)
     Prerequisite: EE 380 with a grade of "C" or better.
   - MAE 501 Engineering Analysis I (3)
     Prerequisite: MATH 370A with a grade of "C" or better.
   - MAE 502 Engineering Analysis II (3)
     Prerequisite: MAE 501 with a grade of "C" or better.

**Ph.D. in Engineering and Industrial Applied Mathematics**

Program Director: Burkhard Englert

**Degree Designation**

In accordance with an agreement between Claremont Graduate University and CSULB, the degree is granted at Claremont Graduate University in the name of the two universities. The diploma indicates the dual nature of the degree and specifies that it is granted only when requirements have been satisfied in both subject areas as specified by the collaborating institutions.

**Program Supervision**

Overall program supervision is the responsibility of the Program Committee, consisting of the directors of the Joint Doctoral Program (JDP) from each institution, the Dean of Mathematics at CGU, and the Dean of Engineering at CSULB.

**Admission Requirements**

Students must be admitted to both institutions jointly. Admission will be granted to a limited number of qualified students; therefore, application should be made as early as possible. Applications are encouraged from both men and women, particularly from members of minority groups or individuals with disabilities. Completed applications must be received by April 1 for the fall semester or October 1 for the spring semester, although late applications are allowed at the discretion of the Program Committee. The Program Committee is responsible for making admission decisions consistent with campus regulations (see Application Procedure in this booklet).

To be admitted to the Joint Doctoral Program, an applicant must have received a bachelor’s or master’s degree in science, engineering, or mathematics from an accredited institution. Moreover, he or she must have attained scholastic records and present confidential recommendations which indicate that he or she is well qualified to pursue, with distinction, advanced study and research. Be advised that admission may be refused solely on the basis of limited facilities in the option desired.
GRE Requirement

The analytical, verbal, and quantitative portion of the Graduate Record Examination (GRE) is required before admission. GRE subject examinations (mathematics and engineering) are not required. Applicants whose first or native language is not English are required to have a current minimum score of 550 (213 on the new scale) on the Test of English as a Foreign Language (TOEFL); however, this requirement is waived for students with a bachelor’s or master’s degree from an accredited U. S. university.

Registration and Enrollment

It is important that students register and enroll in classes each semester at either CGU or CSULB. Failure to enroll at any given semester will be considered leave without permission (discontinued enrollment) and the student will be dropped from the program.

Program Planning and Supervision

At CSULB, an initial engineering advisor is assigned to the student at the time of admission. At CGU, the student needs to arrange with the program director, within the first semester of study, for a mathematics advisor. The student’s program of study is arranged individually in collaboration with their advisors, the two advisors confer periodically regarding the student’s progress. The Program Committee monitors the student’s overall performance.

Course Work and Examinations

A minimum 72 units of course work, independent study, and research (including transfer credit) must be completed. Transfer credit of up to 24 units of related courses at the master’s level is permissible on approval of the Program Committee; this course work must have been completed with at least a grade of "B" or better, at an accredited institution, and must be directly related to the joint program and the student’s goals. Of the 72 units, a minimum of 24 units must be completed in the graduate engineering program at CSULB and a minimum of 24 units in the graduate mathematics program at CGU. Both sets of 24 units must conform to the area requirements of the relevant institution and must be approved by the Program Committee. All degree requirements must be completed within seven years (or six with the transfer of 24 units according to CGU regulations) from the time a student begins graduate study.

Every doctoral student must maintain a cumulative grade-point average (GPA) of 3.0 and a grade-point average of 3.0 in all courses applicable to the degree. Furthermore, students must earn at least a grade of "B" or better in any course that is counted towards the course work requirement. Students are put on academic probation if they fail to maintain a cumulative or term GPA of at least 3.0 in all units attempted subsequent to admission to the degree program. After two consecutive semesters on probation, students are subject to disqualification if they fail to earn sufficient grade points to be removed from the probationary status.

CSULB Course Requirement

The only specific CSULB course requirement is four units of Engr 796 Doctoral Seminar (2). The remaining 20 units, for students who have received transfer credit, may include courses needed for the Preliminary Examinations (see the Preliminary Examination section of this handbook), Doctoral Dissertation, Advanced Special Topics, and Advanced Directed Studies. Presently, students are permitted to count the following courses in addition to the regular graduate courses, offered by the five engineering departments, towards meeting the CSULB 24-unit course requirement.

- ENGR 790: Advanced Special Topics in Engineering
  - Prerequisites: MS or equivalent and formally admitted to the Ph.D. program.
- ENGR 795 or MAE 795: Advanced Directed Studies
- ENGR 796: Doctoral Seminar (4 units required)
  - Prerequisite: Graduate Standing.
- ENGR 798 or MAE 798: Doctoral Dissertation (4 units allowed)

Minimum Student Load Per Semester

It is highly recommended that doctoral students enroll in at least 9.0 units per semester in order to demonstrate progress towards the degree. The CSULB director of the program, in consultation with the doctoral advisor, may require that a student take at least 9.0 units per semester if the student is not showing adequate progress.

These courses may include the following:

- ENGR 797A Preparation for Ph.D. Preliminary Examinations
  - Prerequisite: Graduate Standing.
- ENGR 797B Preparation for Ph.D. Qualifying Examination
  - Prerequisite: Graduate Standing.

Students may take from 4.0 to 12.0 units of ENGR 797A or ENGR 797B each semester, though these courses may not be used to fulfill the 72-unit course work. Both of these courses are offered on Credit/No Credit bases and are designed to formally recognize the students' efforts towards the program.

Residency Requirements

Doctoral students must complete their program within a period of seven years (or six with the transfer of 24 units) according to CGU regulations (see below). During this time, a minimum of 72 units of course work, independent study, and research (including transfer credit) must be completed. Normally no more than 16 units per semester may be credited toward the degree. No more than 12 units per summer session may be credited toward the degree. The transfer of credit form is available on the CGU website. The Program Committee will consider petitions for extensions and/or exemptions.

All degree requirements must be completed within seven years from the time a student begins graduate study. Work for which transfer credit is granted will be counted as part of the seven years, e.g., if transfer credit of 24 units (one year) is granted, the time limit will be six years.

The residency requirements for the Ph.D. may be met either by two semesters of full-time study in a 24-month period or by the completion of 48 units of course work within a 48-month period (including work in the summer session). There are special provisions for students transferring units as described below.

Students who receive transfer credit for 12 units or less
may meet the residency requirement either by completing two full-time semesters of course work within a 24-month period or by completing 36 units within a 48-month period. Those receiving transfer credit for 13 to 24 units may meet the residency requirement by completing 24 units within a 36-month period. The seven-year maximum time period for the Ph.D. degree is reduced by six months for 12 units or less of transfer credit and by 12 months for 13 to 24 units of transfer credit.

Plan of Study

After consultation with their advisors, students are required, before the end of the first year, to prepare and file with the Program Committee a Plan of Study for completing the course requirements for the degree. The purpose of the Plan of Study is to ensure that the student is aware of the requirements for the degree. The Plan of Study should indicate the areas of study that the student will be taking in preparation for the preliminary examinations. In consultation with the student’s advisor and Program Committee, the Plan of Study may be altered at a subsequent time by petition.

If a student withdraws from the program after completing a substantial portion of the course work, a master’s degree at either or both institutions is still possible by satisfaction of the appropriate requirements. Both CGU and CSULB require 30-36 semester units of course work for master’s degrees.

Preliminary Examinations

The student is required to pass written preliminary examinations. These examinations consist of four examination areas: two in engineering and two in mathematics. These examinations should be taken immediately after completion of the relevant course work at each institution. These examinations are given two or three times a year at the discretion and under the control of the Program Committee. Should a student fail an examination, they may petition the Program Committee for one retake.

Before taking the first preliminary examination, the student is required to complete the Preliminary Examination Permission Form (available at the CSULB website, www.csulb.edu/colleges/coe, or at the CGU site, www.cgu.edu/math). This form requires the student to specify the four areas of the Preliminary Examination; the student’s intended dissertation advisor and the directors of the Joint Doctoral Program must sign it. The purpose of this form is to certify that the student and dissertation advisor are in agreement on the set of examinations. If, in the course of time, this set of examinations and/or the advisor is amended, the form must be resubmitted. The preliminary examinations are considered completed when the four examinations specified on the student’s form have been successfully passed. You must be enrolled at CSULB (e.g., enrolling in at least 4.0 units of 797A) in order to take the CSULB portion of the Preliminary Examinations. For a list of courses, please review the student handbook at our web site www.csulb.edu/coe/phd

Research Tool

Students in the Joint Doctoral Program must demonstrate proficiency in problem-solving ability using computer programs. This demonstration may take different forms depending on the student's engineering sub-discipline, but must include evidence that the student has used an appropriate computer language and an algorithmic method to solve a problem from an engineering discipline.

Research and Dissertation

Upon completion of at least 48 units of course work (including transfer units), the preliminary examinations, and the research tool requirement, a student embarks on the research phase of the Joint Doctoral Program. In preparation for the research phase, the student is expected to spend at least a semester in advanced graduate courses, seminars, or directed reading courses where exposure to research material is emphasized. From these and other sources, the student gains the ability to understand the motivation for research in engineering and applied mathematics and learns to apply research techniques.

Doctoral Committee

During entry to the program and through the period of the main body of course work at CGU and CSULB, the Program Committee will monitor the student’s progress. Upon successful completion of the preliminary examinations, the student petitions the Program Committee to constitute the Doctoral Committee. The student chooses this committee with advice from the faculty advisor and with approval of the Program Committee. The committee must include at least two faculty members each from CGU and CSULB; it must also provide breadth and depth in mathematics and engineering in the chosen faculty members. The Doctoral Committee supervises the student’s progress through research preparation and dissertation writing; it also administers the qualifying and oral examinations for the degree. The chair of the Doctoral Committee is the dissertation supervisor.

Research Proposal and Qualifying Examination

With these advanced courses as background, and with the guidance of the Doctoral Committee, the student defines an area of proposed research and prepares a written Dissertation Proposal containing an outline of the research to be undertaken and references to relevant source materials. The Dissertation Proposal is presented to the Doctoral Committee at least two weeks prior to the Qualifying Examination. The appropriate form under “Doctoral Degree Forms” can be obtained from the CGU website www.cgu.edu (under Current Students, Registrar Information). The Qualifying Examination is an oral presentation to the Doctoral Committee describing the planned research. The student is expected to present evidence both as to the mathematical content and to the engineering application of the proposed research, supporting such evidence with references to previous research in both areas. The Doctoral Committee judges the fitness and quality of the Dissertation Proposal from this presentation and from the written proposal. It subsequently communicates its recommendations to the Program Committee. Only upon a positive recommendation may the student embark on a dissertation. In the event of failure, the qualifying examination may be retaken once after petition to the Program Committee.
Advancement to Candidacy

After successful completion of the Qualifying Examination and certification that all other requirements are fulfilled, the student is advanced to candidacy. The appropriate form under “Doctoral Degree Forms” may be obtained from the CGU website. This must occur at least six months before the Final Oral Defense.

Dissertation and Final Oral Examination

Upon completion of the research, the student will prepare the dissertation in accordance with CGU regulations. A final draft of the dissertation will be presented to each member of the Doctoral Committee at least three weeks prior to the final oral examination. The appropriate form under “Doctoral Degree Forms,” along with an abstract of the dissertation, must be filed with CGU’s Office of Admission and Records three weeks before the exam. This deadline is very strict and no exceptions will be made. Please see the CGU website under “Academic Calendar” for the final defense scheduling dates. The oral defense will normally be held on the campus of the dissertation supervisor.

Policies and Procedures

1. Throughout their entire program of study, unit-taking students must be registered at either CGU or CSULB. Students, who intend not to take course work at either institution, including those who have finished their required units, must take the necessary steps to maintain continuous enrollment. This is achieved by registering for Math 499 (Doctoral Study) at Claremont Graduate University or by registering for Engineering 798 (Doctoral Dissertation) at California State University, Long Beach. At least two semesters of registration for Math 499 at CGU must be maintained during the last year prior to graduation. In order for the degree to be conferred, a student must meet all regulations as stated in the CGU Bulletin under “Degree Regulations.”

Requests for leave of absence must be submitted to each registrar’s office and approved by both institutions according to the standards of each; upon approval of leave the student should advise the math office at CGU and the office of the Joint Doctoral Program at CSULB. Students should contact each registrar’s office for leave of absence policies. If the student fails to advise the registrar at CGU of his/her leave granted by CSULB, he/she will be dropped from the program (CGU has no official arrangement for leaves). Upon return, the student will be required to pay CGU a reinstatement fee in addition to regular semester tuition.

2. International students registered for units at CSULB must provide the CGU International Student Advisor, Nusha Shishegar, with proof of registration within two weeks of the beginning of the semester at CGU. Proof of full-time registration (8 units minimum) is required to maintain immigration status. (In the circumstance of completion of units, registration in Doctoral Study, CGU Math 499, is required.)

3. Students should arrange for advisors, one in math at CGU and one in engineering at CSULB, at the earliest opportunity. The program committee will help provide advisors.

4. After consultation with their advisors, students must submit a plan of study, including a petition for transfer of credits, if applicable, during their first year of study. The Plan of Study must be approved and transfer of units recommended to the Registrar by the program committee.

Procedures for Student Admission

1. Students must complete application forms for both CGU and CSULB. The completed application package must include official transcripts, three letters of reference (preferably on the forms supplied in the CGU package), a personal statement and a resume. Current, official GRE scores are required. Scores may not be older than 5 years.

2. The completed application package (including a separate Long Beach fee and application) must be submitted to the CGU Admissions Office, 160 East Tenth Street, Claremont, CA 91711-6163. Do not send application materials to CSULB as this will result in considerable delay. Both application fees are required.

3. Online applications are acceptable for the Joint Program; however, consult the Program Advisors at CGU and CSULB for appropriate procedures.

4. The CGU director of the CSULB/CGU Joint Doctoral Program, Ellis Cumberbatch, reviews completed files. In the event of a negative review, a rejection letter is issued by CGU. In the event of a positive review, the application, along with a copy of the completed file, is forwarded to the CSULB director of the CSULB/CGU Joint Doctoral Program, Dr. Mahyar Amouzegar.

5. Results of the Long Beach review are transmitted back to CGU Math. Upon a positive review by CSULB, the application and fee are sent to the CSULB Admissions Office to be processed. A negative review initiates a rejection letter from CGU.

6. Upon admission to the program, CGU will generate two admission letters; one is mailed to the student and one is sent to CSULB. This letter includes a decision card and specifies a required $200 tuition deposit that should be submitted to CGU if the student chooses to accept the offer of admission.

7. Students admitted to provisional status must provide the materials needed to complete their files before the end of their first semester of enrollment. Official scores for the GRE General Test are required of all students before admission to full graduate standing. The joint faculty program committee will review completed files for change of status.

8. The academic progress of students admitted to conditional status will be reviewed by the program committee prior to a decision about change of status.

Courses (ENGR)

LOWER DIVISION

100. Fundamentals of Engineering Analysis (4)
Prerequisites: Appropriate ELM score, ELM exemption, or MAPB11.
Use of an application-oriented, hands-on approach to math topics in a variety of core engineering courses; analysis of experimental data; applications of MATLAB in solving engineering problems.
Letter grading only (A-F). (Lecture 3 hours, Laboratory 3 hours)
101. Introduction to the Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122
Freshman orientation seminar on careers in engineering. Speakers from various fields illustrate opportunities and challenges in the engineering profession.
(Lecture-problems 1 hour) Letter grade only (A-F).

102. Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.
Development of skills and identification of strengths and weaknesses for success in a COE major.
(Lecture 1 hour). Letter grade only (A-F).

123. Inventions and Innovations: Good, Bad, and Weird (3)
Use of language, thought, and logic in science, distinguishing scientific fact from science fiction. Critical review of technological achievements from ancient times to the present, from practical inventions to perpetual motion machines. Science, pseudoscience, and paranormal. Experimentation and witchcraft.
(Lecture-Problems 3 hours)

130. Health, Energy, Environment, Transportation (HEET) (3)
Prerequisites: Completion of high school classes in geometry, algebra, chemistry, and environmental sciences.
Introductory course in healthy environment requirements, renewable energy, elements green design, transport systems and management, economics, environmental impacts of transportation. Hybrid, module-based class, with simulations, interact exercises, design projects and assessments renewable energy, green design, water resources, and air quality.
Letter grade only (A-F). (Lecture 3 hours)

170. Introduction to Solid Modeling and Engineering Graphics (2)
Prerequisites: Knowledge of geometry and intermediate algebra.
Introduction to part modeling, solid models, detail drawings with dimensioning and assembly modeling using SolidWorks software. Focuses on project-based learning, which organizes learning around complete projects.
Letter grade only (A-F). (Lecture-problems 1 hour, Lab 2 hours)

203. Engineering Problems and Analysis (3)
Prerequisite: MATH 122 with a grade of "C" or better; Corequisite: ENGR 203L
Formulation of engineering problems and methods for their analysis. Application of vectors, matrices, derivatives and integration into engineering problems. Computer aided analysis using MATLAB, MathCad, etc.
(Lecture - Problems hours) Letter grade only (A-F).

203L. Engineering Problems and Analysis Laboratory (1)
Prerequisite: MATH 122 with a grade of "C" or better; Corequisite: ENGR 203
Computer-based exercises on fundamental concepts such as vectors, matrices, derivatives, integrals. Practical engineering problems are assigned and solved using MATLAB.
(Laboratory 3 hours) Letter grade only (A-F).

UPPER DIVISION

302I. Energy and Environment: A Global Perspective (3)
Prerequisites: G.E. Foundation requirements, one or more Exploration courses, and upper-division standing.
Renewable/nonrenewable energy sources, including fossil fuels, nuclear, solar, wind, wave, geothermal, hydroelectric and biomass. Available resources, market, trends, and technology. Energy conservation, balance, alternatives, social, cultural, and political impacts. Ecosystem, human-induced climate changes.
Environment and power generation, pollution, ozone depletion. Recycling.
(Lecture-Problem 3 hours) Letter grade only (A-F).

310. Business Communications in Engineering Profession (3)
Prerequisites: ENGL 100, COMM 110 all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-Problem 3 hours) May be used to satisfy the GWAR. Students who have failed the WPE at least once can take the course and submit a portfolio at the end for GWAR credit that will be issued if the student passes the portfolio that is reviewed by a committee.

340. Guitar Electronics: Engineering Sound (3)
Prerequisites: Upper division standing, GE Foundation requirements, one course from G.E. category B1 and 3 units from GE Category D (Social and Behavioral Science).
Historical review of electro-magnetic principles and their application to the reproduction, modification, and creation of sound. The electric guitar, its amplifiers, and special effects devices (analog and digital) will be used to gain practical experience. Electrical safety, physiology and physics of the ear.
Not open for credit to students with credit in EE 333. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

350. Computers, Ethics and Society (3)
Prerequisites: 3 units from GE Category A.1 (Writing) and 3 units from GE Category D (Social and Behavioral Science).
Examination of the social impact of information technologies. Topics include a survey of the technology (software, hardware and key applications), ethical obligations of specialists, the computer in the workplace, shifts of power, privacy, and legal issues related to computing.
(Lecture-problems 3 hrs)

360. Robotic Technology in Health Care (3)
Explores various robotic innovations developed for biomedical applications and their global impact on the quality of patient care, economy, and policy through new methods and tools for diagnosis and treatment, clinical training, education, and rehabilitation.
Letter grade only (A-F). (Lecture-Problems 3 hours)

370L. Astronautics and Space (3)
Prerequisites: GE Foundation requirements, one or more Exploration courses, and upper-division standing.
Combines the disciplines of space engineering with economics, human physiology, satellite meteorology, earth resources and environmental science, astronautics and space exploration.
Emphasis on oral and written communications, numeracy and use of computers. Extensive use of computer animation, videographics and the Internet.
(Lecture–problems 3 hours) Letter grade only (A-F).

388. Engineering for Elementary School Teachers (3)
Developing and fabricating teaching aids and integrated hands-on projects for elementary schools. Basic skill in teaching engineering and technology in the elementary grades.
(Lecture 2 hours, Laboratory 3 hours)

392. Water: People, Politics, and Processes (3)
Prerequisite: GE Foundation requirements.
Explores the impact of water resources management on society, economy, and governance through socio-political and hydrological overviews as well as both domestic and international case studies.
Letter grade only (A-F). Same course as I/ST 350. Not open for credit to students with credit in I/ST 350. (Lecture-Problems 3 hours)
Courses (ENGR)

432./532. Logistics Systems Engineering (3)
Prerequisite: Consent of instructor.
Logistics concepts, methods and techniques for engineering. Logistics from a historical perspective, the economic impact of logistics, the engineering tool chest, and logistics as an integrating function. Logistics systems requirements and design; transportation and distribution, inventory analysis and operational support.
(Lecture-problems 3 hours) Letter grade only (A-F).

492B. Internship in Engineering (3)
Prerequisites: Major in the College of Engineering, completion of 9 units of upper division COE coursework, a 2.5 GPA overall or 2.75 GPA in the student’s major, and consent of instructor prior to registration.
Qualifying students must provide contact information for the major- or career-related assignment in private industry or in public agencies for which the course is being used. The position may be either a volunteer or paid work assignment. The instructor is required to visit the work site. Learning assignments will be arranged through the Career Development Center and the instructor. Final written report required.
Minimum of 120 hours of field experience required. Credit/No Credit grading only. May be repeated to a maximum of 6 units in different semesters. (Activity 6 hours)

498. Engineering Systems Senior Project (3)
Prerequisite: Senior Standing.
Senior Project in Engineering Systems. Design and development of a senior project. Presentation of oral and written report.
(Seminar 3 hours) Letter grade only (A-F).

GRADUATE LEVEL

511. Quality Assurance in Manufacturing (3)
Prerequisites: CE 406 with a grade of "C" or better or consent of instructor, and graduate standing.
In-depth studies of planning for quality, productivity and competitive positioning in manufacturing. Understanding the TQM process. Inspection and standardization and product reliability strategies. Case study projects.
Letter grade only (A-F). (Lecture-problems 3 hours)

532./432. Logistics Systems Engineering (3)
Prerequisite: Consent of instructor.
Logistics concepts, methods and techniques for engineering. Logistics from a historical perspective, the economic impact of logistics, the engineering tool chest, and logistics as an integrating function. Logistics systems requirements and design; transportation and distribution, inventory analysis and operational support.
(Lecture-problems 3 hours) Letter grade only (A-F).

790. Selected Topics in Engineering (1-4)
Prerequisites: MS or equivalent and formally admitted to the Ph.D. program.
Each offering is based on an area of engineering in which recent advances have been made.
Letter grade only (A-F). Topics announced in the Schedule of Classes.

795. Advanced Directed Studies (4)
Explorations of theoretical and experimental (if applicable) engineering problems in great depth with emphasis on mathematical modeling and analysis. Students must present the findings in a formal report and a seminar.
Letter grade only (A-F).

796. Doctoral Seminar (2)
Prerequisite: Graduate Standing.
Research seminar on advanced technical fields.
May be repeated to a maximum of 4 units in different semesters. (Seminar 2 hours) Letter grade only (A-F).

797A. Preparation for Ph.D. Preliminary Examinations (4-12)
Prerequisite: Graduate Standing.
Tutorial. Limited to doctoral students who are preparing for the preliminary examinations.
ENGR 797A does not count towards the 48 units of course requirement. Credit/No Credit grading only.

797B. Preparation for Ph.D. Qualifying Examination (4-12)
Prerequisite: Graduate Standing.
Tutorial. Limited to doctoral students who are preparing for the qualifying examination.
ENGR 797B does not count towards the 48 units of course requirement. Credit/No Credit grading only.

797C. Research for Ph.D. Dissertation (4-12)
Prerequisite: Graduate Standing. Tutorial. Limited to doctoral students who are preparing or working on the dissertation research. ENGR 797C does not count towards the 48 units of course requirement. Credit/No Credit grading only.

798. Doctoral Dissertation (4-12)
Prerequisites: Successful completion of the Ph.D. preliminary examinations, research tool test, and at least 48 units of course work. A written dissertation proposal containing an outline of the research to be undertaken and references to relevant source material must be submitted. Only upon a positive recommendation a student may embark on a dissertation.
Letter grade only (A-F).

Courses (MSEM)

UPPER DIVISION

406B. Engineering Economy and Administration (3)
Prerequisite/Corequisite: ECON 300 or consent of instructor.
Engineering management principles and economic analysis: with time value of money, after-tax analysis for rate of return. Graduate students will be required to do an additional assignment.
Letter grade only (A-F).

GRADUATE LEVEL

506B. Management of Engineering Technology and Innovation (3)
Prerequisite: Graduate engineering standing.
Analysis of the principles and theory of engineering administrative organizations, information systems, management functions, decision making tools, strategies and administrative policy formulations.
Letter grade only (A-F).

507B. Engineering Project Management (3)
Prerequisite: Graduate engineering standing.
Theory and philosophies of project management, principles of internal and industrial organization planning and control systems, motion in time study, industrial statistics, industrial research as aid to decision making.
Letter grade only (A-F).
508B. Systems Engineering and Integration (3)
Prerequisite: Senior standing or consent of instructor.
Introduction to the tools and methods employed by systems engineers in the aerospace industry. Development of system functions, requirements, verification and validation, and interfaces in the context of integrated product teams and the product life cycle.
Letter grade only (A-F).

511B. Advanced Manufacturing Management Systems (3)
Prerequisite: Consent to instructor.
Letter grade only (A-F).

570B. Engineering Management Principles and Applications (3)
Prerequisite: Graduate standing, or consent of instructor.
Engineering management principles/applications. Relationships of management functions -modern products or service based companies. Technical organization in global market place. Reengineering, empowerment, concurrent engineering, and systemic thinking. Evolutionary theories of management. Strategic planning, goal setting, communication, resource distribution, etc. Team projects.
Letter grade only (A-F).

591B. Engineers to Managers – A Transition (3)
Prerequisites: Consent of instructor and graduate standing.
Engineers transitioning to management. Engineering mindset advantages and disadvantages; Successful managers; Corporations - system of people, machines, and facilities; Requirements; Inter-acting disciplines; “people skills” in non-coercive supervision; Technical managers; Managing Changes and technology; Team projects.
(Lecture-Problems 3 hours) Letter grade only (A-F).

596B. Special Projects in Engineering Management (3)
Prerequisites: Eligible for advancement to candidacy and consent of instructor.
Under faculty supervision students will pursue synthesis work, as a culminating experience, on the topics learned for the interdisciplinary MSEM degree. In consultation with the Program Advisor, an Independent Study form must be completed. An acceptable project report must be submitted.
May be repeated to a maximum of 6 units. Letter grade only (A-F).
CHEMICAL ENGINEERING
College of Engineering

Department Chair: Larry K. Jang
Department Office: EN2 101
Telephone: (562) 985-4909
Website: http://www.csulb.edu/coe/che
Faculty: Larry K. Jang, Chih-Cheng Lo, Sergio Mendez, Sepideh Faraji
Undergraduate Advisor: Sepideh Faraji
Graduate Advisor: Chih-Cheng Lo
Environmental Technology Advisor: Sepideh Faraji
General Education Advising: Academic Advising - Horn Center

Career Possibilities
Chemical Engineer • Process Engineer • Automation Control Engineer • Chemical Research Engineer • Chemical Test Engineer • Biochemical Engineer • Biomedical Engineer • Technical Sales • Management • Technical Writer • Quality Control Specialist • Consultant • Safety Engineer • Environmental Engineer • (Some of these careers require additional education or experience. For more information, see www.careers.csulb.edu.)

Introduction
Chemical engineering is a major that opens the way for many career opportunities. As the name implies, chemical engineers must build a foundation on engineering, science, and math while specializing in the application of chemistry to engineering systems. This is a versatile major that also encourages students to take courses from the other engineering disciplines as well as the biological sciences. In general, chemical engineers integrate their broad knowledge and analytical skills to design, implement and optimize chemical processes that convert raw materials into valuable products in a sustainable manner. Chemical engineers ensure that processes are operated safely and economically with minimum energy consumption and waste emission. Many of our graduates find career opportunities in traditional industries such as petroleum refining, energy production, chemical manufacturing and pharmaceuticals. Because of their diverse technical skill set, our graduates are increasingly finding employment in emerging industries such as alternative energy, biomedical engineering, environmental engineering, semiconductors, materials, and nanotechnology.

Program Educational Objectives
The Chemical Engineering bachelor degree program's educational objective statement is directed towards the career accomplishments and expectations of the alumni. The objectives of the program are that recent alumni become successful in their professional careers, and that they continue on a path of professional development. Specific educational objectives of the program are to:
• Prepare graduates with broad knowledge in process design, simulation and optimization; and research and development for new chemical products.
• Prepare graduates who communicate effectively and work collaboratively in multidiscipline teams.
• Prepare graduates to be productive professionals in technical careers with the highest level of professional ethics.
• Prepare graduates with the ability to continue to learn and adapt to future changes in the technical work environment.

The faculty members of the Department of Chemical Engineering strive to continuously improve the program and the curriculum as well as laboratory facilities to ensure the professional career success of our recent graduates. The goal is to prepare students for a wide range of career routes that use chemical engineering principles with a solid foundation in engineering, math, science, and societal awareness. The scope of this program is broadened by courses from general education as well as specialized technical elective courses in chemical engineering and other engineering disciplines. Students develop teamwork skills and gain interdisciplinary experience particularly in laboratory courses, lecture courses with laboratory components, and the capstone design class that require team projects. This program provides ample opportunities for students to develop communication skills such as oral and poster presentations as well as written technical reports. Students are encouraged to participate in lifelong learning activities such as professional meetings on or off campus and field trips. The goal is to have a comprehensive, student-centered program that can allow us to meet the educational objectives.

Chemical Engineering Advisory and Development Council
The Department of Chemical Engineering Advisory and Development Council, consisting of outstanding engineers and executives from industry and government in Southern California, provides guidance to our program. Its mission is to advise and assist in developing the Department and to support its efforts to serve students, the community, and industry. This liaison between the University and industry ensures that industry concerns are addressed in our curricula and provides career guidance for our graduates.

Accreditation
The Bachelor of Science in Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Other Related Programs
Students interested in obtaining a Minor in Environmental Engineering should refer to the College of Engineering section of this catalog. Students who take required Chemistry courses are most likely eligible for Minor in Chemistry degree. See the College of Natural Science and Mathematics section of this catalog.

Students wishing to pursue advanced study may be interested in the College of Engineering's Master of Science in Engineering (MSE) degree. Thesis work may be supervised by chemical engineering faculty. For detailed MSE requirements, see the College of Engineering section of this catalog.
Grade Requirements
In addition to other University requirements, all students must obtain a grade of "C" or better in each prerequisite for any chemical engineering course. Also, required Written English (GE A1), Speech (GE A2), and Interdisciplinary (IC) courses must be taken for a letter grade, not Credit/No Credit.

Undergraduate Programs

Bachelor of Science In Chemical Engineering (128 units)

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements
A grade of "C" or better must be achieved in all required courses listed below.

Lower Division:
Take all the following courses:

- CH E 200 Chemical Engineering Fundamentals (3)
  Prerequisites: CHEM 111A, MATH 122, PHYS 151 all with a grade of "C" or better.
  Corequisite: CHE 210.
- CH E 210 Computer Methods in Chem Engineering (3)
  Corequisite: CHE 200
- CH E 220 Chemical Engineering Thermodynamics I (3)
  Prerequisite: CH E 200 with a grade of "C" or better.
- CHEM 111A General Chemistry (5)
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).
- CHEM 111B General Chemistry (5)
  Prerequisite: CHEM 111A with a grade of "C" or better.
- C E 205 Analytical Mechanics I (Statics) (3)
  Prerequisite: PHYS 151 with a grade of "C" or better.
  Prerequisite/Corequisite: MATH 123.
- ENGR 101 Introduction to Engineering Profession (1)
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122
- ENGR 102 Academic Success Skills (1)
  Prerequisite: ENGR 101 with a grade of "C" or better.
- CH E 100 Introduction to Chemical Engineering (1)
  Prerequisite: None.

- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- MATH 224 Calculus III (4)
  Prerequisite: A grade of "C" or better in MATH 123 or 222.
- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 122.

Take one of the following choices:

- PHYS 152 Electricity and Magnetism (4)
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.
- or both of the following:
  - EE 210 Electro-Magnetic Foundations in EE (3)
    Prerequisite: PHYS 151 with a grade of "C" or better.
    Corequisites: MATH 123, EE 210L.
  - EE 210L Electro-Magnetic Foundations in EE Lab (1)

Take one course from the following:

- BIOL 200, CHEM 251, MICR 200

Upper Division:

Take all the following courses:

- CH E 310 Chemical Engineering Thermodynamics II (3)
  Prerequisites: CH E 210, 220 all with a grade of "C" or better.
- CH E 320 Fluids (3)
  Prerequisites: CH E 200, C E 205 all with a grade of "C" or better.
- CH E 330 Separation Processes (4)
  Prerequisite: CHE 310 all with a grade of "C" or better.
- CH E 420 Heat and Mass Transport (3)
  Prerequisites: CHE 310, CHE 320 all with a grade of "C" or better.
- CH E 430 Chemical Reactor Kinetics (3)
  Prerequisites: CHEM 371A, MATH 370A or CHE 480) all with a grade of "C" or better.
  Corequisite: CHE 420.
- CH E 440 Chemical Engineering Laboratory I (2)
  Prerequisites: CHE 320, CHE 330 all with a grade of "C" or better.
- CH E 450 Chemical Engineering Laboratory II (2)
  Prerequisites: CHE 420, 430, 440 all with a grade of "C" or better.
  Corequisite: CHE 460.
- CH E 460 Chemical Process Control (3)
  Prerequisites: CHE 420, CHE 430, and (MATH 370A or CHE 480) all with a grade of "C" or better.
- CH E 470 Chemical Engineering Design (4)
  Prerequisites: CHE 330, CHE 420, CHE 430 all with a grade of "C" or better.
  Corequisite: CHE 460.
- CHEM 371A Physical Chemistry: Thermodynamics and Kinetics (3)
  Prerequisites: CHEM 251, MATH 123, PHYS 152 (all with a grade of "C" or better), MATH 224 (may be taken concurrently).
- MATH 370A Applied Mathematics I (3)
  Prerequisites: MATH 123. Not open to Freshmen.
Take one of the following choices:
CHEM 320A and CHEM 320B
or
CHEM 322A and 323A and CHEM 322B and 323B
or
CHEM 327 and approved science laboratory
Take six units from the following courses:
Take three units from the following courses:
EE 211, CE 406, approved ECON elective course, or
Approved Engineering elective course.
All students must show evidence of having registered for
the FE Exam (also known as EIT Exam) prior to graduation.
Those who pass the FE Exam before graduation can waive 3
units of elective course.

Minor in Environmental Engineering
For requirements, see the description in the College of
Engineering section of this catalog.

Certificate in Safety Operations
Not accepting new students as of Fall 2012.
This interdisciplinary certificate is designed to prepare
students for safety positions that require a strong background
in the technology of safe industrial environments.
Please be aware that this program is not eligible for
Financial Aid unless pursued concurrently with a degree
program.

Requirements
1. May be earned concurrently with or subsequent to the
baccalaureate degree.
2. Open to all majors who have fulfilled the required
prerequisites as stated below.
3. Requires a total of 24 units as specified below:
   A. Completion of supporting technical courses chosen in
      consultation with an advisor.
   B. 24 units are required from the following courses:
4. Any deviation from this program requires the written
   permission of the program advisor.

Chemical Engineering Courses (CH E)

LOWER DIVISION

100. Introduction to Chemical Engineering (1)
Chemical engineering as a profession. Nature of profession and
career opportunities. Emerging frontiers of chemical engineering.
(Lecture 1 hour) Letter grade only (A-F).

200. Chemical Engineering Fundamentals (3) F
Prerequisites: CHEM 111A, MATH 122, PHYS 151 all with a grade of
"C" or better.
Corequisite: CHE 210.
Dimensional analysis of units, steady and transient balances
of mass, momentum and energy, the mathematical solution of
chemical engineering problems.
(Lecture-problems 3 hrs) Letter grade only (A-F).

210. Computer Methods in Chemical Engineering (3) F
Corequisite: CHE 200
Beginning programming and techniques of numerical analysis applied
to typical problems in chemical engineering.
(Lecture-problems 2 hours, lab 3 hours) Letter grade only (A-F).

220. Chemical Engineering Thermodynamics I (3) S
Prerequisite: CHE 200 with a grade of "C" or better.
Applications of the first and second laws of thermodynamics to
chemical processes. Concepts of heat, work, and energy. Energy
balances in batch and flow processes, with and without chemical
reaction. Gas behavior, phase change, vapor pressure, humidity.
(Lecture-problems 3 hours) Letter grade only (A-F).

UPPER DIVISION

300. The Chemical Industry (3)
Prerequisite: CHE 200 with a grade of "C" or better.
Survey of industrial chemical processing techniques and the
activities of engineers in this area, illustrated by field trips, speakers,
professional society meetings, films, readings, etc.
(Lecture 3 hours) Letter grade only (A-F).

310. Chemical Engineering Thermodynamics II (3) F
Prerequisites: CHE 210, 220 all with a grade of "C" or better.
Analysis and design of process equipment and systems using
thermodynamics. Turbines, compressors, power plants, refrigeration
cycles. Phase equilibria and nonideal solution behavior. Chemical
reaction equilibria and heat effects.
(Lecture-problems 3 hours) Letter grade only (A-F). Not open for
credit to students with credit in CHE 410.

320. Fluids (3) S
Prerequisites: CHE 200, C E 205 all with a grade of "C" or better.
Study of the deformation and flow of fluids, both liquids and gases,
with applications to chemical engineering.
(Lecture-problems 3 hours) Letter grade only (A-F).

330. Separation Processes (4) F
Prerequisite: CHE 310 with a grade of "C" or better.
Computation methods for predicting the separation of materials by
distillation, absorption, extraction and other methods.
(Lecture-problems 3 hours, lab 3 hrs) Letter grade only (A-F).

400./500. Chemical Processes (3)
Prerequisite: CHE 200 or 300 all with a grade of "C" or better or
consent of instructor.
In depth study of chemicals and chemical manufacturing processes
and related environmental problems and energy conservation issues.
Graduate students have additional assignments. (Lecture-problem 3
hours). Letter grade only (A-F).

415./515. Occupational and Environmental Safety Engineering and Management (3)
Prerequisite: CHEM 327 all with a grade of "C" or better or consent of
instructor.
Safety analysis and management, legislation, regulations and
standards; toxicology and personal protective equipment; fire hazards;
noise control; electrical safety; container and spill management;
statistical analysis. Extra requirements for graduate students.
(Lecture-problems 3 hours) Letter grade only (A-F).

420. Heat and Mass Transport (3) F
Prerequisites: CHE 310, CHE 320 all with a grade of "C" or better.
Heat exchange by conduction, convection and radiation. Diffusion in
fluids and solids. Simultaneous heat and mass transport.
(Lecture-problems 2 hours, lab 3 hours) Letter grade only (A-F).
430. Chemical Reactor Kinetics (3) F
Prerequisites: CHEM 371A, (MATH 370A or CHE 480) all with a grade of "C" or better.
Corequisite: CHE 420
Homogeneous and heterogeneous reactions and application to reactor design, catalysts.
(Lecture-problems 2 hours, lab 3 hours) Letter grade only (A-F).

431./531. Heterogeneous Catalysts (3)
Prerequisite: CHE 430 with a grade of "C" or better or consent of instructor.
Basic principles of solid catalysts and solid catalyzed reactions. Proper choice of catalysts and how to solve catalyst-related problems in chemical engineering. Development of chemical processes that utilize innovative catalysts. Graduate students will need to do more assignments.
Letter grade only (A-F). (Lecture-problems 3 hours).

432./532. Microfabrication and Microfluidics Technology (3)
Prerequisites: CHE 320, CHEM 327, (MATH 370A or CHE 480) all with a grade of "C" or better or consent of instructor.
Fundamentals of major microfabrication techniques for device construction and microfluidics technology. Topics: photolithography, wet/dry etching, metal/dielectric deposition, soft lithography, diffusion/mixing/separation in microfluidic devices, and chip-to-world interfaces. Graduate students need to do more assignments.
Letter grade only (A-F). (Lecture-problems 3 hours).

433./533. Green Engineering II: Alternative Energy (3)
Prerequisites: CHE 220, CHE 330, CHE 310 all with a grade of "C" or better or consent of instructor.
Letter grade only (A-F). (Lecture-Problems 3 hours).

437./537. Materials Purification Processes (3)
Prerequisite: CH E 330, 420 all with a grade of "C" or better or consent of instructor.
Rate-controlled separation processes such as membrane separations, pressure swing adsorption, molecular sieve separation, supercritical fluid extraction, reverse osmosis, and spray drying.
Additional projects required for CH E 537. (Lecture-problems 3 hours) Letter grade only (A-F).

440. Chemical Engineering Laboratory I (2) F
Prerequisites: CHE 320, CHE 330 all with a grade of "C" or better.
Laboratory study of fluid mechanics, separation processes and thermodynamics. Experimental design and analysis and preparation of engineering reports.
(Laboratory 6 hours) Letter grade only (A-F).

445./545. Pollution Prevention (3)
Prerequisite: CH E 330 with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

450. Chemical Engineering Laboratory II (2) S
Prerequisites: CHE 420, 430, 440 all with a grade of "C" or better.
Corequisite: CHE 460
Laboratory study of heat and mass transport, chemical kinetics and control theory. Experimental design and analysis and preparation of engineering reports.
(Laboratory 6 hours) Letter grade only (A-F).

455./555. Environmental Compliance (3)
Prerequisite: CHEM 327 with a grade of "C" or better or consent of instructor.
Physical and chemical properties of hazardous materials and wastes. Environmental hazards. An examination of environmental laws, regulations and standards dealing with storage, transportation, treatment and disposal of hazardous wastes. Emergency planning and preparedness. Extra requirement for graduate students: term papers or projects.
(Lecture-problems 3 hours) Letter grade only (A-F).

460. Chemical Process Control (3) S
Prerequisites: CHE 420, CHE 430, and (MATH 370A or CHE 480) all with a grade of "C" or better.
Control theory and practice, instrumentation, system responses, transfer functions, feed-back control, and stability as applied to chemical engineering processes.
(Lecture-problems 2 hours, lab 3 hours) Letter grade only (A-F).

465./565. Biochemical Engineering (3)
Prerequisite: CH E 200, 330, 430 all with a grade of "C" or better and life science course(s) with instructor's approval.
Extra requirements for graduate students. (Lecture-problems 3 hrs) Letter grade only (A-F).

470. Chemical Engineering Design (4) S
Prerequisites: CHE 330, 420, 430 all with a grade of "C" or better and consent of instructor.
Application of chemistry to the problems of pollution. Graduate students have additional assignments.
(Lecture-problem 3 hours) Letter grade only (A-F).

475./575. Environmental Pollution (3)
Prerequisite: CHEM 320A or 327 all with a grade of "C" or better or consent of instructor.
Application of chemistry to the problems of pollution. Graduate students have additional assignments.
(Lecture-problem 3 hours) Letter grade only (A-F).

480./580. Theoretical Methods in Chemical Engineering (3)
Prerequisites: CH E 420, 430 all with a grade of "C" or better.
Simulation and optimization of chemical engineering processes by mathematical formulation and computer modeling.
Extra requirements for graduate students: term papers or projects.
(Lecture-problems 3 hours) Letter grade only (A-F).

481./581. Advanced Theoretical Methods in Chemical Engineering (3)
Prerequisites: MATH 370A, CHE 480, or 580 all with a grade of "C" or better or consent of instructor.
Solutions of problems encountered in models of chemical processes: boundary value ordinary differential equations and partial differential equations.
Graduate students have additional assignments. (Lecture-problem 3 hours). Letter grade only (A-F).

485./585. Air Pollution (3)
Prerequisite: CH E 475 or CE 364 all with a grade of "C" or better or consent of instructor.
Air pollution chemistry; control strategies; origin of pollutants; meteorology; vapor dispersion models; control principles for particulates, sulfur dioxide, and nitrogen oxides.
Extra requirements for graduate students: term papers or projects.
(Lecture-problems 3 hrs) Letter grade only (A-F).
490. Special Problems (1-3)
Prerequisite: Consent of instructor.
Assigned topics in technical literature or laboratory projects and reports on same.
Letter grade only (A-F).

GRADUATE LEVEL

500./400. Chemical Processes (3)
Prerequisite: CH E 200 or 300 all with a grade of "C" or better or consent of instructor.
In depth study of chemicals and chemical manufacturing processes and related environmental problems and energy conservation issues.
Graduate students have additional assignments. (Lecture-problem 3 hours). Letter grade only (A-F).

515./415. Occupational and Environmental Safety Engineering and Management (3)
Prerequisite: CHEM 327 all with a grade of "C" or better or consent of instructor.
Safety engineering and management, legislation, regulations and standards; toxicology and personal protective equipment; fire hazards; noise control; electrical safety; system safety analysis; container and spill management; use of computer systems and statistical methods.
Extra requirements for graduate students: term papers or projects. (Lecture-problems 3 hours) Letter grade only (A-F).

520. Advanced Transport Phenomena (3)
Prerequisites: CH E 320, 420, 430 all with a grade of "C" or better.
Application of differential and integral mass, momentum and energy balances to chemical engineering processes. Analysis of fluid flow, heat transfer, diffusion and chemical reaction in various unit operations.
(Lecture-Problems 3 hours) Letter grade only (A-F).

521. Advanced Mass Transfer Operations of Chemical Engineering (3)
Prerequisite: CH E 520 with a grade of "C" or better or consent of instructor.
Fundamental laws of diffusion and diffusion with chemical reaction in traditional and unconventional mass transfer operations.
(Lecture-problem 3 hours). Letter grade only (A-F).

530. Advanced Reactor Kinetics (3)
Prerequisite: CH E all with a grade of "C" or better.
Modeling of chemical reactors; effects of multiple phases, mixing, adsorption, diffusion and catalysts on reactor performance.
(Lecture-Problems 3 hrs) Letter grade only (A-F).

531./431. Heterogeneous Catalysts (3)
Prerequisite: CHE 430 with a grade of "C" or better or consent of instructor.
Basic principles of solid catalysts and solid catalyzed reactions. Proper choice of catalysts and how to solve catalyst-related problems in chemical engineering. Development of chemical processes that utilize innovative catalysts. Graduate students will need to do more assignments.
Letter grade only (A-F). (Lecture-Problems 3 hours).

532./432. Micro fabrication and Microfluidics Technology (3)
Prerequisites: CHE 320, CHEM 327, MATH 370A or CHE 480 all with a grade of "C" or better or consent of instructor.
Fundamentals of major microfabrication techniques for device construction and microfluidics technology. Topics: photolithography, wet/dry etching, metal/dielectric deposition, soft lithography, diffusion/mixing/separation in microfluidic devices, and chip-to-world interfaces. Graduate students need to do more assignments.
Letter grade only (A-F). (Lecture-Problems 3 hours).

533./433. Green Engineering I: Alternative Energy (3)
Prerequisites: CHE 220, CHE 330, CHE 310 all with a grade of "C" or better or consent of instructor.
Letter grade only (A-F). (Lecture-Problems 3 hours).

537./437. Materials Purification Processes (3)
Prerequisites: CH E 330, 420 all with a grade of "C" or better or consent of instructor.
Rate-controlled separation processes such as membrane separations, pressure swing adsorption, molecular sieve separation, supercritical fluid extraction, reverse osmosis, and spray drying.
Additional projects required for CH E 537. (Lecture-problems 3 hours) Letter grade only (A-F).

545./445. Pollution Prevention (3)
Prerequisite: CH E 330 with a grade of "C" or better.
Pollution prevention strategies in chemical industry; hierarchical approach waste minimization; life cycle analyses of wastes; identification of pollution source; environmentally compatible materials; unit operations for minimizing waste; economics of pollution prevention.
Extra requirement for graduate students. (Lecture-problems 3 hours) Letter grade only (A-F).

555./455. Environmental Compliance (3)
Prerequisite: CHEM 327 with a grade of "C" or better or consent of instructor.
Extra requirement for graduate students: term papers or projects. (Lecture-problems 3 hours) Letter grade only (A-F).

560. Advanced Chemical Process Control (3)
Prerequisite: One of the following: CH E 460, E E 370/L, 411, 470, 471, 511, MAE 376, E T 492 all with a grade of "C" or better or consent of instructor.
Principles and practices of controller selection and tuning, advanced control loops, model predictive control, decoupling, hands-on experience of control loop design and implementation using Labview.
(Lecture-Problems 3 hours) Letter grade only (A-F).

565./465. Biochemical Engineering (3)
Prerequisites: CH E 200, 330, 430 all with a grade of "C" or better and life science course(s) with instructor's approval.
Extra requirements for graduate students. (Lecture-problems 3 hrs) Letter grade only (A-F).

575./475. Environmental Pollution (3)
Prerequisite: CHEM 320A or 327 all with a grade of "C" or better or consent of instructor.
Application of chemistry to the problems of pollution. Graduate students have additional assignments.
(Lecture-problem 3 hours). Letter grade only (A-F).
580./480. Theoretical Methods in Chemical Engineering (3)
Prerequisites: CH E 420, 430 all with a grade of "C" or better.
Simulation and optimization of chemical engineering processes by mathematical formulation and computer modeling.
Extra requirements for graduate students: term papers or projects. (Lecture-problems 3 hours) Letter grade only (A-F).

581./481. Advanced Theoretical Methods in Chemical Engineering (3)
Prerequisites: MATH 370A, CH E 480, or 580 all with a grade of "C" or better or consent of instructor.
Solutions of problems encountered in models of chemical processes: boundary value ordinary differential equations and partial differential equations.
Graduate students have additional assignments. (Lecture-problem 3 hours). Letter grade only (A-F).

585./485. Air Pollution (3)
Prerequisite: CH E 475 or CE 364 all with a grade of "C" or better or consent of instructor.
Air pollution chemistry; control strategies; origin of pollutants; meteorology; vapor dispersion models; control principles for particulates, sulfur dioxide, and nitrogen oxides.
Extra requirement for graduate students: term papers or projects. (Lecture-problems 3 hrs) Letter grade only (A-F).

697. Directed Research (1-3)
Prerequisite: Graduate standing.
Individual research or intensive study under the guidance of a faculty member on theoretical or experimental problems in chemical engineering.
(Independent Study) Letter grade only (A-F).

698. Thesis or Industrial Project (2-6)
Prerequisite: Advancement to Candidacy.
Preparation and completion of a thesis or industrial project in chemical engineering.
May be repeated to a maximum of 6 units.
CIVIL ENGINEERING AND CONSTRUCTION ENGINEERING MANAGEMENT
College of Engineering

Department Chair: Emelinda M. Parentela
Department Office: Vivian Engineering Center (VEC) – 104
Telephone: (562) 985-5118
Website: www.csulb.edu/colleges/coe/cecem/

Undergraduate Advisors:
Antonella Sciortino (CE), Tang-Hung Nguyen (CEM), Tariq Shehab-Eldeen (CE/CEM), Shadi Saadeh (CE)

Graduate Advisor: Steve Tsai

General Education Advising: Academic Advising - Horn Center

Administrative Support Coordinator: Ameeta Perera

Students desiring detailed information about Civil Engineering or Construction Engineering Management programs should contact the department office for referral to one of the faculty advisors.

Career Possibilities
Civil Engineer • Traffic Engineer • Sanitary Engineer
• Structural Engineer • Hydraulic Engineer • Highway Administration Engineer • Harbor Engineer • Airport Engineer • Environmental Engineer • Transportation Engineer • Drainage Design Coordinator • Technical Sales and Consulting • Field Engineer • Facilities Engineer • Plant Engineer • Project Engineer • Safety Engineer • Sales Representative • Estimator • Construction Coordinator • Procurement Construction Coordinator • Construction Inspector • Cost Analysis Coordinator • Contract Coordinator • Consultant (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

Advisory and Development Councils

The Civil Engineering Advisory and Development Council

This council consists of outstanding engineers and executives from industry and government in Southern California. Its function is to form a liaison between the University and industry and to keep the administration and faculty informed of modern engineering practices. This ensures that the curricula are kept up-to-date. It also advises on placement opportunities before and after graduation.

Construction Engineering Management Advisory and Development Council

This council provides current information and guidance about industrial developments in methods, materials and techniques. Members make recommendations in course content, methods and/or facilities. Present membership in the council is made up of representatives from the different sectors of the construction industry.

Accreditation

The Bachelor of Science in Civil Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Undergraduate Programs

Bachelor of Science in Civil Engineering (130 units)

Mission

The mission of the Civil Engineering Program is to prepare students to succeed in the civil engineering profession by providing them with essential technical tools and skills and to promote the need for lifelong learning.

Educational Objectives

The Civil Engineering Program Educational Objectives are to produce graduates, who after entering the civil engineering practice will:

1. Apply knowledge of fundamental science and engineering principles and design to the solution of complex engineering projects.
2. Pursue lifelong learning through continuing education and/or advanced degrees in civil engineering or other related fields.
3. Progress to professional registration and continue to develop professionally.
4. Progress to leadership or management in engineering.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Lower Division:

Take all of the following:

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

CE 101 Intro CE & Construction Engr Management (1)
Upper Division:
Take all of the following:

CE 130 Surveying and Mapping (1)
Corequisites: CE 130L and MAE 172 or CEM 121.

CE 130L Surveying and Mapping Laboratory (1)
Corequisite: CE 130.

CE 200 Materials for Civil Engineering (2)
Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better; consent of department undergraduate advisor.

CE 205 Analytical Mechanics I (Statics) (3)
Prerequisite: PHYS 151 with a grade of "C" or better.
Prerequisite/Corequisite: MATH 123.

CE 206 Computer Programming & CE Applications I (2)
Prerequisites: MATH 122, PHYS 151 all with a grade of "C" or better.

ENGR 101 Intro to the Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

MATH 123 Calculus II (4)
Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)
Prerequisite: A grade of "C" or better in MATH 123 or 222.

MAE 172 Engineering Design Graphics (3)
Prerequisites: None.

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 122.

Take one of the following:

BIOL 200 General Biology (4)
Prerequisite: GE Foundation requirements.

MICR 200 Microbiology for Health Professionals (4)
Prerequisites: CHEM 111A or 140 with a grade of "C" or better and GE Foundation requirements.

Take 4 units of the following:

EE 210 Electro-Magnetic Foundations in EE (3)
Prerequisite: PHYS 151 with a grade of "C" or better.
Corequisites: MATH 122, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)

PHYS 152 Electricity and Magnetism (4)
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:
Take all of the following:

CE 335 Fluid Mechanics (3)
Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.

CE 345 Geotechnical Engineering I (3)
Prerequisite: Consent of Department Undergraduate Advisor.
Corequisites: MAE 373; GEOL 370.

CE 346 Geotechnical Engineering Laboratory (1)
Prerequisite: ENGL 100 or equivalent with a grade of "C" or better.
Corequisite: CE 345.

CE 359 Structural Analysis I (3)
Prerequisite: MAE 373 with a grade of "C" or better.

CE 364 Environmental Engineering (3)
Prerequisites: CHEM 111A, BIOL 200/MICR 200 with a grade of "C" or better.
Prerequisite/Corequisite: CE 335.

CE 406 Cost Engineering and Analysis (3)
Prerequisite: GE Foundation requirements.

CE 407 Probability & Statistics in Civil Engineering (2)
Prerequisites: CE 206 and MATH 224 all with a grade of "C" or better.

CE 426 Transportation Engineering (3)
Prerequisite: CE 345 with a grade of "C" or better.
Corequisite: CE 406.

CE 437 Engineering Hydraulics (3)
Prerequisites: C E 335, MATH 370A all with a grade of "C" or better.

CE 459 Reinforced Concrete Design I (3)
Prerequisites: C E 200 and 359 all with a grade of "C" or better.

CE 481 Professional Practice in Civil Engineering (1)
Prerequisite: Senior standing.

CE 490 Senior Design Project (3)
Prerequisite: CE 459; completion of all 300-level engineering courses for the civil engineering major all with a grade of "C" or better and consent of department undergraduate advisor.
Prerequisite/Corequisite: CE 426, 437. Normally taken in the last year of the undergraduate program.

ECON 300 Fundamentals of Economics (3)
Prerequisites: GE Foundation requirements.

GEOL 370 Geology for Engineers (2)
Prerequisites: MAE 172, CE 130.

MAE 370A Applied Mathematics I (3)
Prerequisites: MATH 123. Not open to Freshmen.

MAE 330 Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 371 Analytical Mechanics II (Dynamics) (3)
Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.

MAE 373 Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 with a grade of "C" or better.

Take six units of technical design electives from:

CE 427, 428, 438/438L, 445, 455, 456, 457, 466, 495

Take two laboratories from:

CE 326, 336, 365, 454, MAE 374

Take three units of technical electives from:


A grade of "C" or better must be achieved in the required courses below:

CHEM 111A, MATH 122, 123, 224, 370A, BIOL 200,
MICR 200, PHYS 151, ECON 300, MAE 172, MAE 373,
CE 130, 130L, 200, 205, 206, 335, 345, 359, 406, 459 and 490.

Bachelor of Science in Construction Engineering Management (127units)

Mission
The Mission of the Construction Engineering Management program is to educate and prepare students to succeed in the construction engineering management profession by providing them with essential technical, managerial and communication skills and tools which will enable them to perform current and future construction engineering management tasks and to promote the need for life-long learning.

Educational Objectives
The Construction Engineering Management program educational objectives are to produce graduates, who after
entering the construction engineering management practice with a knowledge of fundamental construction engineering management principles and current technologies, communication skills and practical construction experience, will:

1. Provide substantial contributions to the construction industry.
2. Pursue life-long learning through continuing education and/or advanced degrees in construction engineering management or other related fields.
3. Continue to develop professionally through participation in professional organizations and/or participation in professional development activities in the industry.
4. Progress towards professional certifications.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 111 and 113, and PHYS 100A within one calendar year.

Transfer Students: A grade "C" or better must be achieved in MATH 122 and PHYS 100A & B within one calendar year.

Requirements

Lower Division:

Take all of the following:

CE 101 Introduction to Civil Engineering and Construction Engineering Management (1)
   Prerequisites: None.

CE 130 Surveying and Mapping (1)
   Corequisites: CE 130L and MAE 172 or CEM 121.

CE 130L Surveying and Mapping Laboratory (1)
   Corequisite: CE 130.

ENGR 101 Intro to the Engineering Profession (1)
   Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)
   Prerequisite: ENGR 101 with a grade of "C" or better.

MATH 122 Calculus I (4)
   Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

PHYS 100A General Physics (4)
   Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 100B General Physics (4)
   Prerequisite: PHYS 100A.

CEM 121 Construction Drawing I (2)
   Prerequisites: None.

CEM 125 Fundamentals of Construction (3)
   Prerequisites: None.

CEM 200 Concrete Construction (1)
   Prerequisite: CEM 125 with a grade of "C" or better.
   Corequisite: CEM 200L.

CEM 200L Concrete Construction Laboratory (1)
   Corequisite: CEM 200.

CEM 202 Probability and Statistics for CEM (3)
   Prerequisite: High School Algebra.

CEM 204 Applied Mechanics-Statics (3)
   Prerequisites: MATH 122 and PHYS 100A all with a grade of "C" or better.

CEM 205 Computer Systems and Programming (2)
   Prerequisites: None.

CEM 225 Residential and Light Commercial Construction Practices and Estimating (3)
   Prerequisites: CEM 121, 125 all with a grade of "C" or better.
   Corequisites: CEM 200, 200L.

BLAW 220 Introduction to Law and Business Transactions (3)
   Prerequisites: None.

Take one of the following:

BLAW 220 Introduction of Law and Business Transactions (3)
   Prerequisites: None

BLAW 320 Legal and Regulatory Environment of Business (3)
   Prerequisites: None

Take one of the following:

CEM 201 Cost Accounting for Construction Engineering (3)
   Prerequisites: None.

ACCT 201 Elementary Financial Accounting (3)
   Prerequisites: None.

Upper Division:

Take all of the following:

CE 406 Cost Engineering and Analysis (3)
   Prerequisite: GE Foundation requirements.

CEM 304 Applied Mechanics-Strength of Materials (2)
   Prerequisite: CEM 204 with a grade of "C" or better.

CEM 315 Construction Safety (2)
   Prerequisite: CEM 225 or CE 200 with a grade of "C" or better.

CEM 324 Commercial, Institutional, and Industrial Construction Practices and Estimating (3)
   Prerequisites: CEM 315 with a grade of "C" or better.

CEM 335 Soil Mechanics Technology (2)
   Prerequisite: CEM 304 with a grade of "C" or better.
   Corequisite: CEM 335L.

CEM 335L Soil Mechanics Technology Laboratory (1)
   Prerequisite: CEM 304 with a grade of "C" or better.
   Corequisite: CEM 335.

CEM 365 Mechanical Equipment for Buildings (2)
   Prerequisite: PHYS 100B with a grade of "C" or better.
   Corequisite: CEM 324.

CEM 375 Electrical Equipment Buildings (2)
   Prerequisites: CEM 324, PHYS 100B all with a grade of "C" or better.

CEM 404 Structural Design I (2)
   Prerequisite: CEM 304 with a grade of "C" or better.

CEM 421 Construction Planning and Scheduling (3)
   Prerequisite: CEM 324 with a grade of "C" or better.

CEM 425 Earthwork and Civil Works Construction Practices (2)
   Prerequisite: CEM 324, CE 406 with a grade of "C" or better.

CEM 426 Business and Construction Law (3)
   Prerequisites: CEM 324; BLAW 220 with a grade of "C" or better.

CEM 429 Advanced Estimating and Bidding (3)
   Prerequisite: CEM 315 with a grade of "C" or better.
   Corequisite: CEM 425.
The certificate may be earned concurrently with or subsequent to the baccalaureate degree.

2. This program is open to all majors who have fulfilled the prerequisites as stated below.

3. Requires a total of 25 units as specified below.

   A. The completion of supporting technical courses chosen in consultation with an advisor.

   B. Take 25 units selected from the following:

      1. **CEM 409 Directed Studies in Construction Engineering Management (1-3)**
         Prerequisite: Senior standing in CEM or consent of instructor.

      2. **CEM 421 Construction Project Management (3)**
         Prerequisite: None.

      3. **CEM 429 Facility and Property Management (3)**
         Corequisite: CEM 432.

      4. **CEM 430 Construction Cost Control (3)**
         Prerequisite: CE 406 and CEM 421 all with a grade of "C" or better.

      5. **CEM 432 Facility Administration (3)**
         Prerequisite: CEM 421 with a grade of "C" or better.

      6. **CEM 433 Facility Finance Management (3)**
         Corequisite: CEM 432.

      7. **CEM 434 Facility and Property Management (3)**
         Prerequisite: CEM 433 with a grade of "C" or better.

      8. **CEM 436 Facility Operations Management (3)**
         Prerequisite: CEM 433 with a grade of "C" or better.

      9. **CEM 437 Facility Management Emphasis (3)**
         Prerequisite: CEM 432 with a grade of "C" or better.

   C. Take six units of electives in consultation with an advisor:

      1. **CEM 413 Managing Quality for Productivity (3)**
         Prerequisites: MGMT 300. Recommended: IS 301, 310.

      2. **HRM 361 The Human Resource Function (3)**
         Prerequisites: None.

   D. Take one of the following:

      1. **ECON 300 Fundamentals of Economics (3)**
         Prerequisites: GE Foundation requirements.

      2. **MGMT 300 Principles of Management & Operations (3)**
         Recommended: IS 310.

   Upper Division Electives:

   Take six units of electives in consultation with an advisor:

   1. **Design-build Emphasis: CEM 373, 409, 443**

   2. **Facility Management Emphasis: CEM 374, 409, 432, 433, 434, 436**

   3. **Heavy Construction Emphasis: CEM 409, 476, 486.**

   A grade of "C" or better must be achieved in all required courses listed below:

   PHYS 100A and B, MATH 122, CEM 121, 125, 200, 200L, 204, 225, 304, 315, 324, 421, 429, 431, 490; CE 130, 130L, 406, MGMT 300; ACCT 201; BLAW 220 or 320.

**Fieldwork Requirements**

Fieldwork experience is required for the BS in Construction Engineering Management, consisting of no less than three months full-time (or equivalent part-time) of employment in an approved industry or governmental agency. The student must hold a position equivalent to a technician or higher which affords the opportunity to exercise responsibility usually given to those who have completed two years of college. The fieldwork must be completed prior to graduation, be certified and approved by the faculty of the department.

**Certificate in Facilities Operations**

Not accepting new students as of Fall 2012.

The certificate is designed to qualify the graduate to serve in plant engineering, industrial construction coordination, facilities development and design, plant layout, and facilities project management. This program provides graduates with a depth of technical knowledge in facilities operations-oriented technical courses, as well as the knowledge of behavioral sciences essential for managing technical functions.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirements**

1. The certificate may be earned concurrently with or subsequent to the baccalaureate degree.

2. A bachelor’s degree in an ABET accredited curriculum in civil engineering with a minimum GPA of 2.8; or

3. A bachelor’s degree with a minimum GPA of 2.8 in engineering, a natural science or other appropriate discipline with the requirement that essential undergraduate prerequisites in civil engineering are satisfied;
3. The general Graduate Record Examination (GRE) is required and appropriate level of competency will be determined by the Department.

4. Graduate students must consult with the graduate advisor for information concerning procedures and requirements for appropriate approval of their courses of study prior to enrolling in their graduate programs.

5. The Graduation Writing Assessment Requirement (GWAR) must be met during the first semester in residence. Failure to attempt to fulfill the GWAR during the first semester will prevent registration in engineering courses in subsequent semesters.

**Advancement to Candidacy**

1. Removal of all undergraduate deficiencies as determined by the Department Graduate Studies Committee;
2. Completion of at least 12 graduate units at CSULB; minimum GPA of 3.0; currently enrolled;
3. Fulfillment of the Graduation Writing Assessment Requirement (GWAR).

**Requirements**

Completion of a minimum of 30 units beyond the bachelor’s degree and graduate coursework as follows:

1. A minimum of 24 units in engineering, probability and statistics and mathematics courses with 18 units of 500-/600-level courses in Civil Engineering. Within these 18 units a student may include six units of CE 698 or three units of CE 697.
   - Students are required to complete successfully either:
     - 697 Directed Studies (1-3)
     - 698 Thesis (2-6)
2. Six units of electives selected from approved graduate courses in appropriate subjects;
3. Fulfill one of the following alternatives:
   - I - Write and present orally a thesis to be approved by the thesis committee;
   - II - Pass a written comprehensive examination on coursework in the student’s program.

**Graduate Certificate in Waste Engineering and Management**

Not accepting new students as of Fall 2012. This 24-unit program is conducted in cooperation with local engineering consulting firms and government agencies and could accommodate an internship of three units through directed study (CE 697). This certificate may be taken (1) by a graduate as a matriculated student, (2) admitted to a CSULB graduate degree program, or admitted as an unclassified graduate student.

A grade of “C” or better must be obtained in all courses applied to the certificate, with an overall G.P.A. of 3.0. Courses taken on Credit/No Credit or Audit basis will not apply to the certificate. Graduate students taking courses in this program are reminded that grades received will be included in calculations of the M.S. requirement.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirements**

1. Completion of an accredited baccalaureate degree in engineering or a related scientific discipline, with appropriate prerequisites to be met.
2. Take both of the following courses:
   - CE 543 Waste Management & Landfill Engr (3) Prerequisite: Graduate standing or consent of instructor.
   - PPA 590 Topics in Public Policy & Administration (3) Prerequisites: None.

Take a minimum of 9 units (electives) from the following:

- C E 504, 562, 563, 564, 566, 567; CH E 555, and 585.
- Normally, at least one of these courses should be from non-Civil Engineering offerings.

3. Fulfillment of the Graduation Writing Assessment Requirement (GWAR).
4. Filing of a program application card with Admissions and Records, and filing for the certificate at least one semester prior to completion.

**Civil Engineering Courses (C E)**

**LOWER DIVISION**

**101. Introduction to Civil Engineering and Construction Engineering Management (1)**

Civil engineering and construction engineering management as a profession. Current trends and challenges, ethical, social and environmental issues in professional practice. Professional organizations and licensure. Communication and lifelong learning skills for professional practice.

Letter grade only (A-F). (Lecture-problems 1 hour)

**130. Surveying and Mapping (1)**

Corequisites: CE 130L and MAE 172 or CEM 121.


Letter grade only (A-F). (Lecture-Problems 1 hour)

**130L. Surveying and Mapping Laboratory (1)**

Corequisite: CE 130.

Fundamentals of surveying methods as applied to construction layout. Use of level and total station for location and control of structures, vertical and horizontal control, and area determination.

Letter grade only (A-F). Not open for credit to students with credit in CE 131. (Laboratory 3 hours)

**200. Materials for Civil Engineering (2)**

Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better and consent of department undergraduate advisor.

Basic properties of materials in civil engineering, including concrete, masonry, steel, wood, asphalt and composites.

Letter grade only (A-F). (Lecture 1 hour, Laboratory 3 hours)

**205. Analytical Mechanics I (Statics) (3)**

Prerequisite: PHYS 151 with a grade of "C" or better. Prerequisite/Corequisite: MATH 123.

Application of the mechanics of equilibrium to force systems using analytical and graphical solutions of problems involving structures and machines.

Letter grade only (A-F). (Lecture 2 hours, Activity 2 hours)

**206. Computer Programming and Civil Engineering Applications I (2)**

Prerequisites: MATH 122, PHYS 151 all with a grade of "C" or better.

Introduction to programming and application of computers to elementary civil engineering problems.

Letter grade only (A-F). (Lecture-Problems 1 hour, Laboratory 3 hours)
326. GIS Laboratory for Civil Engineers (1)
Prerequisites: CE 130, 130L, 206 all with a grade of "C" or better.
Fundamentals of geographic information systems (GIS); spatial and network analyses. Hands-on application of GIS software to solve civil engineering problems.
(Laboratory 3 hours) Letter grade only (A-F).

335. Fluid Mechanics (3)
Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.
Properties of fluids, fluid statics, fluid dynamics, dynamic similitude, flow of compressible and incompressible fluids in closed conduits, uniform flow in prismatic open channels.
Letter grade only (A-F). (Lecture-Problems 3 hours)

336. Fluid Mechanics Laboratory (1)
Prerequisite: ENGL 100 or equivalent all with a grade of "C" or better.
Prerequisite/Corequisite: CE 335.
Experiments in and study of the phenomena of fluid flow.
Letter grade only (A-F). (Laboratory 3 hours)

345. Geotechnical Engineering I (3)
Corequisites: MAE 373; GEOL 370.
Prerequisite: Consent of Department Undergraduate Advisor.
Soil mechanics applied to engineering structures. Soil exploration, identification, classification, drainage, stability and bearing capacity.
Letter grade only (A-F). (Lecture-Problems 3 hours)

346. Geotechnical Engineering Laboratory (1)
Prerequisite: ENGL 100 or equivalent all with a grade of "C" or better.
Corequisite: CE 345.
Laboratory investigation and experiments in the phenomena of soil mechanics.
Letter grade only (A-F). (Laboratory 3 hours)

359. Structural Analysis I (3)
Prerequisite: MAE 373 with a grade of "C" or better.
Analysis of structures including trusses, beams, and frames, conjugate beam, virtual work, energy methods, approximate methods, and influence lines. Use of code based finite element computer programs in analysis of frame and truss type structures.
Letter grade only (A-F). (Lecture-Problems 3 hours)

364. Environmental Engineering I: Fundamentals (3)
Prerequisites: CHEM 111A, BIOL 200/MICR 200 all with a grade of "C" or better.
Introduction to the fundamental physical, chemical and biological processes affecting air and water quality. Models of transport and transformation of impurities. Emphasis on theory underlying the design of water quality control technologies.
Letter grade only (A-F). (Lecture-Problems 3 hours)

365. Environmental Engineering Laboratory (1)
Prerequisite/Corequisite: CE 364.
Experiments in routine water quality analysis and environmental engineering applications.
Letter grade only (A-F). (Laboratory 3 hours)

370. Analytical Mechanics (3)
Prerequisites: PHYS 151 with a grade of "C" or better.
Prerequisite/Corequisite: MATH 123.
Fundamental principles of statics, kinematics and kinetics, with application to idealized structures and systems.
Intended for Electrical Engineering majors. Not open for credit to Civil or Mechanical Engineering majors. Letter grade only (A-F).

404. Laboratory Techniques (1)
Prerequisites: ENGL 100 or equivalent with a grade of "C" or better, senior standing in Civil Engineering and consent of instructor.
Study in the techniques of organizing and directing of the civil engineering laboratory.
May be repeated to maximum of 3 units. Letter grade only (A-F). (Conference 1 hour, Laboratory 3 hours)

405. Selected Topics in Civil Engineering (3)
Prerequisites: Senior standing in civil engineering and consent of instructor.
Selected topics from recent advances in civil engineering. Course content will vary from year to year.
Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in Schedule of Classes. (Lecture-Problems 3 hours)

406. Project Cost-Benefit Analysis (3)
Prerequisite: GE Foundation requirements.
Systematic evaluation of the economic and social benefits and costs of projects. Decision-making in an environment of limited resources, environmental and economic constraints, and uncertainty. The economy of multi-year projects, selection among competing independent alternatives, before and after tax analyses, replacement economy and inflation.
Letter grade only (A-F). (Lecture-Problems 3 hours)

407. Probability and Statistics in Civil Engineering (2)
Prerequisites: CE 206 and MATH 224 all with a grade of "C" or better.
Analysis of uncertainties, and applications of the basic theories of probability and statistics in civil engineering areas of geotechnical, environmental, water resources, structural and transportation engineering.
Letter grade only (A-F). (Lecture-problems 1 hour, Lab 3 hrs)

408. Special Problems (1-3)
Prerequisite: Senior standing in civil engineering.
Assigned topics in technical literature or laboratory projects and report on same.
Letter grade only (A-F).

426. Transportation Engineering (3)
Prerequisite: CE 345 with a grade of "C" or better.
Corequisite: CE 406.
Operation of various modes of transportation; Characteristics of the driver, pedestrian, vehicle and the road; fundamental principles of traffic flow; introduction to intersection design and control, planning, and geometric design; transportation issues and safety.
Letter grade only (A-F). (Lecture-Discussion 3 hours)

427. Highway Design (3)
Prerequisite: CE 345 with a grade of "C" or better.
Geometric design of highways and streets. Route location and earthwork computation. Introduction to roadside and pavement design. Design problems in highway engineering.
Letter grade only (A-F). (Lecture-Problems 3 hours)

428. Highway Engineering Materials (3)
Prerequisites: CE 200 and 345 all with a grade of "C" or better.
Design and properties of highway materials, including aggregates, asphalt binder, and mixtures. Hot Mix Asphalt (HMA) aggregate gradation, blending procedure, volumetrics, design, plant operation, and lay down. Superpave binder testing and specifications.
(Lecture 2 hours, Laboratory 3 hours) Letter grade only (A-F).
Civil Engineering Courses (C E)

429. Traffic Engineering (2)
Corequisite: CE 426, 429L.
Capacity and level of service analyses of highway facilities. Intersection signal timing design. Introduction to traffic control devices. Volume, speed and delay studies. Use of traffic data for design, planning and operational levels of analyses.
Letter grade only (A-F). Graduate students required to do extra projects. (Lecture-Problems 3 hours)

429L. Traffic Engineering Laboratory (1)
Corequisites: CE 426, 429
Laboratory activities on traffic flow theory, capacity and level of service analyses, signal timing, parking lot design, and travel demand forecasting; traffic volume, speed and delay studies. Use of traffic engineering software.
(Laboratory 3 hours) Letter grade only (A-F). Not open for credit to student with credit in CE 430.

435. Hydrology and Water Resources Engineering (3)
Prerequisite: CE 335 with a grade of "C" or better.
Fundamental surface and ground water hydrology concepts and quantitative methods. Selected topics and procedures of the hydrological cycle. Planning, development and management of water resource system.
Letter grade only (A-F). (Lecture-Problems 3 hours)

437. Engineering Hydraulics (3)
Prerequisites: CE 335, MATH 370 A with a grade of "C" or better.
Theory and analysis of steady uniform and non-uniform flow in open conduits. Energy and momentum principles, critical flow computations and applications, design of channels, computations of gradually varied, spatially varied and rapidly varied flows.
Letter grade only (A-F). (Lecture-Problems 3 hours)

438. Hydraulic Engineering Design I (2)
Corequisites: CE 437, 438L
Application of hydraulic principles to the design of dams, water courses, water systems and their related structures and devices.
Letter grade only (A-F). (Lecture 2 hours)

438L. Hydraulic Design I Laboratory (1)
Corequisite: CE 438
Computer laboratory activities with the design of water courses, water systems and their related structures and devices
Letter grade only (A-F). (Laboratory 3 hours)

439. Fundamentals of Groundwater Flow and Contaminant Transport (3)
Corequisite: CE 437
(Lecture-Discussion 3 hours) Letter grade only (A-F).

445. Geotechnical Engineering II (3)
Prerequisites: CE 345, 346 all with a grade of "C" or better.
Methods of design and construction of various geotechnical engineering projects utilizing theory of soil mechanics.
Letter grade only (A-F). (Lecture-Problems 3 hours)

446. Geotechnical Projects (3)
Prerequisite: CE 345 with a grade of "C" or better.
Design and problem solving oriented geotechnical projects utilizing soil mechanics theory and experimental methods according to the state-of-the-art practice.
Letter grade only (A-F). Graduate students required to do additional readings and write a research term paper to deal with current topics in geotechnical engineering. (Lecture-Problems 3 hours)

454. Structures Laboratory (1)
Prerequisite: CE 359 with a grade of "C" or better.
Corequisite: CE 459.
Laboratory examination of structural concepts. Utilize computer simulation modeling techniques in combination with structural tests.
Letter grade only (A-F). (Lecture 3 hours) Not open for credit to students with credit in CE 491.

455. Structural Steel Design (3)
Prerequisite: CE 359 with a grade of "C" or better.
Detailed design of components with typical codes and specifications.
Letter grade only (A-F). (Lecture-Problems 3 hours)

456. Timber Design (3)
Prerequisite: CE 359 with a grade of "C" or better.
Design of various structural elements made of wood material subjected to both vertical and lateral loads. Application of current building codes and specifications in timber design.
Letter grade only (A-F). (Lecture-Problems 3 hours)

457. Reinforced Masonry Design (3)
Prerequisite: CE 359 with a grade of "C" or better.
Letter grade only (A-F). Graduate students required to do a design project and assigned readings from journals and research papers.
(Lecture-Problems 3 hours)

458. Structural Analysis II (3)
Prerequisite: CE 359 with a grade of "C" or better.
Solution of indeterminate truss and frame structures using moment distribution and slope deflection methods. Introduction to matrix methods. Energy theorems and virtual work principles. Use of code based finite element computer programs in the analysis of indeterminate structural systems.
Letter grade only (A-F). (Lecture-Problems 3 hours)

459. Reinforced Concrete Design I (3)
Prerequisites: CE 200 and 359 all with a grade of "C" or better.
Theory and design of structural elements of reinforced concrete, analysis by working stress and ultimate strength design theories.
Letter grade only (A-F). (Lecture-Problems 3 hours)

464. Environmental Engineering II: Unit Processes (3)
Prerequisites: CE 335 and 364 all with a grade of "C" or better.
Civil engineering applications of the fundamentals of chemical reactions, kinetics of biochemical systems, gas transfer systems, liquid/solid separations, solubility equilibria, adsorption, ion exchange and membrane processes.
Letter grade only (A-F). (Lecture-Problems 3 hours)

466. Environmental Systems Design (3)
Prerequisite: CE 364 with a grade of "C" or better.
Principles of environmental systems design. Design and planning of systems for water distribution, wastewater collection and storm water management.
Letter grade only (A-F). (Lecture-Problems 3 hours)

481. Professional Practice In Civil Engineering (1)
Prerequisite: Senior standing.
Topics related to practice of civil engineering profession. Professional society meetings and readings.
Letter grade only (A-F). (Lecture-Problems 1 hour)
490. Senior Design Project (3)
Prerequisite: CE 459; completion of all 300-level engineering courses for the civil engineering major all with a grade of "C" or better and consent of department undergraduate advisor.
Prerequisite/Corequisite: CE 426, 437.
Normally taken in the last year of the undergraduate program. A supervised design group project, incorporating all aspects from concept to completed design and oral presentations. Technical aspects, social, environmental, and economic issues considered. Ethical concepts discussed.
Letter grade only (A-F). (Lecture-Problems 2 hrs, Design lab 3 hrs)

495. Seismic Design I (3)
Prerequisites: CE 459 with a grade of "C" or better.
Elements of lateral-force design in steel, concrete, masonry, and timber structures. Application of current building codes.
Letter grade only (A-F). (Lecture 3 hours)

497. Senior Problem Directed Studies (2)
Prerequisites/Corequisites: CE 406, 481, 490.
Directed study on assigned topics or lab/field studies practicum and report on same.
Letter grade only (A-F).

GRADUATE LEVEL

500. Engineering Analysis I (3)
Prerequisites: MATH 370A with a grade of "C" or better.
Letter grade only (A-F). (Lecture-Problems 3 hours)

501. Engineering Analysis II (3)
Prerequisite: MATH 370A with a grade of "C" or better.
Analysis of engineering mechanics by matrix theory and complex variables; introduction to numerical techniques.
Letter grade only (A-F). (Lecture-Problems 3 hours)

502. Finite Element Method and Applications (3)
Prerequisite: CE 458 with a grade of "C" or better or consent of instructor.
(Lecture-Problems 3 hours) Letter grading only (A-F).

503. Selected Topics in Civil Engineering (3)
Prerequisites: Graduate standing and consent of instructor.
Selected topics, with laboratory work required, from the most recent developments in civil engineering.
Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in the Schedule of Classes. No more than 6 units of CE 503 or CE 504 may be counted for the Master's Degree. (Lecture-Problems 2 hours, Laboratory 3 hrs)

504. Selected Topics in Civil Engineering (3)
Prerequisite: Graduate standing or consent of instructor.
Selected topics from recent developments in civil engineering. Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in the Schedule of Classes. No more than 6 units of CE 503 and/or CE 504 may be counted for the master's degree. (Lecture-Problems 3 hrs)

508. Probabilistic and Statistical Methods in Engineering Applications (3)
Prerequisite: Graduate standing or consent of instructor.
Civil Engineering applications of nondeterministic models and decision theory. Applications of proven statistical computer programs.
Letter grade only (A-F). (Lecture-Problems 3 hours)

509. Computational Methods in Civil Engineering (3)
Prerequisite: Graduate standing or consent of instructor.
Numerical analysis and computer methods applied to various areas of civil engineering. Application of proven computer methods, including special problem-oriented languages.
Letter grade only (A-F). (Seminar 3 hrs)

516. Timber Design II (3)
Prerequisite: CE 359 and 456 all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-Problems 3 hours)

517./457. Reinforced Masonry Design (3)
Prerequisite: CE 359 with a grade of "C" or better.
Letter grade only (A-F). Graduate students required to do a design project and assigned readings from journals and research papers. (Lecture-Problems 3 hours)

520. Seaport Planning and Design (3)
Prerequisite: CE 426 with a grade of "C" or better or consent of instructor.
Planning and design of seaports and facilities as access systems. Support transportation, use analysis and ocean transport crafts. Site selection and comprehensive planning.
Letter grade only (A-F). (Lecture-Problems 3 hours)

522. Transportation Planning (3)
Prerequisite: CE 428 with a grade of "C" or better or consent of instructor.
Planning of transportation facilities in urban setting; application of travel forecasting and analytical models in the planning process; evaluation of transportation alternatives and impacts; transportation system and demand management techniques.
Letter grade only (A-F). (Lecture-Problems 3 hours)

526. Pavement Engineering (3)
Corequisite: CE 427 or consent of instructor.
Aggregate, binder systems. Theory and design of pavement structures.
Letter grade only (A-F). (Lecture-Problems 3 hours)

528. Advanced Highway Materials (3)
Prerequisite: CE 428 with a grade of "C" or better or consent of instructor.
Hot mix asphalt design methods and lay down methods. Distress identification and rehabilitation procedures of highway materials.
(Lecture-Discussion 3 hours) Letter grade only (A-F)

529. Advanced Traffic Engineering (3)
Prerequisite/Corequisite: CE 426 or consent of instructor.
Analysis of arterial streets traffic operations. Queuing Analysis; Signal timing coordination and optimization; Use of traffic optimization and simulation computer models to solve problems.
Letter grade only (A-F). (Lecture-Problems 3 hours)
Civil Engineering Courses (C E)

530. Groundwater Flow: Principles and Modeling (3)
Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.
(Lecture 3 hrs). Letter grade only (A-F).

532. Sediment Transportation (3)
Prerequisite: C E 437 with a grade of "C" or better.
Phenomena of sediment transportation related to streams and marine environments.
Letter grade only (A-F). (Lecture-Problems 3 hours)

533. Groundwater Contaminant Transport: Principles and Modeling (3)
Prerequisites: CE 437, 530 all with a grade of "C" or better or consent of instructor.
(Lecture 3 hrs). Letter grade only (A-F).

535. Advanced Hydrology (3)
Prerequisite: Graduate standing or consent of instructor.
Letter grade only (A-F). (Lecture-Problems 3 hours)

536. Urban Surface Water Management (3)
Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.
Planning and design of facilities to control flooding, erosion, sedimentation, and non-point source pollution for urban storm water runoff management. Presentation of analysis and design methodologies, structural and non-structural measures for management, and master planning principles.
Letter grade only (A-F). (Lecture-Problems 3 hours)

538. Hydraulic Engineering Design II (3)
Prerequisites: C E 437, 438 all with a grade of "C" or better or consent of instructor.
Letter grade only (A-F). (Lecture-Problems 3 hours)

542./446. Geotechnical Projects (3)
Prerequisite: CE 345 with a grade of "C" or better.
Design and problem solving oriented geotechnical projects utilizing soil mechanics theory and experimental methods according to the state-of-the-art practice.
Letter grade only (A-F). Graduate students required to do additional readings and write a research term paper to deal with current topics in geotechnical engineering. (Lecture-Problems 3 hours).

543. Waste Management and Landfill Engineering (3)
Prerequisite: Graduate standing or consent of instructor.
Advanced principles and practices of landfill engineering for waste management and subsurface flow problems. Presentation of research and case studies in geotechnical aspects of waste management and landfill engineering.
Letter grade only (A-F). (Lecture-Problems 3 hours)

546. Theory and Design of Foundation Structures (3)
Prerequisite: CE 345 with a grade of "C" or better or consent of instructor.
Foundation, explorations, stress and deformation relationships and design of various footings, piles, piers and caissons. Analysis of lateral loads and design of retaining structures, machinery foundations and foundation dewatering.
Letter grade only (A-F). (Lecture-Problems 3 hours)

547. Soil Dynamics (3)
Prerequisite: CE 345 with a grade of "C" or better or consent of instructor.
Theories and field behaviors of dynamically loaded foundation systems and soil responses with emphasis on engineering applications.
Letter grade only (A-F). (Lecture-Problems 3 hours)

548. Geotechnical Engineering III (3)
Prerequisite: C E 435 with a grade of "C" or better or consent of instructor.
Stress-strain time relationship of soils. Theory and methods of analysis with special emphasis on the applications and limitations in soil engineering.
Letter grade only (A-F). (Lecture-Problems 3 hours)

551. Prestressed Concrete (3)
Prerequisite: C E 459 with a grade of "C" or better.
Principles of prestressed concrete. Materials used, applications to structural design, review of existing specifications.
Letter grade only (A-F). (Lecture-Problems 3 hours)

552. Theory of Plates and Shells (3)
Prerequisite: Completion of C E Graduate MATH Requirement.
Review of theory of elasticity; formulation of general equation of bending of thin elastic plates; methods of obtaining exact and approximate solutions; membrane and bending theories of shells with emphasis on cylindrical shells and shells of revolution.
Letter grade only (A-F). (Lecture-Problems 3 hours)

553. Behavior and Design of Steel Structures (3)
Prerequisite: C E 455 with a grade of "C" or better.
Study of torsion, unsymmetrical bending, stability. Plastic design, code provisions and commentary. Design of complete structural systems in steel.
Letter grade only (A-F). (Lecture-Problems 3 hours)

554. Analysis and Design with Composite Materials (3)
Prerequisite: Graduate standing or consent of instructor.
Mechanics of composite materials with design applications in aerospace, civil engineering and construction. Lab experiments on composite samples. Project required with canned computer programs.
(Lecture-Problems 3 hrs) Letter grade only (A-F).

555. Seismic Design II (3)
Prerequisite/Corequisite: CE 495 or consent of instructor.
Characteristics of earthquakes and seismic response spectra, seismic load resisting systems, mechanisms of nonlinear deformation and seismic fuses. Advanced seismic analysis and design of irregular buildings and other structures. Seismic behavior of base isolation structures.
(Lecture-Problems 3 hours) Letter grading only (A-F).

557. Advanced Structural Analysis (3)
Prerequisite: C E 458 with a grade of "C" or better or consent of instructor.
Virtual forces and displacements, strain energy and complementary energy. Force and displacement matrix methods. Computer
applications to planar and space frames, trusses, floor beams and shear wall systems.

(Lecture-Problems 3 hours) Letter grade only (A-F).

558. Dynamics of Structures (3)
Prerequisite: CE 458 with a grade of "C" or better or consent of instructor.
Response of structures and structural components having one or more degrees of freedom. Damping and inelastic action; earthquake and nuclear blasts, dynamic resistance of structural elements and structures, elastic and inelastic response of structures.
(Lecture-Problems 3 hours) Letter grade only (A-F).

562. Water and Wastewater Treatment Design I (3)
Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.
Design of physical and chemical processes for water and wastewater treatment, with emphasis on water treatment plants.
(Lecture-Problems 3 hours) Letter grade only (A-F).

563. Water and Wastewater Treatment Design II (3)
Prerequisite: CE 562 with a grade of "C" or better or consent of instructor.
Design of chemical and biological processes for water and wastewater treatment with emphasis on wastewater treatment.
(Lecture-Problems 3 hours) Letter grade only (A-F).

564. Environmental Health Engineering (3)
Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.
(Lecture-Problems 3 hours) Letter grade only (A-F).

566. Unit Operations in Environmental Engineering (3)
Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.
Civil engineering applications of the fundamentals of chemical reactions, kinetics of biochemical systems, gas transfer operations, liquid/solid separations, solubility equilibria, adsorption, ion exchange and membrane processes.
(Lecture-Problems 3 hours) Letter grade only (A-F).

567. Liquid and Solid Waste Project Planning and Management (3)
Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.
The presentation of research and case studies of liquid and solid waste project planning and management.
Letter grade only (A-F). (Lecture-Problems 3 hours)

570. Engineering Management Principles and Practices (3)
Prerequisites: CE 406 with a grade of "C" or better, graduate standing or consent of instructor.
Transition of engineers into management. Analysis of technical manager’s functions at lower and middle levels as support to corporate management. Principles of engineering management and applications to private and public sector organizations. Case studies of practices in different technical organizations.
Letter grade only (A-F). (Lecture 3 hours)

571. Construction Planning and Cost Control (3)
Prerequisite: Graduate standing or consent of instructor.
Planning, scheduling and resource allocation for a complex construction project. Topics include traditional critical path method, advanced computer expert systems and optimization techniques for construction planning and cost control.
Letter grade only (A-F). (Lecture-Problems 3 hours)

573. Engineering Specifications, Law and Contracts (3)
Prerequisite: Graduate standing or consent of instructor.
Application of law of contracts to construction contracts. Legal matters of concern to engineers.
(Lecture-Problems 3 hours) Letter grade only (A-F).

574. Methods, Analysis and Design of Construction Operations (3)
Prerequisite: CE 571 with a grade of "C" or better or consent of instructor.
equipment, methods, analysis and design of a construction operation, from site work improvement and data acquisition to modeling and design. Particular attention will be paid to interfacing between design and construction activities and work method development, productivity and safety.
(Lecture-Problems 3 hours) Letter grade only (A-F).

576. Construction Organization and Management (3)
Prerequisite: Graduate standing or consent of instructor.
An introduction to construction organization, control concepts and labor, emphasizing the business aspects of construction engineering management. Topics include legal framework, finance in construction management, labor, accounting and other decision making in the construction business.
(Lecture-Problems 3 hours) Letter grade only (A-F).

577. Business Aspects and Finance of Construction Projects (3)
Prerequisite: CE 406 with a grade of "C" or better or consent of instructor.
Economics and business aspects in construction, financing structure, methodology, and project financial evaluation. Emphasis is on financial aspects in property acquisition, development, construction, and project management.
(Lecture-Problems 3 hours) Letter grade only (A-F).

578. Management of Advanced Technologies in Construction (3)
Prerequisite: Consent of instructor.
New development of advanced technology as applied to construction engineering and management. Topics include legal framework, finance in construction management, labor, accounting and other decision making in the construction business. Emphasis is on financial aspects in property acquisition, development, construction, and project management.
(Lecture-Problems 3 hours) Letter grade only (A-F).

581. Sustainability and Green Construction (3)
Prerequisite: Graduate standing or consent of instructor.
Comprehensive coverage of the green building design and construction practices through high-performance, market-leading design, construction, and operation practices. Presents the green operations and management of new construction and major renovation projects, with emphasis on green building rating systems.
(Lecture 3 hours) Letter grade only (A-F).

582. Management of Productivity and Quality (3)
Prerequisite: CE 570 with a grade of "C" or better or consent of instructor.
System approaches to quality and productivity in construction. Total Quality Management (TQM) in construction engineering and management. Investigation of methods and strategies for improving competitiveness at the company level. Domestic and international competitiveness in the construction business.
(Lecture-Problems 3 hours) Letter grade only (A-F).

585. Utility Rehabilitation and Construction (3)
State of infrastructure systems with a focus on underground facilities, diagnostic and evaluation techniques of underground utility pipes, planning, equipment, materials and methods for rehabilitation and construction of sewer and water mains using Trenchless (i.e. NO-DIG) Technology.
(Lecture-Problems 3 hours). Letter grade only (A-F).
Civil Engineering Courses (C E)

602. Seminar in Civil Engineering (3)
Prerequisite: Graduate Standing or consent of instructor.
Presentation of research in special fields of structures, transportation, environmental, urban, geotechnical, water resources, or construction engineering management. May be repeated once for credit. No more than six units of CE 602.
(Lecture-Problems 3 hours) Letter grade only (A-F).

629. Traffic Operations (3)
Prerequisite: CE 429 or 529 all with a grade of "C" or better, or consent of instructor.
Principles of traffic flow. Highway traffic operations. Evaluation of quality of traffic operations including long-range impact on efficient use of the systems and on safety. Identification and evaluation of measures of effectiveness. Travel demand management strategies and intelligent transportation system applications.
(Lecture-Problems 3 hours) Letter grade only (A-F).

630. Mathematical Modeling in Hydraulic Engineering (3)
Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.
Numerical techniques for solving hydraulic problems in water supply, waste water disposal and storm drainage systems. Prediction of important parameters by mathematical modeling on problems encountered in artificial channels, rivers, estuaries and marine environments.
(Lecture-Problems 3 hours) Letter grade only (A-F).

640./740. Mathematical Modeling in Geotechnical Engineering (3)
Prerequisite: Graduate standing or consent of instructor.
Mathematical modeling techniques used in geotechnical engineering. Application of proven computer programs.
M.S. students register in CE 640; Ph.D. students register in CE 740. Ph.D. students will be required to complete a more rigorous computer project. (Lecture-Problems 3 hours) Letter grade only (A-F).

696. Research Methods (1)
Prerequisite: Candidacy or consent of instructor.
Bibliographical and library techniques and resources. Preparation and presentation of theses and directed studies technical papers.
Letter grade only (A-F).

697. Directed Studies (1-3)
Prerequisite: Graduate standing. Corequisite: CE 696 or written consent of directed studies advisor.
MSCE and MSE degree candidates in Civil Engineering and Interdisciplinary Areas need to have either CE 697 or CE 698 as their program requirement. Theoretical and experimental problems in civil engineering requiring intensive analysis.
Letter grade only (A-F).

698. Thesis (2-6)
Prerequisite: Admission to candidacy for degree of master of science in civil engineering. Corequisite: C E 696 or written consent of faculty advisor.
Planning, preparation and completion of a thesis and/or project in the field of civil engineering.
Letter grade only (A-F). May be repeated to a maximum of 6 units.

699. Thesis (3-9)
Prerequisite: Admission to candidacy for degree of Civil Engineer. Corequisite: C E 696 or written consent of faculty advisor.
Planning, preparation and completion of a thesis in the field of civil engineering practice.
Letter grade only (A-F). May be repeated to a maximum of 9 units.

740. Ph.D. students will be required to complete a more rigorous computer project. (Lecture-Problems 3 hours) Letter grade only (A-F).

Construction Engineering Management Courses (CEM)

LOWER DIVISION

121. Construction Drawing I (2) F
An introduction to conventional and computer aided drafting techniques in the relation of drawings for construction. Interpretation of details in construction drawings/blueprints and reference materials. Laboratory: Drafting plans for a residential building using the techniques introduced in the course.
(Lecture 1 hr, laboratory 3 hrs) Letter grade only (A-F).

125. Fundamentals of Construction (3)
Survey of the professional activities and environments of Construction Education. Overview of residential, commercial, institutional, industrial, and heavy civil construction and associated codes, standards, and ethical boundaries. Areas of focus to include type of foundations, materials, contract documents, working drawings and vocabulary.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

200. Concrete Construction (1)
Prerequisite: CEM 125 with a grade of "C" or better.
Corequisite: CEM 200L.
Concrete composition, Concrete mix design technology, physical properties of concrete, use of admixtures, concrete batching, curing, testing. Includes physical testing of designed mixes. Modern concepts as fundamental solution to concrete construction challenges. New developments in concrete chemistry and strength theory.
Letter grade only (A-F). Not open for credit to students with credit in CEM 235. (Lecture-Discussion 1 hour)

200L. Concrete Construction Laboratory (1)
Corequisite: CEM 200.
Laboratory exercises in support of CEM 200. Concrete Construction. Develop concrete mix designs and prepare concrete samples for testing, such as compressive strength, slump and air entrainment, and aggregate testing.
(Laboratory 3 hours) Letter grade only (A-F). Not open for credit to students with credit in CEM 235L.

201. Cost Accounting for Construction Engineering (3)
Theoretical practical concepts of cost accounting. Variable and fixed costs, break-even point, interrelationships of costs, volume and profits; job-order accounting, general and flexible budgeting, standard costs; product costing methods; cost allocation; inventory planning; control and valuation; joint product.
(Lecture-Problems 3 hours) Letter grade only (A-F).

202. Probability and Statistics for Construction Engineering Management (3)
Prerequisite: High School Algebra.
Statistics and probability theories, sampling, correlation, regression applied to Construction Engineering Management.
Laboratory. (Simulation using statistical packages)
(Lecture 2 hours, Activity 2 hours) Letter grade only (A-F).
204. Applied Mechanics—Statics (3)
Prerequisites: MATH 122 and PHYS 100A all with a grade of "C" or better.
(Lecture 2 hours, Activity 2 hours) Letter grade only (A-F).

205. Computer Systems and Programming (2)
Overview of computer systems. Hardware topics include: Updated coverage of the central processing unit and memory, input/output devices, and storage mechanism. Software topics include: operating systems, and systems analysis. For laboratory exercises oriented object was used to solve problems.
(Lecture - Discussion 1 hour and Laboratory 3 hrs). Letter grade only (A-F).

Prerequisites: CEM 121, 125 with a grade of "C" or better. Corequisites: CEM 200, 200L.
An introductory course in planning, design, and construction of residential and light commercial buildings including materials, equipment, construction/assembly methods, quantity take-off, and building codes/standards. Field trips or visual presentation is required.
(Seminar 2 hours and Activity 2 hours) Letter grade only (A-F).

UPPER DIVISION

304. Applied Mechanics Strength of Materials (2)
Prerequisite: CEM 204 with a grade of "C" or better.
Strength of structural materials and applications in building structures and machines. Mechanical properties of materials, structural behaviors of load resisting components associated with construction processes.
(Lecture-Discussion 1 hr, Activity 2 hrs) Letter grade only (A-F).

310. Communication in Engineering Profession (3)
Prerequisites: ENGL 100, COMM 110 all with a grade of "C" or better and Senior standing.
(Lecture - Discussion 3 hours) Letter grade only (A-F).

315. Construction Safety (2)
Prerequisite: CEM 225 or CE 200 all with a grade of "C" or better. Terminology, safety functions, accident costs, workman's compensation and liability laws, O.S.H.A., governmental and non-governmental codes, regulations and field safety methods pertinent to the construction industry. Field trips.
Not open for credit to students with credit in CEM 328. (Lecture 1 hour , Activity 2 hours) Letter grade only (A-F).

320. Operations Management in Contemporary Organizations (3)
Prerequisites: MGMT 300, ENGR 310 all with a grade of "C" or better.
Overview of Managerial and organizational theories and practices - introduction to concepts, methods to analyze and improve operations performance in construction and in service organizations. Decision-making and problem-solving processes for organizations, management Effectiveness and efficiency at the organizational, process level, and performer level.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

324. Commercial, Institutional and Industrial Construction Practices and Estimating (3)
Prerequisites: CEM 315 with a grade of "C" or better.
Fundamental of commercial construction, including building layout, shallow and deep foundations, introduction to formwork systems, high strength, heavy and light weigh concrete, framing, flooring and roofing systems, construction and expansion joints, masonry and steel construction. Quantity takeoff.
(Lecture-Discussion 2 hours, Activity 2 hours). Letter grade only (A-F).

335. Soil Mechanics Technology (2)
Prerequisite: CEM 304 with a grade of "C" or better. Corequisite: CEM 335L.
Soil Composition, description, and classification; soil compaction; determination of physical properties of soils.
(Lecture-Problem 2 hours) Letter grade only (A-F).

335L. Soil Mechanics Technology Laboratory (1)
Prerequisite: CEM 304 with a grade of "C" or better. Corequisite: CEM 335.
Laboratory investigations and experiments in the phenomena of soil mechanics. Field trips.
(Laboratory 3 hours) Letter grade only (A-F).

365. Mechanical Equipment for Buildings (2)
Prerequisite: PHYS 100B with a grade of "C" or better. Corequisite: CEM 324.
Principles and current practices in water supply, waste disposal, heating, ventilating, air conditioning and fire protection.
(Lecture 1 hour and Activity 2 hours) Letter grade only (A-F).

373. Fundamentals of Integrated Project Delivery (3)
Prerequisite: Junior standing.
General overview of the attributes of all major project delivery systems, procurement methodologies and contracting approaches. (2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

374. Plant Planning and Layout (2)
Prerequisite: CEM 324 with a grade of "C" or better or consent of instructor.
Planning practices, procedures and requirements for laying out industrial facilities.
(Lecture - Discussion 2 hours) Letter grade only (A-F).

375. Electrical Equipment for Buildings (2)
Prerequisites: CEM 324, PHYS 100B all with a grade of "C" or better. Principles and current practices in the application of electrical equipment and material utilization, sound and signal systems.
(Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

404. Structural Design I (2)
Prerequisite: CEM 304 with a grade of "C" or better.
Fundamentals of design for structural concrete and masonry buildings in compliance with current building codes.
(Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

409. Directed Studies in Construction Engineering Management (1-3)
Prerequisites: Senior standing in CEM or consent of instructor. Advanced work of a technical nature within area of specialization on an experimental or research basis. Letter grade only (A-F).

421. Construction Planning and Scheduling (3)
Prerequisite: CEM 324 with a grade of "C" or better. Planning and scheduling of construction projects by graphic charts and Critical Path Method (CPM) networks utilizing manual and computer methods.
Letter grade only (A-F). Field trips. (Lecture-Discussion 2 hrs, Activities 2 hrs)
### Construction Engineering Management Courses (CEM)

#### 425. Earthwork and Civil Works Construction Practices (2)
Prerequisite: CEM 324, CE 406 all with a grade of "C" or better. Fundamentals of earthmoving operations, including volume calculation and mass diagrams, soil protection and dewatering systems, volume change characteristics and fundamentals of moving earth, equipment selection, management and economics. (Seminar 1 hour and Activity 2 hours) Letter grade only (A-F).

#### 426. Business and Construction Law (3)
Prerequisites: CEM 324; BLAW 220 all with a grade of "C" or better. Contractors license, mechanics lien, subdivision laws; public works projects, bid and bid requirements. Litigation and legal trends in affirmative action, design professional's liability. Administrative procedures of contractors. Study documentation, claims, waivers, arbitration, bonding, insurance, and indemnification. Discuss ethical practices. (Lecture-Discussion 3 hrs.) Letter grade only (A-F).

#### 429. Advanced Estimating and Bidding (3)
Prerequisite: CEM 315 with a grade of "C" or better. Corequisite: CEM 425. Concept and practices involved in the total estimate bidding process in construction, form initial project selection for submission of final bids. A complete project estimate and bid is prepared by each study. (Lecture 2 hours, Activity 2 hours) Letter grade only (A-F).

#### 431. Construction Cost Control (3)
Prerequisites: CE 406 and CEM 421 all with a grade of "C" or better. Establishing and controlling construction projects cost through utilization of procedures, techniques and systems commonly used to control resources allocated and to be expended on construction projects. (2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

#### 432. Facility Administration (3)
Prerequisite: CEM 421 with a grade of "C" or better. Management skills for facility management. Emphasis is placed on the management functions of planning, organizing, directing and controlling. Topics include: negotiation; communication; performance measurement; job enrichment; motivation; contracting services and interpersonal relationships. (Lecture-Discussion 3 hours) Letter grade only (A-F).

#### 433. Facility Finance Management (3)
Corequisite: CEM 432. Analysis of financial management strategies associated with facility management. Topics include: buy-lease considerations; building efficiency; leasing considerations; cost control and record keeping; facility capitalization; facility budgeting; cost benefit analysis and financial reports. (Lecture-Discussion 3 hours) Letter grade only (A-F).

#### 434. Facility and Property Management (3)
Prerequisite: CEM 433 with a grade of "C" or better. Principles of facility and property management. Topics include: property development; cost benefit analysis; site selection; architectural design; layout plans; building engineering; specifications; stacking and blocking plans; aesthetic standards; renovation and contracting standards. (Lecture-Discussion 3 hours) Letter grade only (A-F).

#### 436. Facility Operations Management (3)
Prerequisite: CEM 432 with a grade of "C" or better. Analysis of the functions of facility operations management. Topics include: building systems; mechanical systems; energy management; electrical systems; trades operations; grounds maintenance; custodial; furniture and equipment; waste removal contracting services; furniture standards; security systems and planned maintenance. (Lecture-Discussion 3 hours) Letter grade only (A-F).

#### 438. Structural Design II (2)
Prerequisite: CEM 304 with a grade of "C" or better. Simplified designs for steel and wood structures in accordance with current building codes. Selection of structural steel and wood systems with structural characteristics of members and connections. (Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

#### 443. Principles of Design-Build Project Delivery (3)
Prerequisite: CEM 373 with a grade of "C" or better. General overview and unique distinguish essential elements of design-build project delivery and how to make the mental-shift needed to transition from traditional Design-Bid-Build to design-build project delivery. (2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

#### 476. Construction and Maintenance of Infrastructure Facilities (2)
Prerequisites: CEM 425 with a grade of "C" or better. Comprehensive coverage of the construction principles and technologies embraced by the heavy civil industry. The course presents the construction methods and maintenance practices of heavy civil projects, with emphasis on utility pipes, bridges and roads. (Lecture 1 hour - Activity 2 hours) Letter grade only (A-F).

#### 485. CEM Senior Seminar (3)
Prerequisites: CEM 429 and 431 all with a grade of "C" or better or consent of instructor. Advanced work of a technical nature within the construction industry. All students will be required to participate into the Bid Compitations. (Lecture 2 hours, Activity 2 hours). Letter grade only (A-F).

#### 486. Infrastructure Management (2)
Prerequisites: CEM 476 and CE 406 all with a grade of "C" or better. Integrated approach to infrastructure management theories and practices including: tools, models and applied systems. The course presents the principles required to manage, preserve and improve the performance of infrastructure systems, with emphasis on utility pipes, bridges and roads. (1 hr lecture, 2 hrs activities) Letter grade only (A-F).

#### 490. Construction Project Management (3)
Prerequisites: CEM 426, 429 and 431 all with a grade of "C" or better. Capstone course where integrated project management principles are applied to a case study of actual construction project. Topics include plans and specifications, site logistics, estimating, planning, scheduling, cost control, and contract administration. Additionally, relationships with owners, designers and other officials are analyzed. (2 hrs lecture, 2 hrs activities) Letter grade only (A-F).
COMPUTER ENGINEERING AND COMPUTER SCIENCE
College of Engineering

Department Chair: Kenneth James
Department Office: Engineering & Computer Sciences (ECS) - 552
Telephone: (562) 985-4285
Website: http://www.cecs.csulb.edu/

Faculty: Anastasios Chassiakos, Michael Chelian, Sandra Cynar (Emerita), Wayne Dick (Emeritus), Todd Ebert, Burkhard Englert, Arthur Gittleman, Darin Goldstein, Min He, Michael Hoffman, Tom Johnson, Shui Lam, Dar-Biau Liu, Tracy Bradley Maples, Alvaro Monge, Frank Murgolo, Thinh Nguyen, Dennis Volper, Xiaolong Wu

Undergraduate Advisors: Michael Chelian, Alvaro Monge
Graduate Advisor: Shui Lam
General Education Advising: Academic Advising - Horn Center
Minor and Certificate Advisor: Alvaro Monge, Michael Chelian
Administrative Support Coordinator: Robin Ikemi
Administrative Support Assistant: Karyl Anthony

Students desiring detailed information should contact the department for referral to one of the faculty advisors.

Career Possibilities
Computer Engineer • Software Engineer • Systems Analyst • Hand-held Appliance Programmer • Web Application Developer • Mainframe Programmer • Applications Programmer • LAN/WAN Administrator • Systems Administrator • Computer Service Representative • Database Administrator • Technical Services Manager • Telecommunications Analyst (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

Accreditation
The Bachelor of Science in Computer Engineering is accredited by the Engineering Accreditation Commission, and the Bachelor of Science in Computer Science is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

Advisory Board
The Department of Computer Engineering and Computer Science is supported by an Advisory Board composed of engineers, computer scientists, and business executives in the Southern California area. This liaison helps the department keep its curricula responsive to the needs of the community.

Undergraduate Degree Programs

Bachelor of Science in Computer Engineering (121 units)

This program provides students with a strong background in mathematics, physics, and engineering science. Courses, especially those in the junior and senior years, emphasize an open-ended, design-oriented approach to solving engineering problems. Teamwork, communication skills, and an interdisciplinary approach to problem solving are integrated into the senior computer engineering design courses.

Program Educational Objectives
Our students following graduation will be able
• to enter California's high technology workforce, and make significant contributions to Computer Engineering through the research, design and development of a wide range of embedded systems and system-on-chip applications.
• to help further the state's economic growth by developing innovative ideas, and translating them into commercial products that benefit society.
• to function effectively as a team member and/or leader in multidisciplinary and multicultural environments.
• to recognize the societal and global context of their work and to understand professional and ethical responsibilities.
• to pursue lifelong learning through such activities as graduate school, distance education, professional training and membership in professional societies and to be able to adapt to new engineering tools.

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of “C” or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of “C” or better must be achieved in MATH 123 and PHYS 151 within one calendar year.
Requirements

Lower Division:

Take all of the following courses:

- CECS 100 Critical Thinking in the Digital Information Age (3)
  Prerequisite/Corequisite: ENGL 100 or its equivalent all with a grade of "C" or better.
- CECS 105 Introduction to Computer Engineering and Computer Science (1)
  Prerequisites: None.
- CECS 174 Principles of Computer Engineering II (3)
  Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.
- CECS 201 Computer Logic Design I (3)
  Prerequisite: MATH 113 or equivalent all with a grade of "C" or better.
- CECS 211 Principles of Computer Engineering I (3)
  Prerequisite: MATH 122 with a grade of "C" or better.
- CECS 228 Discrete Structures With Computing Applications I (3)
  Prerequisites: CECS 174 and MATH 113 or equivalent all with a grade of "C" or better.
- CECS 262 C for Embedded Programming (3)
  Prerequisites: CECS 174 and 201 all with a grade of "C" or better.
- CECS 271 Introduction to Numerical Methods (3)
  Prerequisites: CECS 174 and MATH 123 all with a grade of "C" or better.
- CECS 274 Object Oriented Programming and Data Structures (3)
  Prerequisite: CECS 174 with a grade of "C" or better.
- CECS 282 C++ for Java Programmers (3)
  Prerequisite: CECS 274 with a grade of "C" or better.
- ENGR 101 Introduction to the Engineering Profession (1)
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.
- ENGR 102 Academic Success Skill (1)
  Prerequisite: ENGR 101 with a grade of "C" or better.
- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 122.

Take one of the following choices:

- PHYS 152 Electricity and Magnetism (4)
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.
  or both of the following:
  - EE 210 Electro-Magnetic Foundations in EE (3)
    Prerequisite: PHYS 151 with a grade of "C" or better.
    Corequisites: MATH 123, EE 210L.
  - EE 210L Electro-Magnetic Foundations in EE Lab (1)

Upper Division:

Take all of the following courses:

- CECS 301 Computer Logic Design II (3)
  Prerequisites: CECS 174, 201 all with a grade of "C" or better.
- CECS 311 Principles of Computer Engineering II (3)
  Prerequisites: CECS 201 and CECS 211 all with a grade of "C" or better.
- CECS 346 Microprocessors and Controllers I (3)
  Prerequisites: CECS 211 and 262 all with a grade of "C" or better.
- CECS 347 Microprocessors and Controllers II (3)
  Prerequisites: CECS 301, 311, and 346 all with a grade of "C" or better.
- CECS 360 Integrated Circuit Design Software (3)
  Prerequisites: CECS 301, 346, MATH 123 or 222 all with a grade of "C" or better.
- CECS 362 Real-time Operating Systems (3)
  Prerequisites: CECS 285 or 346, and 262 all with a grade of "C" or better.
- CECS 440 Computer Architecture (3)
  Prerequisites: CECS 346 with a grade of "C" or better.
- CECS 447 Microprocessors and Controllers III (3)
  Prerequisite: CECS 347 with a grade of "C" or better.
- CECS 460 System on Chip Design (3)
  Prerequisite: CECS 360 with a grade of "C" or better.
- CECS 463 System on Chip Applications (3)
  Prerequisite: CECS 360 with a grade of "C" or better.
- CECS 490A Senior Project I (3)
  Prerequisites: CECS 347 with a grade of "C" or better, senior standing.
- CECS 490B Senior Project II (3)
  Prerequisites: CECS 490A or 491 with a grade of "C" or better and consent of instructor.
- EE 380 Probability, Statistics & Stochastic Modeling (3)
  Prerequisites: MATH 123; (CECS 100 or equivalent) all with a grade of "C" or better.

Take nine units of approved electives to be selected from:

- CECS 343, 406, 451, 456, 474, 475, 497; EE 386, 486; CE 406; ECON 300; CEM 310 (or ENGL 317); ENGR 350; MATH 370A.

A grade of "C" or better must be achieved in all required and elective courses. CE 406; CEM 310; CECS 100, 105, 174, 201, 211, 228, 262, 271, 274, 282, 301, 311, 343, 346, 347, 360, 362, 406, 440, 447, 451, 461, 463, 474, 475, 490A, 490B, 497; ECON 300; EE 210 and 210L, 380, 386, 486; ENGL 317; ENGR 101, 102, 350; MATH 122, 123, 370A; PHYS 151, 152.

Bachelor of Science in Computer Science (122 units)

This degree is designed to prepare graduates for a variety of professional careers in the computer field. The curriculum is designed to provide a balance between the theoretical and practical aspects of computer science. Extensive laboratory time is required for these courses, and design and analysis experiences are emphasized.

Program Educational Objectives

Our students following graduation will be able

- to enter California's high technology workforce, and make significant contributions through the research, design and development of software and networked computer systems.
- to help further the state's economic growth by developing innovative ideas, and translating them into commercial products that benefit society.
- to function effectively as a team member and/or leader in multidisciplinary and multicultural environments.
- to recognize the societal and global context of their work and to understand professional and ethical responsibilities.
• to pursue lifelong learning through such activities as graduate school, distance education, professional training and membership in professional societies and to be able to adapt to new engineering tools.

**Degree Progress**

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

**Requirements**

**Lower Division:**

Take all of the following courses:

- **CECS 100 Critical Thinking in the Digital Information Age (3)**
  Prerequisite/Corequisite: ENGL 100 or its equivalent.

- **CECS 105 Introduction to Computer Engineering and Computer Science (1)**
  Prerequisites: None.

- **CECS 174 Introduction to Programming and Problem Solving (3)**
  Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.

- **CECS 201 Computer Logic Design I (3)**
  Prerequisite: MATH 113 or equivalent all with a grade of "C" or better.

- **CECS 228 Discrete Structures With Computing Applications I (3)**
  Prerequisites: CECS 174 and MATH 113 or equivalent all with a grade of "C" or better.

- **CECS 274 Object Oriented Programming and Data Structures (3)**
  Prerequisite: CECS 174 with a grade of "C" or better.

- **CECS 277 Object Oriented Application Development (3)**
  Prerequisite: CECS 274 with a grade of "C" or better.

- **CECS 282 C++ for Java Programmers (3)**
  Prerequisite: CECS 274 with a grade of "C" or better.

- **CECS 285 Computer Organization and Assembly Language Programming (3)**
  Prerequisites: CECS 201, 274 all with a grade of "C" or better.

- **ENGR 101 Intro to the Engineering Profession (1)**
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

- **ENGR 102 Academic Success Skills (1)**
  Prerequisite: ENGR 101 with a grade of "C" or better.

- **MATH 122 Calculus I (4)**
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

- **MATH 123 Calculus II (4)**
  Prerequisite: A grade of "C" or better in MATH 122.

Three units of math elective taken from the following:

- **MATH 224 Calculus III (4)**
  Prerequisite: A grade of "C" or better in MATH 123 or 222.

- **MATH 233 Fundamental Concepts for Adv. Math (3)**
  Prerequisite: A grade of "C" or better in MATH 123 or 222.

- **MATH 247 Introduction to Linear Algebra (3)**
  Prerequisite: MATH 123 or 222.

Take a minimum of 12 units of approved science-electives to include a two-semester science sequence chosen from the following pairs of courses:

- **PHYS 151 Mechanics and Heat (4)**
  Prerequisite/Corequisite: MATH 122.

- **PHYS 152 Electricity and Magnetism (4)**
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123, or

- **PHYS 151 Mechanics and Heat (4)**
  Prerequisite/Corequisite: MATH 122.

- **EE 210 Electro-Magnetic Foundations in EE (3)**
  Prerequisite: PHYS 151 with a grade of "C" or better.
  Corequisites: MATH 123, EE 210L.

- **EE 210L Electro-Magnetic Foundations in EE Lab (1)**

- **CHEM 111A General Chemistry (5)**
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).  

**CHEM 111B General Chemistry (5)**

Prerequisite: CHEM 111A with a grade of "C" or better.

Remaining units to be chosen from the following:

- **BIOL 153, 200, 205, 207.**

**Upper Division:**

Take all of the following courses:

- **CECS 323 Database Fundamentals (3)**
  Prerequisites: CECS 228, 277 all with a grade of "C" or better.

- **CECS 326 Operating Systems (3)**
  Prerequisites: CECS 282 and either 285 or 346 all with a grade of "C" or better.

- **CECS 327 Net-Centric Computing (3)**
  Prerequisite: CECS 326 with a grade of "C" or better.

- **CECS 328 Data Structures and Algorithms (3)**
  Prerequisite: CECS 228 with a grade of "C" or better;
  Corequisite: CECS 277.

- **CECS 341 Computer Architecture and Organization (3)**
  Prerequisites: CECS 285 with a grade of "C" or better.

- **CECS 343 Introduction to Software Engineering (3)**
  Prerequisites: CECS 277 or 282 all with a grade of "C" or better.

- **EE 380 Probability, Statistics and Stochastic Modeling (3)**
  Prerequisites: MATH 123; (CECS 100 or equivalent) all with a grade of "C" or better.

- **ENGR 350 Computers, Ethics and Society (3)**
  Prerequisites: 3 units from GE Category A.1 (Writing) and 3 units from GE Category D (Social and Behavioral Science).

Take one course from the following:

- **CEM 310 Communications in Engineering Profession (3)**
  Prerequisites: ENGL 100, COMM 110 all with a grade of "C" or better and Senior standing.

- **ENGL 317 Technical Writing (3)**
  Prerequisites: GE Foundation requirements, upper-division standing, and a previous composition course, i.e., ENGL 100, 101, 102, 300, or equivalents.
Take three units of study in formal languages and computation to be chosen from the following courses:

CECS 419, 424, 444

Take 15 units of approved electives chosen from:

Take six units of core electives chosen from the following:

CECS 419, 424, 428, 429, 444, 445, 448, 449, 451, 474, 478, MATH 323

Take three units of applied electives to be chosen from the following:

CECS 455, 470, 472, 475, 476

Take three units from a capstone course to be chosen from the following:

CECS 423, 491, 492

Take three units chosen from either the core, applied, or senior capstone course list, or from the following:

CECS 405, 406, 490B, 497.

A grade of "C" or better is required in the following courses:

BIOL 153, 200, 205, 207; CEM 310; CHEM 111A, 111B; CECS 100, 105, 174, 176, 201, 228, 274, 277, 282, 285, 323, 326, 327, 328, 341, 343, 423, 490A, 491, 492; EE 210 and 210L, 380; ENGL 317; ENGR 101, 102, 350; MATH 122, 123, 222, 224, 233, 247, 380; PHYS 151, 152.

**Bachelor of Science in Engineering Technology**

**Technology and Engineering Education Option**

For requirements, see the description in the Engineering Technology Programs section of this catalog.

**Minor in Computer Science Applications**

**Requirements**

A minimum of 21 units.

Take all of the following:

CECS 174 Introduction to Programming and Problem Solving (3)
Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.

CECS 228 Discrete Structures with Computing Applications (3)
Prerequisites: CECS 174 and MATH 113 or equivalent all with a grade of "C" or better.

CECS 274 Object Oriented Programming and Data Structures (3)
Prerequisite: CECS 174 all with a grade of "C" or better.

CECS 323 Database Fundamentals (3)
Prerequisites: CECS 228, 277 all with a grade of "C" or better.

Take one of the following courses:

CECS 277 Object Oriented Application Development (3)
Prerequisite: CECS 274 with a grade of "C" or better.

CECS 282 C++ for Java Programmers
Prerequisite: CECS 274 with a grade of "C" or better.

Take two courses selected from the following:

CECS 328, 343, 419, 423, 428, 445, 451, 455, 470, 475, 497

**Minor in Web Technologies and Applications**

Open to all majors except those seeking a B.S. Engineering Technology, Option in Technology and Engineering Education. The minor is conferred concurrently with the BS/BA degree.

This minor will provide the technical skills not included in non-technical degrees, but required for success in a highly technical world. Students will gain an understanding of the system design process and learn to acquire and evaluate information via the internet including ethical issues encountered. In addition, students will learn to create a robust, useable, and accessible website.

**Requirements**

A minimum of 18 units as specified below.

Complete the 12 core units:

CECS 100 Critical Thinking in the Digital Information Age (3)
Prerequisite/Corequisite: ENGL 100 or its equivalent.

CECS 110 Beginning Web Design (3)
Prerequisites: None.

CECS 200 Intermediate Web Design (3)
Prerequisite: CECS 110 with a grade of "C" or better.
Prerequisite/Corequisite: CECS 100.

CECS 300 Design of Dynamic Web Sites (3)
Prerequisite: CECS 200 with a grade of "C" or better.

Complete 6 units from the following list of electives:

ART 366; CECS 323, 410, 412, 470; ENGR 350; ETEC 435; IS 380, 445, 484; MKTG 437; PSY 327.

**Minor in Computer Science Applications**

This minor is not open to students majoring in Computer Science or Computer Engineering.

This minor is designed to prepare students to write small programs and to maintain and upgrade PC software and hardware as well as understand how to set up a local area network. In addition it prepares students to be able to design and implement web applications.

**Requirements**

Completion of 18 units.

Complete the 12 core units:

CECS 110 Beginning Web Design (3)
Prerequisites: None.

CECS 174 Intro to Programming & Problem Solving (3)
Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.

CECS 200 Intermediate Web Design (3)
Prerequisite: CECS 110 with a grade of "C" or better.
Prerequisite/Corequisite: CECS 100.

CECS 410 Computers and Networks (3)
Prerequisite: Course design assumes familiarity with computers.

Complete 6 units from the following list of electives:

CECS 300, 310, 412; IS 300, 340, 343; ETEC 435.

**Certificate in Web Technologies and Applications**

Open to all majors except those with or seeking a B.S. Engineering Technology, Option in Technology and Engineering Education. The certificate is conferred as a post-baccalaureate certificate or concurrently with the BS/BA degree.

This certificate will prepare students to work with a variety of technologies including computers and related technologies and the proper setup and operation of equipment along with valuable troubleshooting skills. Students will gain an understanding of the system design process and learn to acquire and evaluate information from the internet and to
communicate information via the internet including ethical issues. They will learn to create a robust, useable, and accessible website.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

Requirements
A minimum of 24 units as specified below

Complete the 18 core units:
- CECS 100 Critical Thinking in the Digital Information Age (3)
  Prerequisite/Corequisite: ENGL 100 or its equivalent.
- CECS 110 Beginning Design (3)
- CECS 200 Intermediate Design (3)
  Prerequisite: CECS 110 with a grade of "C" or better.
- CECS 300 Design of Dynamic Web Sites (3)
  Prerequisite: CECS 200 with a grade of "C" or better.
- CECS 410 Computers and Networks (3)
  Prerequisite: Course design assumes familiarity with computers.
- CECS 412 Intro to Computer Network Architectures (3)
  Prerequisite: Familiarity with computers.

Complete 6 units from the following list of electives:
- ART 366; CECS 323, 470; ENGR 350; ETEC 435; IS 380, 445, 484; MKTG 437; PSY 327I

Option in Computer Engineering
This option offers advanced study in the theory, analysis, design and applications of both computer hardware and software.

Prerequisites
1. A bachelor’s degree in computer science, engineering, or other appropriate discipline from an accredited college or university, with a minimum grade point average (GPA) of 2.7 in the last 60 semester units or 90 quarter units attempted.
2. Students are required to have taken the following prerequisite courses (or their equivalents) in their undergraduate study or have any deficiencies removed prior to Advancement to Candidacy:
   A. One year of instruction in an object-oriented programming language.
   B. Take all of the following courses:
      - CECS 301 Computer Logic Design II (3)
        Prerequisites: CECS 174, 201 all with a grade of "C" or better.
      - CECS 326 Operating Systems (3)
        Prerequisites: CECS 282 and either 285 or 346 all with a grade of "C" or better.
      - CECS 343 Introduction to Software Engineering (3)
        Prerequisites: CECS 277 or 282 all with a grade of "C" or better.
      - CECS 346 Microprocessors and Controllers I (3)
        Prerequisites: CECS 211 and 262 all with a grade of "C" or better.
      - CECS 347 Microprocessors and Controllers II (3)
        Prerequisites: CECS 301, 311, and 346 all with a grade of "C" or better.
      - CECS 360 Integrated Circuit Design Software (3)
        Prerequisites: CECS 301, 346, MATH 123 or 222 all with a grade of "C" or better.
      - CECS 440 Computer Architecture (3)
        Prerequisites: CECS 346 with a grade of "C" or better.
      - MATH 370A Applied Mathematics I (3)
        Prerequisites: MATH 123. Not open to Freshmen.

3. Students must consult with the graduate program advisor prior to enrolling in any course for the program.

Requirements
Students must complete a minimum of 30 graduate and approved upper-division course units including the following:
1. At least 21 units at the graduate level of instruction;
2. 12 units of required courses consisting of:
   A. CECS 460 System on Chip Design (3)
      Prerequisite: CECS 360 with a grade of "C" or better.
   B. CECS 530 Advanced Computer Architecture I (3)
      Prerequisite: CECS 341 or 440 with a grade of "C" or better.
   C. One course from the following:
      - CECS 531 Advanced Computer Architecture II (3)
        Prerequisite: CECS 530 with a grade of "C" or better.
      - CECS 546 Fault Tolerant Computing Systems (3)
        Prerequisite: CECS 530 with a grade of "C" or better.
   D. One course from the following:
      - CECS 526 Advanced Operating Systems (3)
        Prerequisites: CECS 228 and 326 all with a grade of "C" or better.
      - CECS 528 Advanced Analysis of Algorithms (3)
        Prerequisites: CECS 328, MATH 380 or EE 380 all with a grade of "C" or better.
3. All students must complete either:
   A. Comprehensive examination, or
   B. Thesis with oral defense which requires a total of 6 units from the following (at least 4 units must be CECS 698):
      - CECS 697 Directed Research (1-3)
      - CECS 698 Thesis or Industrial Project (2-6)
      Prerequisite: Classified Graduate standing.

CECS 698 Thesis or Industrial Project (2-6)
Prerequisite: Advancement to Candidacy.

Option in Computer Science
This option offers advanced study in software development and engineering, networking, operating systems, distributed computing, artificial intelligence, security, and analysis of algorithms.

Prerequisites
1. A bachelor’s degree in computer science, engineering, or other appropriate discipline from an accredited college or university, with a minimum grade point average (GPA) of 2.7 in the last 60 semester units or 90 quarter units attempted.
2. Students are required to have taken the following prerequisite courses (or their equivalents) in their undergraduate study or have any deficiencies removed prior to Advancement to Candidacy:
   A. One year of instruction in an object-oriented programming language.
   B. All of the following courses:
      - CECS 228 Discrete Structures with Computing Applications (3)
        Prerequisites: CECS 174 and MATH 113 or equivalent all with a grade of "C" or better.
      - CECS 285 Computer Organization and Assembly Language Programming (3)
        Prerequisites: CECS 201, 274 all with a grade of "C" or better.
      - CECS 323 Database Fundamentals (3)
        Prerequisites: CECS 228, 277 all with a grade of "C" or better.
      - CECS 326 Operating Systems (3)
        Prerequisites: CECS 282 and either 285 or 346 all with a grade of "C" or better.
      - CECS 328 Data Structures and Algorithms (3)
        Prerequisite: CECS 228 with a grade of "C" or better.
        Corequisite: CECS 277.
      - CECS 341 Computer Architecture and Organization (3)
        Prerequisites: CECS 285 with a grade of "C" or better.
      - CECS 343 Introduction to Software Engineering (3)
        Prerequisites: CECS 277 or 282 all with a grade of "C" or better.
      - EE 380 Probability, Statistics and Stochastic Modeling (3) [or MATH 380 (3)]
        Prerequisites: MATH 122; (CECS 100 or equivalent) with a grade of "C" or better.
   C. One of the following:
      - CECS 419 Theory of Computation (3)
        Prerequisite: CECS 328 with a grade of "C" or better.
      - CECS 424 Organization of Programming Languages (3)
        Prerequisites: CECS 326 and 328 all with a grade of "C" or better.
      - CECS 444 Compiler Construction (3)
        Prerequisites: CECS 285 and 328 with a grade of "C" or better.
3. Students must consult with the graduate program advisor prior to enrolling in any course for the program.

Requirements
Students must complete a minimum of 30 graduate and approved upper-division course units including the following:
1. At least 21 units at the graduate level of instruction;
2. 12 units of required courses consisting of:
   A. CECS 528 Advanced Analysis of Algorithms (3)
      Prerequisites: CECS 328, MATH 380 or EE 380 all with a grade of "C" or better.
   B. One course from the following:
      - CECS 526 Advanced Operating Systems (3)
        Prerequisites: CECS 228 and 326 with a grade of "C" or better.
      - CECS 530 Advanced Computer Architecture I (3)
        Prerequisite: CECS 341 or 440 with a grade of "C" or better.
   C. Two courses from the following:
      - CECS 521, 531, 543, 546, 572, 575
3. All students must complete either:
   A. Comprehensive examination, or
   B. Thesis with oral defense which requires a total of 6 units from the following (at least 4 units must be CECS 698):
      - CECS 697 Directed Research (1-3)
      - CECS 698 Thesis or Industrial Project (2-6)

Advancement to Candidacy for Both Options
Students applying for advancement to candidacy must:
1. have completed all undergraduate deficiencies with grades of "C" or better;
2. have attained an overall grade point average (GPA) of 3.0;
3. have completed at least 12 units of required courses applicable to the degree with a GPA of at least 3.0 for the completed units;
4. have fulfilled the Graduation Writing Assessment Requirement (GWAR);
5. and have their plans of studies approved by the CECS department graduate advisor.

Computer Engineering and Computer Science Courses (CECS)

LOWER DIVISION
100. Critical Thinking in the Digital Information Age (3)
Prerequisite/Corequisite: ENGL 100 or its equivalent.
Help students develop critical thinking skills using technical software. Main topics include: identifying engineering issues for investigation, developing planning and problem solving strategies, locating pertinent information and examples, critically analyzing these sources, forming and testing hypotheses, synthesizing and organizing results for effective communication, and developing transferable problem solving skills.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

105. Introduction to Computer Engineering and Computer Science (1)
Introduction to the fields of computer engineering and computer science. Current and future trends and challenges in various fields of computing. Social, ethical and economical issues related to computing technology. Exploration of career and professional development opportunities.
(Lecture 3 hour) Letter grade only (A-F).
### 110. Beginning Web Design (3)
Introduction to HTML and CSS using modern tools, following the W3C guidelines for coding. Web sites designed with usability and accessibility principles implemented. Overview of graphics, video, sound, JavaScript and Dreamweaver.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

### 174. Introduction to Programming and Problem Solving (3)
Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.
Introduction to basic concepts of computer science and fundamental techniques for solving problems using the Java programming language. Structured problem solving, object-oriented programming, programming style. Applications to numerical and non-numerical problems.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

### 262. C for Embedded Programming (3)
Prerequisites: CECS 174 and 201 all with a grade of "C" or better.
Introduction to embedded system architecture, memory organization and programming using C. Interfacing with external I/O devices. Use of internal special function registers. Development tools and extended C instructions unique to embedded systems. Course will be taught using an embedded processor development board.
(Lecture 2 hours, laboratory 3 hours.) Letter grade only (A-F).

### 271. Introduction to Numerical Methods (3)
Prerequisites: CECS 174 and MATH 123 all with a grade of "C" or better.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

### 274. Object Oriented Programming and Data Structures (3)
Prerequisite: CECS 174 with a grade of "C" or better.
Disciplined methods of design, coding and testing using the Java programming language. Data abstraction, object-oriented design. Introduction to data structures (linked lists, stacks, queues and trees.) Recursion. Sorting and searching.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

### 277. Object Oriented Application Development (3)
Prerequisite: CECS 274 with a grade of "C" or better.
Advanced introduction to the fundamentals of computer science and software engineering methodology. Advanced programming techniques and design methodology typically used in large programming projects using the Java programming language.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

### 282. C++ for Java Programmers (3)
Prerequisite: CECS 274 with a grade of "C" or better.
Structured and Object Oriented Programming in C++. Common features and differences between Java and C++. Pointers, references, and memory management, stream I/O, classes, operator overloading, exception handling, STL.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

### 285. Computer Organization and Assembly Language Programming (3)
Prerequisites: CECS 201, 274 all with a grade of "C" or better.
Study of computer organization and assembly language programming using embedded processor based systems to solve practical problems. Laboratory projects using embedded system software development and hardware simulation tools. Hands-on projects using hardware prototyping boards.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

### UPPER DIVISION

#### 300. Design of Dynamic Web Sites (3)
Prerequisite: CECS 200 with a grade of "C" or better.
Dynamic Web design using modern tools. Creation of domains, using hosting services and content management systems. Website portability, usability and accessibility.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

#### 301. Computer Logic Design II (3)
Prerequisites: CECS 174, 201 all with a grade of "C" or better.
Sequential logic, programmable logic design, basic Arithmetic Logic Unit (ALU) design and memory devices. Laboratory projects with Medium Scale to Very Large Scale Integration (MSI to VLSI) implementations and Computer Aided Design (CAD).
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

#### 310. Computer-Based Learning Resources (3)
Prerequisite: CECS 200 with a grade of "C" or better.
Explore and learn to use the many existing web-based education tools that focus on teaching technology. Evaluation of resources for age appropriateness and gender preferences. Students will develop a web-based tool to teach a technical subject of their choice. Field work required.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)
311. Principles of Computer Engineering II (3)
Prerequisites: CECS 201 and CECS 211 all with a grade of "C" or better.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)
312. Introduction to Distributed Operating Systems (3)
Prerequisite: CECS 174 with a grade of "C" or better.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
323. Database Fundamentals (3)
Prerequisites: CECS 228, 277 all with a grade of "C" or better.
Fundamental topics on database management. Topics include entity-relationship models, database design, data definition language, the relational model, data manipulation language, database application programming and normalization.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)
326. Operating Systems (3)
Prerequisites: CECS 282 and either 285 or 346 all with a grade of "C" or better.
The structure and functions of operating systems. Interrupt handling, processes and interprocess communication, memory management, resource scheduling, information sharing and protection. Project implementation in C/C++.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
327. Net-centric Computing (3)
Prerequisite: CECS 326 with a grade of "C" or better.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
328. Data Structures and Algorithms (3)
Prerequisite: CECS 228 with a grade of "C" or better.
Corequisite: CECS 277.
A broad view of data structures and the structure-preserving operations on them. Abstract data types, algorithms, complexity. Programming projects to exemplify these concepts.
341. Computer Architecture and Organization (3)
Prerequisites: CECS 285 with a grade of "C" or better.
(Lecture 2 hours, laboratory, 3 hours) Letter grade only (A-F).
343. Introduction to Software Engineering (3)
Prerequisites: CECS 277 or 282 all with a grade of "C" or better.
Principles of software engineering, UML, modeling large software systems, requirements elicitation, object oriented analysis and design using UML, introduction to design patterns, implementation of large systems, software testing, project management, the software lifecycle. Semester long programming project.
Letter grade only (A-F). (Lecture 2 hours, lab 3 hours)
345. Fundamentals of Embedded Systems (3)
Prerequisite: CECS 202 with a grade of "C" or better.
Beginning course in embedded system design and technology. Examines embedded systems market, their fundamental basis, key hardware and software technology drivers, critical applications and component segments. Provides up-to-date analysis of recent developments and current trends in market space.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
346. Microprocessors and Controllers I (3)
Prerequisites: CECS 211 and 262 all with a grade of "C" or better.
Intro microprocessor/controller, embedded programming and design. Basic computer organization, representation of information and instruction, addressing techniques, input/output, assembly language programming. Introduction to assemblers, linkage editors and loaders. Study of the 8051. Design of microprocessor-based systems.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
347. Microprocessors and Controllers II (3)
Prerequisites: CECS 301, 311, and 346 all with a grade of "C" or better.
Study of embedded processor applications and interfacing. Embedded systems design, control of external devices, embedded programming in C and Assembly, A/D and D/A converters, digital signal processing, motor and LCD controllers. Laboratory implementation of embedded designs and hardware-assisted debugging.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
360. Integrated Circuit Design Software (3)
Prerequisites: CECS 301, 346, MATH 123 or 222 all with a grade of "C" or better.
Introduction to Computer Aided Design tools used in the design and fabrication of integrated circuits. Discussion of the IC fabrication process, the layout and routing of basic gates, transistor level design of gates, synthesis and RTL level design, floor planning, and IC development costs.
(Lecture 2 hours, lab 3 hours) Letter grade only (A-F).
362. Real-Time Operating Systems (3)
Prerequisites: CECS 285 or 346, and 262 all with a grade of "C" or better.
Introduction to embedded Real-Time Operating Systems (RTOS) and device drivers. Work with open-source RTOS on an 8-bit hardware platform to understand and write kernels, executives and schedulers along with preemptive multi-tasking systems. Student will study and write device drivers that will be implemented in RTOS. Programming will be done in C and assembly language.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
401. Programming Robots – For Educators (3)
Prerequisite: Some programming experience.
Learn how to inspire interest in engineering and computer science among children ages 9 through 16. Using robotic kits, gain hands-on experience in problem solving and computer programming while constructing and programming unique robot inventions.
May not be used to satisfy any MSCS requirements. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
405. Selected Topics in Computer Science (3)
Prerequisite: Senior standing in computer science major.
Selected topics from recent advances in computer science and technology.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
406. Selected Topics in Computer Science (3)
Prerequisite: Senior standing in the computer science major.
Each offering is based upon an area of computer science and technology in which recent advances have been made.
Letter grade only (A-F). May be repeated to a maximum of 6 units.
with different topics in different semesters. Topics announced in the Schedule of Classes. (Lecture 2 hours, laboratory 3 hours)

410. Computers and Networks (3)
Prerequisite: Course design assumes familiarity with computers. Gain practical, hands-on experience in installing hardware and software on a PC. Learn what a computer network is and how it is similar to the telephone network. Learn the parts that make up a computer and a network. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

412. Introduction to Computer Network Architectures (3)
Prerequisite: Familiarity with computers
Beginning course in computer networking designed to provide a grasp of network architectures through lecture/hands-on laboratory assignments. Overview of networking concepts and design essentials. Networking media and NICs. Network communications/protocols focusing on TCP/IP. Local area networks. Networking administration. Networking problems. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

414. Introduction to Network and System Security Issues (3)
Prerequisites: CECS 174 with a grade of "C" or better.
Controlling the risk of computer security: Security threats and vulnerabilities in the development and use of computer systems. Tools and controls that can reduce or block these threats. Topics in Network Security. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

419./519. Theory of Computation (3)
Prerequisite: CECS 328 with a grade of "C" or better.
Finite Automata and regular expressions. Pushdown automata and context-free languages. Turing machines and computability. Computational complexity. Letter grade only (A-F). Additional projects required for CECS 519. (Lecture-problems 3 hours)

423. Database Web Applications in JEE (3)
Prerequisites: CECS 323 and 343 all with a grade of "C" or better.
Design and development of data-intensive web applications in Java EE. Database topics include transaction management, stored procedures, triggers, and security. Web application design and development using core JEE patterns like Front Controller, MVC, and DAO. Application of software engineering to complete a group project. Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

424. Organization of Programming Languages (3)
Prerequisites: CECS 326 and 328 all with a grade of "C" or better.
Understanding the variety of programming languages and the design trade-offs between current programming language paradigms. Comparison of programming languages in their design, implementation, and run-time supports. Includes programming projects. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

428. Analysis of Algorithms (3)
Prerequisite: CECS 328 with a grade of "C" or better.
Applications of standard combinatorial techniques to applied programming problems. Rigorous analysis of correctness/complexity of algorithms. Advanced graph algorithms are emphasized. Topics include shortest paths on graphs, sorting, string matching, union find problem, divide-and-conquer technique, and weighted-edge problem. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

429./529. Search Engine Technology (3)
Prerequisites: CECS 323 and 328, MATH 380 or EE 380 all with a grade of "C" or better.

440. Computer Architecture (3)
Prerequisites: CECS 346 with a grade of "C" or better.

443. Software Engineering (3)
Prerequisite: CECS 326 with a grade of "C" or better.
Software life cycle. Functional decomposition, data flow and object-oriented development. Reusability and portability. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

444. Compiler Construction (3)
Prerequisites: CECS 285 and 328 all with a grade of "C" or better.
Syntax directed compiler study. Organization of a compiler and overall design: parsing, semantic analysis, optimization and code generation. (Lecture 3 hours, laboratory 3 hours) Letter grade only (A-F).

445. Software Design and Architecture (3)
Prerequisites: CECS 343 with a grade of "C" or better and senior standing.
In-depth look at software design, design patterns, frameworks, architectures and middleware architectures. Component based design including COM, Corba, and .Net. Fundamentals of software metrics, measuring software qualities. Basics of software evolution, reengineering, and reverse engineering. A semester long term project. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

447. Microprocessors and Controllers III (3)
Prerequisite: CECS 347 with a grade of "C" or better.
Embedded system applications and techniques. Real-time multitasking systems, schedulers, kernels, and operating systems for embedded processors. Advanced I/O technologies - CAN, I2C, Ethernet. Embedded Internet applications. Polling vs. interrupt handling. Lab implementation of embedded designs and hardware-assisted debugging. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

448. User Interface Design (3)
Prerequisite: CECS 343 with a grade of "C" or better or consent of instructor.
Evaluation, design and programming of user interface systems. Fundamentals of human cognition, system characteristics, and the interaction between humans and systems. Usability methods and user/task-centered design. Tools for designing and building user interfaces, with emphasis on rapid applications development. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

449. Computer Graphics (3)
Prerequisites: MATH 247, CECS 282 and 328 all with a grade of "C" or better.
Basic software and hardware of 2-D computer graphics. Applications. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

451. Artificial Intelligence (3)
Prerequisites: CECS 277 and 328 all with a grade of "C" or better.
Introduction to the history and implementation of artificial intelligence agents. Topics include search, constraint satisfaction, game-playing, logical agents, belief networks, optimal sequential decision systems. Project implementation. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).
465. Introduction to Game Programming (3)
Prerequisite: CECS 328 with a grade of "C" or better or consent of instructor.
Introduction to game programming and graphics. "Slow" games. Real-time games with no adversary. Adversarial real-time games in 2D.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

466. System on Chip Design (3)
Prerequisite: CECS 360 with a grade of "C" or better.
Complete System on Chip (SOC) design flow from design specification to working SOC. Creation of RTL level modules designed for reuse, integration of Intellectual Property (IP) for RTL and physical level IP; IC verification, creation of self-checking test benches for designs.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

461./561. Hardware/Software Co-design (3)
Prerequisite: CECS 341 or 440 all with a grade of "C" or better.
Introduction to top-down methods for hardware/software system-on-chip co-design. Design flow – system specification, software implementation, hardware synthesis, system design, and verification. Process optimization with various design decisions emphasized. Projects/case studies using system-level design methods and tools. Additional projects required for CECS 561. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

463. System on Chip (SOC) Applications (3)
Prerequisite: CECS 360 with a grade of "C" or better.
System on Chip (SOC) design applications. Study of a variety of signal processing SOC designs and ASIC algorithms. Class projects emphasizing hardware/software integration with use of FPGA/CPLD devices. Design reviews, specification, team design implementation with project planning and tracking for system level design applications.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

470. Web Programming and Accessibility (3)
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

472. Computer Network Programming (3)
Prerequisites: CECS 326 or 362 all with a grade of "C" or better.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

474. Computer Network Interoperability (3)
Prerequisite: CECS 326 or 362 all with a grade of "C" or better.
Overview of computer network theory and practice from a systems perspective. Topics include network infrastructure, local area network (LAN) protocols, wide area network (WAN) protocols, switching technologies, Internet Protocol (IP), Transmission Control Protocol (TCP), network security, and network configuration, design, and performance.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

475. Application Programming Using .NET (3)
Prerequisite: CECS 343 with a grade of "C" or better.
A rigorous introduction to enterprise application development utilizing the .NET environment. Topics include GUI interface concepts, multithreading, collections and web forms as well as application interfaces to database, web services and networks. Intensive individual projects as well as a team project.
Letter grade only (A-F). (Lecture 2 hours, laboratory 3 hours)

476. System and Network Administration (3)
Prerequisites: CECS 326 or 362 all with a grade of "C" or better. Introduction to the management and administration of Unix systems and TCP/IP networks. Managing users, local and network file systems, electronic mail, print queues. Establishing and managing a network.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

478./578. Introduction to Computer Security (3)
Prerequisite: CECS 323, 328, and one course selected from 472, 474, 476 all with a grade of "C" or better.
Controlling the risk of computer security. Security threats and vulnerabilities in the development and use of computer systems. Tools and controls that can reduce or block these threats. Law, privacy and ethics.
Additional projects required for CECS 578. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

490A. Senior Project I (3)
Prerequisite: CECS 347 with a grade of "C" or better, senior standing.
A design course where the student will define a problem and provide a report containing a complete design solution.
(Seminar 3 hours) Letter grade only (A-F).

490B. Senior Project II (3)
Prerequisites: CECS 490A or 491 all with a grade of "C" or better and consent of instructor.
Implementation of previously completed design project from CECS 490A or CECS 491. A formal demonstration with an oral and written presentation is required.
(Seminar 3 hours) Letter grade only (A-F).

491. Software Development Project (3)
Prerequisites: CECS 343 with a grade of "C" or better and senior standing.
Selected topics from recent advances in applied computing. Application of selected topics to the design and implementation of a software system within a team setting. Techniques for project management, documentation, and technical presentations. Software design, implementation, and evaluation strategies.
(Seminar 3 hours) Letter grade only (A-F).

492. Computer Networking Project Course (3)
Prerequisite: CECS 474 with a grade of "C" or better or consent of instructor.
Selected topics from recent advances in computer networking. Design, implementation, and performance analysis of enterprise networks. Network modeling and simulation. Application of selected topics to a semester-long team project focusing on the design and implementation of a large-scale network system.
(Seminar 3 hours) Letter grade only (A-F).

496. Computer Science Problem Solving (1)
Prerequisites: CECS 274 with a grade of "C" or better and consent of instructor.
Problem solving in Computer Science. Theory necessary to solve computer science problems and the solutions to the problems. Problems studied will involve applications of graph theory, data structures, recursion, and algorithms.
497. Directed Studies (1–3)  
Prerequisite: Consent of instructor.  
Assigned study in topics in current computer literature or computer-related projects with a final report.  
May be repeated to a maximum of 6 units with written consent of the Department Chair.

GRADUATE LEVEL

519/.419. Theory of Computation (3)  
Prerequisite: CECS 328 with a grade of "C" or better.  
Finite Automata and regular expressions. Pushdown automata and context-free languages. Turing machines and computability. Computational complexity.  
Additional projects required for CECS 519. (Lecture-problems 3 hours) Letter grade only (A-F).

521/.621. Database Architecture (3)  
Prerequisites: CECS 328 and 342 or 421 all with a grade of "C" or better.  
Relational database design theory-a rigorous approach. Security, recovery, transaction management, distributed databases and query optimization.  
Master’s students register in CECS 521 or 621; Ph.D. students register in CECS 621. Additional projects required for CECS 621. (Lecture-problems 3 hours) Letter grade only (A-F).

524/.624. Advanced Topics in Programming Languages (3)  
Prerequisite: CECS 424 with a grade of "C" or better.  
Intensive study of languages of current interest which support object-oriented, client-server, and multimedia applications (e.g. JAVA).  
Master’s students register in CECS 524 or 624; Ph.D. students register in CECS 624. Additional projects required for CECS 624. (Lecture-problems 3 hours) Letter grade only (A-F).

526/.626. Advanced Operating Systems (3)  
Prerequisites: CECS 228 and 326 all with a grade of "C" or better.  
Theoretical foundations of concepts applied in the design of operating systems. Control of concurrent processes, deadlocks, mutual exclusion, virtual memory, resource management and scheduling.  
Master’s students register in CECS 526 or 626; Ph.D. students register in CECS 626. Additional projects required for CECS 626. (Lecture-problems 3 hours) Letter grade only (A-F).

528/.628. Advanced Analysis of Algorithms (3)  
Prerequisites: CECS 328, MATH 360 or EE 380 all with a grade of "C" or better.  
Theoretical analysis of algorithms. Divide and conquer, dynamic programming and greedy algorithms; basic search and traversal techniques including search trees; sorting; matrix manipulations; NP—completeness.  
Master’s students register in CECS 528 or 628; Ph.D. students register in CECS 628. Additional projects required for CECS 628. (Lecture—problems 3 hours) Letter grade only (A-F).

529/.429. Search Engine Technology (3)  
Prerequisites: CECS 323 and 328, MATH 380 or EE 380 all with a grade of "C" or better.  
Additional projects required for CECS 529. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

530/.630. Advanced Computer Architecture I (3)  
Prerequisite: CECS 341 or 440 all with a grade of "C" or better.  
Master’s students register in CECS 530 or 630; Ph.D. students register in CECS 630. Additional projects required for CECS 630. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

531/.631. Advanced Computer Architecture II (3)  
Prerequisite: CECS 530 with a grade of "C" or better.  
Advanced computer architecture with emphasis on parallel processing. Vector processors and multiprocessor systems. Datalflow computation. RISC/CISC. Hypercube. Parallel software. Applications in artificial intelligence, signal/image processing, neural network and optical computing.  
Master’s students register in CECS 531 or 631; Ph.D. students register in CECS 631. Additional projects required for CECS 631. (Lecture—problems 3 hours) Letter grade only (A-F).

532. Memory Design and Implementation (3)  
Prerequisite: CECS 341 or 440 all with a grade of "C" or better.  
Logic design and operation, physical design and operation, performance characteristics, design trade-offs, energy consumption of modern memory hierarchies, memory errors and error correction.  
Letter grade only (A-F). (Lecture-problems 3 hours)

543/.643. Advanced Software Engineering (3)  
Prerequisite: CECS 343 or 443 all with a grade of "C" or better.  
Study of software engineering as a broad, problem-solving discipline. Includes structured programming and software project management.  
Master’s students register in CECS 543 or 643; Ph.D. students register in CECS 643. Additional projects required for CECS 643. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

544/.644. Software Testing and Verification (3)  
Prerequisite: CECS 543 with a grade of "C" or better.  
Testing/verification techniques for software development including black box, white box, incremental, top-down and bottom-up, static and dynamic, performance, regression, thread, and stress testing. Object-oriented software testing with a hierarchical approach. Metrics for test, and verification will be introduced.  
Master’s students register in CECS 544 or 644; Ph.D. students register in CECS 644. Additional projects required for CECS 644. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

545/.645. Software Architecture (3)  
Prerequisite: CECS 543 with a grade of "C" or better.  
Includes architectural styles, pipes and filters, data abstraction and object-oriented organization, event-based, implicit invocation, layered systems, repositories, interpreters, process control, distributed processes, domain-specific software & heterogeneous architectures. Component-based design patterns & case studies.  
Master's students register in CECS 545 or 645; Ph.D. students register in CECS 645. Additional projects required for CECS 645. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

546/.646. Fault Tolerant Computing Systems (3)  
Prerequisite: CECS 530 with a grade of "C" or better.  
Fault tolerant techniques are studied as tools to assure the reliability and continuous availability of computing systems. Case studies of modern fault tolerant systems reviewed. Software fault tolerant systems studied as alternatives to verification and validation approaches to software reliability.  
Master’s students register in CECS 546 or 646; Ph.D. students register in CECS 646. Additional projects required for CECS 646. (Lecture—problems 3 hours) Letter grade only (A-F).
547./647. Software Maintenance, Reengineering and Reuse (3)
Prerequisite: CECS 343 or equivalent with a grade of "C" or better.
Introduction to software maintenance, defect management, corrective, adaptive and perfective maintenance. Evolution of legacy software systems. Program comprehension techniques, reverse engineering, restructuring, refactoring of software systems. Software re-engineering, data reverse engineering. Software reuse. Impact analysis, regression testing.
Master's students register in CECS 547 or 647; Ph.D. students register in CECS 647. Additional projects required for CECS 647. (Lecture-problems 3 hours) Letter grade only (A-F).

549./649. Advanced Computer Graphics (3)
Prerequisite: CECS 449 with a grade of "C" or better.
Master's students register in CECS 549 or 649; Ph.D. students register in CECS 649. Additional projects required for CECS 649. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

550./650. Pattern Recognition Using Artificial Intelligence (3)
Prerequisite: CECS 451 with a grade of "C" or better or consent of instructor.
General concepts of pattern recognition and trainable classifiers, decision theory, supervised learning, non-parametric techniques, rule-based systems and neural networks.
Master's students register in CECS 550; Ph.D. students register in CECS 650. Additional projects required for CECS 650. (Lecture-problems 2 hours, laboratory 3 hours) Not open for credit to students with credit in CECS 750. Letter grade only (A-F).

551./651. Advanced Artificial Intelligence (3)
Prerequisite: CECS 451 with a grade of "C" or better.
Advanced concepts in artificial intelligence. Topics include knowledge acquisition and representation, fuzzy logic, logical reasoning, multi-sensor integration, Dempster-Shafer's theory of evidential reasoning, real-time expert systems and neural networks.
Master's students register in CECS 551 or 651; Ph.D. students register in CECS 651. Additional projects required for CECS 651. (Lecture-problems 3 hours) Letter grade only (A-F).

552./652. Computer Simulation and Modeling (3)
Prerequisites: EE 380 (or MATH 380) and CECS 326 all with a grade of "C" or better.
Studies of general purpose and special simulation software. Model verification including graphical models Applications in various areas.
Master's students register in CECS 552 or 652; Ph.D. students register in CECS 652. Additional projects required for CECS 652. (Lecture-problems 3 hours) Letter grade only (A-F).

553./653. Machine Vision (3)
Prerequisite: Graduate standing in engineering or computer science.
Discussion and laboratory implementation of current research in vision and image understanding. Topics include image formation, early processing, segmentation, relational structures in 2-D and 3-D, motion, stereo, 3-D reconstruction, morphological methods and computer architecture for machine vision.
Master's students register in CECS 553 or 653; Ph.D. students register in CECS 653. Additional projects required for CECS 653. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

561./461. Hardware/Software Co-design (3)
Prerequisite: CECS 341 or 440 all with a grade of "C" or better.
Introduction to top-down methods for hardware/software system-on-chip co-design. Design flow – system specification, software implementation, hardware synthesis, system design, and verification. Process optimization with various design decisions emphasized. Projects/case studies using system-level design methods and tools.
Additional projects required for CECS 561. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

570./670. Concurrent Parallel Programming (3)
Prerequisite: CECS 328, or 341, or 440 all with a grade of "C" or better.
Introduction to concurrent and parallel programming for multiprocessor and distributed systems. Computational models and paradigms. Parallel programming languages and programming tools. Portable parallel programming and mapping techniques. Heterogeneous concurrent programming. Concurrent programming on local networks on workstations and personal computers.
Master's students register in CECS 570 or 670; Ph.D. students register in CECS 670. Additional projects required for CECS 670. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

572./672. Advanced Computer Networking (3)
Prerequisite: CECS 327 or 474 all with a grade of "C" or better.
Master's students register in CECS 572 or 672; Ph.D. students register in CECS 672. Additional projects required for CECS 672. (Lecture-problems 3 hours) Letter grade only (A-F).

574./674. Topics in Distributed Computer Systems (3)
Prerequisite: CECS 526 or 527 or 626 or 627 all with a grade of "C" or better.
Network operating systems vs distributed operating systems, research and design issues of distributed operating systems, resources and resource management in distributed systems, communication security and user authentication.
Master's students register in CECS 574; Ph.D. students register in CECS 674. Additional projects required for CECS 674. (Lecture–problems 3 hours) Letter grade only (A-F). Not open for credit to students with credit in CECS 673 or 773.

575./675. Object–Oriented Analysis and Design (3)
Prerequisites: CECS 475 and CECS 343 or 443 or 543 all with a grade of "C" or better.
Master's students register in CECS 575 or 675; Ph.D. students register in CECS 675. Additional projects required for CECS 675. (Lecture-problems 3 hours) Letter grade only (A-F).

578./478. Introduction to Computer Security (3)
Prerequisite: CECS 323, 328, and one course selected from 472, 474, 476 all with a grade of "C" or better.
An object–oriented approach to computer security. Security threats and vulnerabilities in the development and use of computer systems. Tools and controls that can reduce or block these threats. Law, privacy and ethics.
Additional projects required for CECS 578. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

590./690. Selected Topics in Computer Science (3)
Prerequisites: Graduate standing and consent of instructor.
Each offering is based on an area in computer science and technology in which recent advances have been made.
Letter grade only (A-F). May be repeated to a maximum of 6 units with consent of department. Topics announced in the Schedule of
Classes. Master’s students register in CECS 590 or 690; Ph.D. students register in CECS 690. Additional projects required for CECS 690. (Lecture–problems 3 hours)

621./521. Database Architecture (3)
Prerequisites: CECS 328 and 323 (or 421) all with a grade of "C" or better.
Relational database design theory—a rigorous approach. Security, recovery, transaction management, distributed databases and query optimization.
Master’s students register in CECS 521 or 621; Ph.D. students register in CECS 621. Additional projects required for CECS 621. (Lecture–problems 3 hours) Letter grade only (A-F).

624./524. Advanced Topics in Programming Languages (3)
Prerequisite: CECS 424 with a grade of "C" or better.
Intensive study of languages of current interest which support object-oriented, client-server, and multimedia applications (e.g. JAVA).
Master’s students register in CECS 524 or 624; Ph.D. students register in CECS 624. Additional projects required for CECS 624. (Lecture–problems 3 hours) Letter grade only (A-F).

626./526. Advanced Operating Systems (3)
Prerequisites: CECS 228 and 326 all with a grade of "C" or better.
Theoretical foundations of concepts applied in the design of operating systems. Control of concurrent processes, deadlocks, mutual exclusion, virtual memory, resource management and scheduling.
Master’s students register in CECS 526 or 626; Ph.D. students register in CECS 626. Additional projects required for CECS 626. (Lecture–problems 3 hours) Letter grade only (A-F).

628./528. Advanced Analysis of Algorithms (3)
Prerequisites: CECS 328, MATH 380 or EE 380 all with a grade of "C" or better.
Theoretical analysis of algorithms. Divide and conquer, dynamic programming and greedy algorithms; basic search and traversal techniques including search trees; sorting; matrix manipulations; NP–completeness.
Master’s students register in CECS 528 or 628; Ph.D. students register in CECS 628. Additional projects required for CECS 628. (Lecture–problems 3 hours) Letter grade only (A-F).

630./530. Advanced Computer Architecture I (3)
Prerequisite: CECS 341 or 440 all with a grade of "C" or better.
Fundamentals of computer architecture. Description of architecture and description languages. Basic computer design and central processor implementation. Memory hierarchy and input/output, Pipelining, Vector processor, multiprocessor systems and dataflow machines.
Master’s students register in CECS 530 or 630; Ph.D. students register in CECS 630. Additional projects required for CECS 630. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

631./531. Advanced Computer Architecture II (3)
Prerequisite: CECS 530 with a grade of "C" or better.
Advanced computer architecture with emphasis on parallel processing. Vector processors and multiprocessor systems. Dataflow computation. RISC/CISC, Hypercube. Parallel software. Applications in artificial intelligence, signal/image processing, neural network and optical computing.
Master’s students register in CECS 531 or 631; Ph.D. students register in CECS 631. Additional projects required for CECS 631. (Lecture–problems 3 hours) Letter grade only (A-F).

643./543. Advanced Software Engineering (3)
Prerequisite: CECS 343 or 443 all with a grade of "C" or better.
Study of software engineering as a broad, problem-solving discipline. Includes structured programming and software project management.
Master’s students register in CECS 543 or 643; Ph.D. students register in CECS 643. Additional projects required for CECS 643. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

644./544. Software Testing and Verification (3)
Prerequisite: CECS 543 with a grade of "C" or better.
Various types of software testing and verification techniques for software development including black box, white box, incremental, top-down and bottom-up, static and dynamic, performance, regression, thread, and stress testing. Discussion of object-oriented software testing with a hierarchical approach. Metrics in complexity for testing, test, and verification plan will be introduced. Automatic software testing and some case studies.
Master’s students register in CECS 544 or 644; Ph.D. students register in CECS 644. Additional projects required for CECS 644. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

645./545. Software Architecture (3)
Prerequisite: CECS 543 with a grade of "C" or better.
Includes architectural styles, pipes and filters, data abstraction and object-oriented organization, event-based, implicit invocation, layered systems, repositories, interpreters, process control, distributed processes, domain-specific software & heterogeneous architectures. Component-based design patterns & case studies.
Master’s students register in CECS 545 or 645; Ph.D. students register in CECS 645. Additional projects required for CECS 645. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

646./546. Fault Tolerant Computing Systems (3)
Prerequisite: CECS 530 with a grade of "C" or better.
Fault tolerant techniques are studied as tools to assure the reliability and continuous availability of computing systems. Case studies of modern fault tolerant systems reviewed. Software fault tolerant systems studied as alternatives to verification and validation approaches to software reliability.
Master’s students register in CECS 546 or 646; Ph.D. students register in CECS 646. Additional projects required for CECS 646. (Lecture–problems 3 hours) Letter grade only (A-F).

647./547. Software Maintenance, Reengineering and Reuse (3)
Prerequisites: CECS 343 or equivalent all with a grade of "C" or better.
Introduction to software maintenance, defect management, corrective, adaptive and perfective maintenance. Evolution of legacy software systems. Program comprehension techniques, reverse engineering, restructuring, refactoring of software systems. Software re-engineering, data reverse engineering.
Master's students register in CECS 547 or 647; Ph.D. students register in CECS 647. Additional projects required for CECS 647. (Lecture–problems 3 hours) Letter grade only (A-F).

649./549. Advanced Computer Graphics (3)
Prerequisite: CECS 449 with a grade of "C" or better.
Master’s students register in CECS 549 or 649; Ph.D. students register in CECS 649. Additional projects required for CECS 649. (Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

650./550. Pattern Recognition Using Artificial Intelligence (3)
Prerequisite: CECS 451 with a grade of "C" or better or consent of instructor.
General concepts of pattern recognition and trainable classifiers, decision theory, supervised learning, non-parametric techniques, rule-based systems and neural networks.
Master’s students register in CECS 550; Ph.D. students register in CECS 650. Additional projects required for Ph.D. students. (Lecture–problems 2 hours, laboratory 3 hours) Letter grade only (A-F).
651./551. Advanced Artificial Intelligence (3)
Prerequisite: CECS 451 with a grade of "C" or better.
Advanced concepts in artificial intelligence. Topics include knowledge acquisition and representation, fuzzy logic, logical reasoning, multi-sensor integration, Dempster-Shafer’s theory of evidential reasoning, real-time expert systems and neural networks.
Master’s students register in CECS 551 or 651; Ph.D. students register in CECS 651. Additional projects required for CECS 651. (Lecture-problems 3 hours) Letter grade only (A-F).

652./552. Computer Simulation and Modeling (3)
Prerequisites: EE 380 or MATH 380 and CECS 326 all with a grade of "C" or better.
Studies of general purpose and special simulation software. Model verification including graphical models. Applications in various areas.
Master’s students register in CECS 552 or 652; Ph.D. students register in CECS 652. Additional projects required for CECS 652. (Lecture-problems 3 hours) Letter grade only (A-F).

653./553. Machine Vision (3)
Prerequisite: Graduate standing in engineering or computer science.
Discussion and laboratory implementation of current research in vision and image understanding. Topics include image formation, early processing, segmentation, relational structures in 2-D and 3-D, motion, stereo, 3-D reconstruction, morphological methods and computer architecture for machine vision.
Master’s students register in CECS 553 or 653; Ph.D. students register in CECS 653. Additional projects required for CECS 653. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

670./570. Concurrent Parallel Programming (3)
Prerequisite: CECS 328, or 341, or 440 all with a grade of "C" or better.
Introduction to concurrent and parallel programming for multiprocessing and distributed systems. Computational models and paradigms. Parallel programming languages and programming tools. Portable parallel programming and mapping techniques. Heterogeneous concurrent programming. Concurrent programming on local networks on workstations and personal computers.
Master’s students register in CECS 570 or 670; Ph.D. students register in CECS 670. Additional projects required for CECS 670. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

675./575. Object–Oriented Analysis and Design (3)
Prerequisites: CECS 475 and CECS 343 or 443 or 543 all with a grade of "C" or better.
An object-oriented approach to software development based on modeling objects from the real world. Object-oriented methodology from problem statement through analysis, system design, and object design. Implementation of object-oriented designs in various target environments. Case studies.
Master’s students register in CECS 575 or 675; Ph.D. students register in CECS 675. Additional projects required for CECS 675. (Lecture-problems 3 hours) Letter grade only (A-F).

690./590. Selected Topics in Computer Science (3)
Prerequisites: Graduate standing and consent of instructor. Each offering is based on an area in computer science and technology in which recent advances have been made.
Letter grade only (A-F). May be repeated to a maximum of 6 units with consent of department. Topics announced in the Schedule of Classes. Master’s students register in CECS 590 or 690; Ph.D. students register in CECS 690. Additional projects required for CECS 690. (Lecture-problems 3 hours)

694. Seminar in Computer Science (3)
Prerequisite: 6 units of 500- or 600-level CECS courses.
Intensive study of a broad selection of conceptual and theoretical problems in computer science. A written student research project and an oral presentation are required.
Letter grade only (A-F).

697. Directed Research (1-3)
Prerequisite: Classified Graduate standing.
Theoretical and experimental problems in computer science requiring extensive research. Advancement to candidacy and program GPA of at least 3.0 are required.
Graduate advisor and project supervisor must be consulted prior to registration.
Independent Study. Letter grade only (A-F).

698. Thesis or Industrial Project (2-6)
Prerequisite: Advancement to Candidacy.
Planning, preparation, completion of thesis or equivalent industrial project report on a suitable topic in computer engineering and computer science following the library’s prescribed format.
Requires consultation with Graduate Advisor and submission of Agreement for Independent Study forms each semester.
May be repeated to a maximum of 6 units.
Department Chair: James Ary
Department Office: Engineering and Computer Science (ECS) 512
Telephone: (562) 985-5102/5103
Website: http://www.csulb.edu/colleges/coe/ee
Faculty: James Ary, Chin Chang, Anastasios G. Chassiakos, Christopher Druzgalski, Fumio Hamano, Kenneth James, I-Hung Kho, Rajendra Kumar, Tulin E. Mangir, Hassan Mohamed-Nour, Alfonso Rueda (emeritus), Bahram Shahian, Robert Teng, Chit-Sang Tsang, Mahmoud Wagdy, Fei Wang, Ray Wang, Heu-Geul (Henry) Yeh
Undergraduate Advisors
Electrical Engineering: Fei Wang
Electronics and Computer Engineering Technology: I-Hung Khoo
Graduate Advisor: Fumio Hamano
General Education Advising: Academic Advising - Horn Center
Biomedical Engineering Advisor: Maryam Moussavi
Administrative Coordinator: Clarice Ross
Students desiring detailed information should contact the department office for referral to one of the faculty advisors.

Career Possibilities
Electrical Engineer • Systems Engineer • Electronics Engineer • Communications Engineer • Electrical Design Engineer • Sales Engineer • Electronics Test Engineer • Research Engineer • Consultant • Manufacturer's Representative • Safety Engineer • Quality Control Specialist • Production Manager (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

Advisory and Development Council
The Department of Electrical Engineering is supported by an Advisory and Development Council consisting of outstanding engineers and executives from industry and government in southern California. Its function is to form a liaison between the University and industry and to keep the administration and faculty informed of modern engineering practices. This ensures that the curricula are kept up-to-date. It also advises on placement opportunities before and after graduation.

Accreditation
The Bachelor of Science in Electrical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Undergraduate Programs

Bachelor of Science in Electrical Engineering (126 units)
The objectives of the Bachelor of Science in Electrical Engineering Program are to prepare students to be successful and advance in their chosen careers in industry, academia, and public institutions, making significant contributions to the field of electrical engineering. These objectives are achieved by providing students:

1. a solid foundation in basic science, mathematics, and EE practices and major design skills to maintain high employability, adaptability, and an ability to develop and apply new technology;
2. effective communication skills to be able to progress in their careers;
3. an awareness of ethical and societal responsibilities;
4. an ability to work effectively in a team environment.

The bachelor's degree in electrical engineering is designed to prepare graduates for responsible engineering positions in design, development, research, applications, and operation in the fields of communications, control systems, digital signal processing systems, electromagnetics, digital and analog electronic circuits, physical electronics, computer-aided design and power systems. The curriculum is built around a strong basic core of mathematics, physics and engineering science. This is followed by intermediate courses in electrical engineering topics and finally a senior elective sequence including a senior design seminar and terminating in a capstone design course.

By choice of senior elective sequence, comprehensive coverage is provided in any one of the above fields.

Laboratory facilities are available in the engineering buildings allowing for basic as well as more advanced laboratory instruction in electronics, digital signal processing, control systems, microelectronics, communications, power, and digital systems.

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an advisor to determine if the student's performance in the courses merits an additional semester to complete the requirements.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements
Core:
Take all the following courses:

CECS 100 Critical Thinking in the Digital Information Age (or equivalent) (3)
Prerequisite/Corequisite: ENGL 100 or its equivalent.
EE 200 Trends in Electrical Engineering (1)
Prerequisites: None.
EE 201 Digital Logic Design (4)
Prerequisite: MATH 117 (or equivalent) all with a grade of "C" or better.
EE 202 Computer Methods in Engineering (3)  
Prerequisites: CECS 100 and MATH 123 all with a grade of "C" or better.

EE 211 Electric and Electronic Circuits I (3)  
Prerequisites: (EE 210 or PHYS 152) and (MATH 123 or equivalent) all with a grade of "C" or better.

EE 211L Electric Circuits Laboratory (1)  
Corequisite: EE 211.

ENGR 101 Intro to the Engineering Profession (1)  
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)  
Prerequisite: ENGR 101 with a grade of "C" or better.

MATH 122 Calculus I (4)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

MATH 123 Calculus II (4)  
Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)  
Prerequisite: A grade of "C" or better in MATH 123 or 222.

MATH 370A Applied Mathematics I (or equivalent) (3)  
Prerequisites: MATH 123. Not open to Freshmen.

PHYS 151 Mechanics and Heat (4)  
Prerequisite/Corequisite: MATH 122.

PHYS 254 Applied Modern Physics (3)  
Prerequisite: PHYS 152 or EE 210; Prerequisite/Corequisite: MATH 224.

EE 301 Digital System Design (3)  
Prerequisite: EE 201 with a grade of "C" or better.

EE 310 Signals and Systems (3)  
Prerequisites: EE 211 and MATH 370A or equivalent all with a grade of "C" or better.  

EE 330 Analog Electronic Circuits I (4)  
Prerequisite: EE 211 with a grade of "C" or better.

EE 346 Microprocessor Principles and Applications (3)  
Prerequisites: EE 201, (CECS 100 or equivalent) all with a grade of "C" or better.

EE 350 Energy Conversion Principles (3)  
Prerequisites: EE 202 or equivalent and EE 211 and 211L all with a grade of "C" or better, or consent of instructor.

EE 360 Electromagnetic Fields (3)  
Prerequisites: MATH 224, EE 310 all with a grade of "C" or better.

EE 370 Control Systems (3)  
Prerequisite: EE 310 all with a grade of "C" or better.

EE 370L Control Systems Laboratory (1)  
Prerequisite/Corequisite: EE 370.

EE 380 Probability, Statistics & Stochastic Modeling (3)  
Prerequisites: MATH 123, (CECS 100 or equivalent) all with a grade of "C" or better.

EE 382 Communications Systems I (3)  
Prerequisite: EE 310 all with a grade of "C" or better.

EE 386 Digital Signal Processing (3)  
Prerequisites: EE 310 or CECS 301 all with a grade of "C" or better.

Take one of the following choices:  
PHYS 152 Electricity and Magnetism (4)  
Prerequisite: PHYS 151 with a grade of "C" or better.  
Prerequisite/Corequisite: MATH 123.

or both of the following:  
EE 210 Electro-Magnetic Foundations in EE (3)  
Prerequisite: PHYS 151 all with a grade of "C" or better.  
Corequisites: MATH 123, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)  

Each of the foregoing courses must be completed with a grade of "C" or better as well as ENGL 100 or equivalent.

Other required courses are:  
EE 400D Electrical Engineering Design Seminar and Project (2)  
Prerequisites: EE 330, 370, and 382 all with a grade of "C" or better; or consent of instructor.

EE 430 Analog Electronic Circuits II (3)  
Prerequisites: EE 330 and 370 all with a grade of "C" or better, or graduate standing.

EE 430L Analog Electronics II Laboratory (1)  
Prerequisite/Corequisite: EE 430.

Each BSEE student must propose course work consisting of a capstone design course supported by at least two related courses, which form an area of in-depth study as approved by the EE Undergraduate Advisor. Possible areas of study include but are not limited to power, digital signal processing, controls, communications and electronics. A list showing the required supporting courses and capstone design course for each area of study is available from the EE Undergraduate Advisor. Combinations of the above areas of study or another area of study may be proposed to the EE Undergraduate Advisor. Additional elective courses must be chosen from EE 400 level courses to total at least 15 units. The entire program must total at least 126 units.

A grade of "C" or better is required for the capstone senior design course in the area of specialization.

Concurrent and/or Summer Enrollment in Another College

Students who wish to take coursework in a community college or another college to meet curricular requirements while enrolled as an undergraduate in the Department of Electrical Engineering must petition the EE Undergraduate Advisor for prior approval to enroll in specific courses. This policy is for either concurrent enrollment or summer enrollment. Prior approval for transfer credit for upper division major courses may generally be approved for no more than six semester units, subject to approval by the EE Undergraduate Advisor and the EE Department Chair who may require sufficient information to determine if each requested course is deemed equivalent to an EE course at CSULB. Exceptions require approval by vote of the EE Undergraduate Curriculum Committee.

Bachelor of Science in Engineering Option in Biomedical and Clinical Engineering (129 units)

The Department of Electrical Engineering administers an option in Biomedical and Clinical Engineering that allows the student to acquire substantive competence in biomedical engineering and biology. The program builds upon a strong base of biology, mathematics, physics, chemistry, and engineering science to develop a clinically oriented biomedical engineer to serve medical and industrial needs. It includes a core of standard electrical engineering courses as well as courses and laboratories in biomedical engineering, anatomy, physiology and biology. Elective units are available in the senior year to explore individual areas of interest.

Students planning to attend medical, dental or other health professional or graduate schools in Biomedical Engineering may select courses in Chemistry and/or Biology with the approval of the Biomedical Engineering advisor.
Laboratory facilities in the field of biomedical engineering are available in the engineering buildings; and laboratory facilities for anatomy and physiology are available on campus. Computer systems are available to simulate biological systems and to collect, process and display physiological data.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade C or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Lower Division

Take all of the following courses:

- BIOL 207 Human Physiology (4)
  Prerequisites: GE Foundation requirements.
- CECS 100 Critical Thinking in the Digital Information Age (3)
  Prerequisite/Corequisite: ENGL 100 or its equivalent.
- CHEM 111A General Chemistry (5)
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).
- EE 200 Trends in Electrical Engineering (1)
  Prerequisites: None.
- EE 201 Digital Logic Design (4)
  Prerequisite: MATH 117 (or equivalent) all with a grade of "C" or better.
- EE 202 Computer Methods in Engineering (3)
  Prerequisites: CECS 100 and MATH 123 all with a grade of "C" or better.
- EE 211 Electric and Electronic Circuits I (3)
  Prerequisites: (EE 210/210L or PHYS 152) and (MATH 123 or equivalent) all with a grade of "C" or better.
- EE 211L Electric Circuits Laboratory (1)
  Corequisite: EE 211.
- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- MATH 224 Calculus III (4)
  Prerequisite: A grade of "C" or better in MATH 123 or 222.
- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 122.
- PHYS 152 Electricity and Magnetism (4)
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.
- PHYS 254 Applied Modern Physics (3)
  Prerequisite: PHYS 152 or EE 210; Prerequisite/Corequisite: MATH 224.

Each of the foregoing courses must be completed with a grade of "C" or better as well as ENGL 100 or equivalent. The interdisciplinary courses as well as the Communications Studies (COMM) courses required for General Education must be taken for a letter grade.

Upper Division:

Take all of the following courses which must be completed with a "C" or better:

- EE 310 Signals and Systems (3)
  Prerequisites: EE 211; and MATH 370A all with a grade of "C" or better or equivalent.
- EE 330 Analog Electronic Circuits I (4)
  Prerequisite: EE 211 all with a grade of "C" or better.
- EE 346 Microprocessor Principles and Applications (3)
  Prerequisites: EE 201, (CECS 100 or equivalent).
- EE 360 Electromagnetic Fields (3)
  Prerequisites: MATH 224, EE 310 all with a grade of "C" or better.
- EE 370 Control Systems (3)
  Prerequisite: EE 310 all with a grade of "C" or better.
- EE 370L Control Systems Laboratory (1)
  Prerequisite/Corequisite: EE 370.
- EE 382 Communication Systems I (3)
  Prerequisite: EE 310 with a grade of "C" or better.
- EE 386 Digital Signal Processing (3)
  Prerequisites: EE 310 or CECS 301 all with a grade of "C" or better.
- EE 406 Medical Instrumentation and Measurements (3)
  Prerequisite: EE 330 with a grade of "C" or better or consent of instructor or graduate standing.
- EE 406L Biomedical Engineering Laboratory (1)
  Prerequisite/Corequisite: EE 406.
- EE 407 Applications of Computers in Medicine (3)
  Prerequisites: EE 346 with a grade of "C" or better or consent of instructor or graduate standing.
- EE 430 Analog Electronic Circuits II (3)
  Prerequisites: EE 330 and 370 all with a grade of "C" or better, or graduate standing.
- EE 444 Microprocessor Based System Design (3)
  Prerequisites: EE 346 with a grade of "C" or better or graduate standing.
- MATH 370A Applied Mathematics I (3)
  Prerequisites: MATH 123. Not open to Freshmen.

Select one course from the following: MAE 330 Engineering Thermodynamics I (3)

CE 370 Analytical Mechanics (3)

Take additional approved biomedical electives, including an approved senior design course to at least 129 units.

Bachelor of Science in Electronics Engineering Technology

For requirements and courses, see description in the Engineering Technology Programs section of this catalog.

Bachelor of Science in Computer Engineering Technology

For requirements and courses, see description in the Engineering Technology Programs section of this catalog.
Graduate Programs

Master of Science in Electrical Engineering

This program affords an opportunity for engineers and others to advance their competency in analysis and design to better meet the high technology needs of local industry. Each student selects two core courses and three graduate courses in one area of emphasis, and the remaining courses must augment and support the area of emphasis. Some current examples of areas of emphasis are biomedical, communications, computer/communication networks and security, control systems and robotics, digital signal processing, digital and computer systems, electromagnetics and optics, electronics, networks and filters, and power. Students may create other areas of emphasis with the approval of the graduate advisor. Students will choose one of the three alternatives: thesis, project, and course-only. Successful completion of a thesis provides a unifying culmination to the program, and an enhanced resume for future industrial or academic endeavor. A limited number of laboratory and teaching assistantships are available to qualified graduate students.

Prerequisites

1. A bachelor's degree from an accredited program in electrical engineering or a bachelor’s degree from an accredited engineering, natural science or other appropriate program with the requirement that essential undergraduate deficiencies in electrical engineering are removed prior to Advancement to Candidacy.

2. The prospective graduate student must have attained a GPA of at least 2.7 for the last 60 semester units (90 quarter units) attempted prior to entry in the MSEE program.

The student should apply online at CSU Mentor. Do not send an application to the Department. International students should apply online at CSU Mentor or through the Center for International Education.

Requirements

Take at least 2 out of the below 5 courses appropriate to area of emphasis and subject to graduate advisor approval:

- EE 503 Advanced Systems Engineering (3)  
  Prerequisite: EE 411 with a grade of "C" or better or equivalent mathematical maturity.

- EE 505 Advanced Engineering Mathematics for EE (3)  
  Prerequisites: Consent of instructor.

- EE 508 Probability Theory and Random Processes (3)  
  Prerequisite: EE 380 with a grade of "C" or better.

- EE 509 Network Theory (3)  
  Prerequisites: EE 386, 410 or 430 all with a grade of "C" or better.

- EE 511 Linear Systems Analysis (3)  
  Prerequisite: EE 411 or 470 all with a grade of "C" or better or equivalent mathematical maturity.

Complete 30 unit minimum in 400-, 500-, or 600-level courses as approved in advance by the graduate advisor. Take one of the following three alternatives:

1. Thesis Alternative:
   - 500/600-level EE courses including core (15 units);

2. Project Alternative:
   - 500/600-level EE courses including core (21 units);
   - EE 697 Directed Research (3) (on a capstone project);
   - 400/500/600-level EE courses (6 units);
   - Comprehensive Oral Exam on the capstone project.

3. Course-Only Alternative:
   - 500/600-level EE courses including core and at least three courses forming area of emphasis (24 units);
   - 400/500/600-level EE courses (6 units);
   - Comprehensive Oral Exam on the area-of-emphasis.

Tentative Program

Upon matriculation graduate students must consult with the graduate advisor and a tentative program must be approved by the advisor by a few weeks into the first semester. The program must contain two core courses and exhibit an area of emphasis comprised of at least three related graduate courses (500 or 600 level). Students should obtain the MSEE Handbook, which covers the procedures and requirements, from the advisor or Electrical Engineering Department office or Electrical Engineering web.

Advancement to Candidacy

At least one semester before the graduating semester students must advance to candidacy. To apply for advancement to candidacy students must satisfy the following requirements:

1. All deficiencies must have been made up with a GPA of at least 3.0.
2. Currently enrolled in a regular session.
3. Demonstration of competence in technical writing by passing an appropriate writing course such as ENGL 317, 417, 418, or 419 with a grade of "C" or better or by providing acceptable proof of technical writing ability to the graduate advisor.
4. Fulfillment of the Graduation Writing Assessment Requirement (GWAR).
5. Completion of at least 9 units as a graduate student in residence while maintaining both an overall GPA and a program GPA of at least 3.0. Students are advised to seek advancement before completing 15 units of the program.

Ph.D. in Engineering and Industrial Applied Mathematics

For requirements, see the description in the College of Engineering section of this catalog.

Courses (E E)

LOWER DIVISION

200. Trends in Electrical Engineering (1)
201. Digital Logic Design (4)
Prerequisite: MATH 117 (or equivalent) with a grade of "C" or better. Practical design of digital circuits. Basic topics in combinational and sequential switching circuits with applications to the design of digital devices.
(Lecture-problems 4 hours)

202. Computer Methods in Engineering (3)
Prerequisites: CECS 100 and MATH 123 all with a grade of "C" or better. Introduction to MATLAB and numerical methods with applications to engineering. Programming in MATLAB. Introduction to SIMULINK and other MATLAB toolboxes.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A‑F). Not open for credit to students with credit in ENGR 202.

210. Electro-Magnetic Foundations in Electrical Engineering (3)
Prerequisite: PHYS 151 all with a grade of "C" or better. Corequisites: MATH 123, EE 210L.
(Lecture-problems 3 hours) Letter grade only (A‑F).

210L. Electro-Magnetic Foundations in Electrical Engineering Laboratory (1)
Laboratory experiments demonstrating behavior of resistive circuits; capacitors and inductors; transient RL and RC circuits; sinusoidal (phasor) RL, RC and RLC circuits; motors, generators, and transformers.
Letter grade only (A‑F).

211. Electric and Electronic Circuits (3)
Prerequisites: (EE 210/210L or PHYS 152) and (MATH 123 or equivalent) all with a grade of "C" or better. Linear circuit analysis techniques including circuit transformations, mesh and node analyses. Thevenin's, Norton's, Superposition, and Maximum Power Transfer theorems. Transient analysis of RL, RC and RLC circuits. Phasors. Power concepts. Nonlinear circuits including diodes. Circuit solution using PSpice.
(Lecture-problems 3 hours) Letter grade only (A‑F).

211L. Electric Circuits Laboratory (1)
Corequisite: EE 211.
(Laboratory 3 hours) Letter grade only (A‑F).

220. Materials Sciences for Electrical Engineers (3)
Prerequisites: MATH 224 and EE 210 all with a grade of "C" or better. Basic principles of optical and wave propagation. Introduction to quantum electronics. Fundamental aspects of photonics and materials sciences and their relevance to solid state electronic circuits.
Letter grade only (A‑F). (Lecture-problems 3 hours)

236. Introduction to Nanotechnology: A Tour in Nano-Land (3)
Prerequisite: Sophomore standing. Overview of the fundamentals of nanoscience and nanotechnology, a wide range of applications, and issues that affect widespread adoption of these technologies based on ongoing research and discourse. An interdisciplinary course, taught by an interdisciplinary team of Instructors. Students will observe nature and matter in submicron and nanometer scale.
(Lecture-problems 3 hours) Letter grade only (A‑F).

248. Security, Information Assurance, and Computers (3)
Computer security and information assurance as crucial challenges, consequences for individuals, economy, and society as a whole. Security threats and vulnerabilities in the use of computer systems. Tools and controls to reduce or block these threats. Law, privacy, and ethics.
(Lecture-problems 3 hours) Letter grade only (A‑F).

260. Analytical Methods for Electromagnetics (4)
Prerequisite: EE 210 or PHYS 152 or equivalent all with a grade of "C" or better. Fundamental concepts and analytical methods for electromagnetics.
(Lecture 3 hours, problem session 2 hours.) Letter grade only (A‑F).

UPPER DIVISION

301. Digital System Design (3)
Prerequisite: EE 201 with a grade of "C" or better. FPGA based digital design. Implementation of FPGA digital hardware systems based on the algorithms and implementation requirements using hardware description languages, optimization, logic synthesis, place and route methods. Implementation of finite state machines.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A‑F).

310. Signals and Systems (3)
Prerequisites: EE211; and MATH 370A or equivalent all with a grade of "C" or better. Corequisite: EE 202.
(Lecture-problems 3 hours) Letter grade only (A‑F).

315. Introduction to Systems Analysis (3)
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A‑F).

330. Analog Electronic Circuits I (4)
Prerequisite: EE 211 with a grade of "C" or better. Analysis and design of diode, bipolar junction transistor, field-effect transistor (MOSFET and JFET), and CMOS circuits. Op-Amp linear and nonlinear circuit applications. Digital electronic circuits. Laboratory includes transistor and operational amplifier circuit design and CAD tools.
(Lecture-problems 3 hours, laboratory 3 hours) Letter grade only (A‑F).

332. Digital Electronic Circuits (3)
Prerequisites: EE 201, 211, 420 all with a grade of "C" or better. Analysis and design of digital electronic circuits. Structure and operation of MOS transistors, including SPICE models. NMOS and CMOS inverters. Bipolar transistor inverters. Bipolar digital gate circuits (TTL & ECL). Regenerative logic circuits (flip-flop, Schmitt trigger, multivibrator). Semi-conductor memories. Basic IC design: Gate Array, Standard Cell, PLA.
(Lecture-problems 3 hrs) Letter grade only (A‑F).
346. Microprocessor Principles and Applications (3)
Prerequisites: EE 201, (CECS 100 or equivalent) all with a grade of "C" or better.
Introduction to the design of modern RISC based microprocessors and microcontrollers. Programming problems written in C++ and assembly using the critical thinking skills learned in CECS100. Architectural principles learned in the classroom illustrated using the assembly programming language.
Letter grade only (A-F). (Lecture-problems 2 hours, lab 3 hours)

350. Energy Conversion Principles (3)
Prerequisites: (EE 202 or equivalent) and EE 211 and 211L, or consent of instructor all with a grade of "C" or better.
Electromechanical energy conversion. Power transformers. DC, synchronous, and induction machines. Laboratory experiments on power electronics and rotating machinery.
Letter grade only (A-F). (Lecture-problems 2 hours, lab 3 hours).

360. Electromagnetic Fields (3)
Prerequisites: MATH 224, EE 310 all with a grade of "C" or better.
Electric and magnetic field theory including propagation of plane waves in lossless and dissipative media. Maxwell’s equations. Transmission lines and waveguides.
(Lecture-problems 3 hours) Letter grade only (A-F). Not open for credit to students with credit in EE 460.

370. Control Systems (3)
Prerequisite: EE 310 with a grade of "C" or better.
Control systems analysis; block diagrams, signal flow graphs, stability criteria, root locus, frequency domain analysis. Examples of classical control system design.
Letter grade only (A-F). (Lecture-problems 3 hours).

370L. Control Systems Laboratory (1)
Prerequisite/Corequisite: EE 370.
Experiments which reinforce concepts learned in EE 370. Digital simulation modeling, analysis, and design. Real time applications.
Letter grade only (A-F). (Laboratory 3 hours)

380. Probability, Statistics, and Stochastic Modeling (3)
Prerequisites: MATH 123; (CECS 100 or equivalent) all with a grade of "C" or better.
Probability with an emphasis on computer modeling of probabilistic systems. Topics such as discrete and continuous random variables, moments, correlation, covariance, Markov processes and queueing theory presented from a mathematical foundation developed and exemplified with realistic computer simulations from students.
Letter grade only (A-F). (Lecture 2 hrs, laboratory 3 hrs)

382. Communication Systems I (3)
Prerequisite: EE 310 with a grade of "C" or better.
Review of Fourier series and transforms. Introduction to passive, active, and digital filters. Basic elements of probability theory, statistics, concept of white noise, AM, DSB, SSB and vestigial modulation, narrowband and wideband FM.
Letter grade only (A-F). (Lecture-problems 2 hours, lab 3 hours)

386. Digital Signal Processing (3)
Prerequisites: EE 310 or CECS 301 all with a grade of "C" or better.
Introduction to discrete-time signals and systems, z-transform, digital filters, system design, and comparison to the analog counterparts. Multimedia-based laboratory experiments for discrete-time signals and systems in time and frequency domain, synthesis of digital sound/music with MATLAB or C.
Letter grade only (A-F). Not open for credit to students with credit in EE 485. (Lecture-problems 2 hours, laboratory 3 hours)

400D. Electrical Engineering Design Seminar and Project (2)
Prerequisites: EE 330, 370, and 382 all with a grade of "C" or better; or consent of instructor.
Design terminologies, processes and issues. Simple design examples. Constraints imposed by factors such as performance, economics, reliability, safety, aesthetics, packaging, codes, standards and practices. Ethics and social and environmental impact. Case studies. Individual and group projects. Oral presentation required.
(Lecture-problems 1 hour, laboratory 3 hours) Letter grade only (A-F).

401. Mathematical Methods for Electrical Engineers (3)
Prerequisite: MATH 370A with a grade of "C" or better.
Analytic techniques relevant to electrical engineering.
Letter grade only (A-F). (Lecture-problems 3 hours).

402/502. Engineering Modeling and Simulation (3)
Prerequisite: EE 380 with a grade of "C" or better.
Projects required for EE 502. (Lecture-problems 3 hours). Letter grade only (A-F).

403. Systems Engineering (3)
Prerequisites: ENGR 203 or EE 202 all with a grade of "C" or better, or graduate standing.
Modeling and analysis, and design of deterministic and stochastic systems. The building blocks of Systems Engineering models ranging from network models with special structured, to unstructured linear and nonlinear optimization.
Letter grade only (A-F). (Lecture-problems 3 hours)

405. Selected Topics in Electrical Engineering (3)
Prerequisites: Senior standing in electrical engineering or consent of instructor or graduate standing.
Selected topics from recent advances in electrical engineering.
Letter grade only (A-F). May be repeated to a maximum of 6 units with undergraduate advisor consent. Topics announced in Schedule of Classes. (Lecture-problems 3 hours).

406. Medical Instrumentation and Measurements (3)
Prerequisite: EE 330 with a grade of "C" or better or consent of instructor or graduate standing.
Design and analysis of medical instruments, electrodes and amplifiers for measurement of physiological signals.
Letter grade only (A-F). (Lecture-problems 3 hours)

406L. Biomedical Engineering Laboratory (1)
Prerequisite/Corequisite: EE 406.
Laboratory study of medical instrumentation, transducers and computer data processing.
(Laboratory 3 hours) Letter grade only (A-F).

407. Applications of Computers in Medicine (3)
Prerequisite: EE 346 with a grade of "C" or better or consent of instructor or graduate standing.
Principles of analysis and design of computers and data collection equipment for real-time on-line medical systems.
(Lecture-problems, computer projects 3 hours) Letter grade only (A-F).

410. Analog Filter Design (3)
Prerequisite: EE 310 with a grade of "C" or better or graduate standing.
Theory and design of active filters using operational amplifiers. Emphasis is placed on low-pass filters.
(Lecture-problems 3 hours) Letter grade only (A-F).
411. Continuous- and Discrete-Time Linear Systems (3)
Prerequisite: EE 370 with a grade of "C" or better or graduate standing.
(Lecture-problems 3 hours) Letter grade only (A-F).

412. Fractals in Engineering (3)
Prerequisite: EE 310 with a grade of "C" or better or graduate standing.
Application of fractal geometry to system theory. Study of system dynamics leading to complex behaviors and chaos. Scaling laws, sensitivity to initial conditions, strange attractors, and if/else will also be discussed.
(Lecture-problems 3 hours). Letter grade only (A-F).

420. Solid State Electronic Devices (3)
Prerequisite: PHYS 254 with a grade of "C" or better or graduate standing.
Not open for credit to students with credit in EE 320. (Lecture-problems 3 hours) Letter grade only (A-F).

427./527. Digital Filter Design and Audio Processing (3)
Prerequisite: EE 386 with a grade of "C" or better or consent of instructor.
Digital filter design methods, filter architectures, round-off noise, implementation and applications to audio signal processing. Additional projects required for EE 527.
(Lecture-problems 3 hours) Letter grade only (A-F).

428./528. Speech Signal Processing (3)
Prerequisite/Corequisite: EE 486 or consent of instructor.

430. Analog Electronic Circuits II (3)
Prerequisites: EE 330 and 370 with a grade of "C" or better, or graduate standing.
(Lecture-problems 3 hours) Letter grade only (A-F).

430L. Analog Electronics Laboratory II (1)
Prerequisite/Corequisite: EE 430.
Advanced transistor, operational amplifier, and linear-integrated circuits and systems design laboratory.
Not open for credit to students with credit in EE 433L. (Laboratory 3 hours) Letter grade only (A-F).

434./534. Mixed-Signal IC Design (3)
Prerequisites: EE 201 and 330 all with a grade of "C" or better or consent of instructor.
Additional projects required for EE 534. (Lecture-problems 2 hours, Laboratory 3 hours) Letter grade only (A-F).

435./535A. Microelectronics (3)
Prerequisites: EE 201 and 330 all with a grade of "C" or better. Theory of microelectronics integrated circuit design, IC fabrication technology, device characterization, modeling, digital and analog simulation tools, physical layout tools, digital standard cell library design, IC digital system designs, I/O pad design, full chip simulation and physical designs. Additional projects required for EE535A. (Lecture-problems 3 hours) Letter grade only (A-F).

435L. Microelectronics Laboratory (1)
Corequisite: EE 435.
Laboratory evaluation of IC process steps. Wafer probe, packaging, and final test. Empirical device model formulation from test data. Not open for credit to students with credit in EE 420L. (Laboratory 3 hours) Letter grade only (A-F).

436./536. Microfabrication and Nanotechnology (3)
Prerequisites: EE 330 and PHYS 254; or MAE 300 all with a grade of "C" or better. Techniques and the technology of miniaturization of electrical, mechanical, optical, and opto-electronic devices in sizes from millimeters to nanometers. Design examples of sensors, microlenses, cantilevers, and micromotors, process fabrication. Additional projects required for EE 536. (Lecture-problems 3 hours) Letter grade only (A-F).

437. Multidisciplinary Nano-Science and Engineering (3)
Prerequisite: Consent of instructor or graduate standing.
Introduces four key areas: nanoscience properties of materials; nanotechnology in biology and nature; observation, measurement, analysis; applications. Importance of understanding and engineering nanoscale structures, materials, and processes for the 21st Century. Use of scanning electron microscope and atomic force microscope. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

443. System-on-Chip Architecture and Applications (3)
Prerequisite: EE 346 with a grade of "C" or better or consent of instructor or graduate standing.
Introduction to System-on-Chip Architecture by using ARM's MCU and MMU. Concepts and methodologies in designing a system-on-chip (SoC) based microprocessor core. Principles of modern SoC and processor design. Embedded applications based around SoC processor cores.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

444. Microprocessor Based System Design (3)
Prerequisites: EE 346 with a grade of "C" or better or graduate standing.
Study of microprocessor based systems and their integration with peripheral devices including sensors, actuators, and serial communications. Following a progressive lab sequence, over the semester the student will design and construct a modern RISC microcontroller based system.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

446. Advanced Microprocessors and Embedded Controllers I (3)
Prerequisite: EE 444 with a grade of "C" or better or consent of the instructor or graduate standing.
Advanced microprocessors such as Pentium series, RISC, and CISC. Hardware features and new instructions. Support for virtual memory, paging, privilegemen, design examples and internal cache. Floating point coprocessors. Embedded controllers, on-chip resources and applications.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).
447. Design of Electronic Systems (3)
Prerequisites: (EE 301 or 435) and EE 346 and EE 430 all with a grade of "C" or better, or graduate standing.
Prerequisite/Corequisite: EE 400D or graduate standing.
Extensive laboratory projects. Design of analog and digital systems. Computer-aided design including, for example, hardware descriptive language (HDL) and SPICE.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

448. Wireless and Mobile Networks and Security in Wireless Networks (3)
Prerequisite: EE 482 with a grade of "C" or better or equivalent.
Wireless and Mobile Ad-hoc Networks and Security. Ad-hoc and geographic routing, resource discovery, MAC, IP-mobility, mobility modelling, wired-wireless networks, security aspects. Lab Projects will include use of tools such as OPNET, Ethereal, Sniffer, Scanner, IDS, etc.
Advanced project required for EE 548. (Lecture-problems 3 hours) Letter grade only (A-F).

449. Topics in Multimedia and Hypermedia (3)
Prerequisite: EE 483 with a grade of "C" or better or equivalent.
Theoretical and practical issues in designing multimedia systems, design and implementation of interactive multimedia and hypermedia applications including interactive television (e.g., video-on-demand, eLearning), hypermedia systems (e.g., the World Wide Web), and video conferencing and groupware.
Emphasis placed on current design issues and research topics.
Extra project for graduate students. (Lecture-problems 3 hours) Letter grade only (A-F).

450. Electronic Control of Motors (3)
Prerequisite: EE 350 with a grade of "C" or better or graduate standing.
Prerequisites/Corequisites: EE 370 or graduate standing.
Characteristics of semiconductor power switches. Modeling and application of control theory to various types of motors. Bidirectional and four-quadrant converter topologies for motion control. Selection of drives to control AC and DC motors. Uninterruptible power supplies and adjustable speed drives.
(Lecture-problems 3 hours) Letter grade only (A-F).

451. Electric Vehicles (3)
Prerequisites: EE 350 and (EE 370 or MAE 376) all with a grade of "C" or better; or graduate standing.
(Lecture-problems 3 hours) Letter grade only (A-F).

452. Computer Applications in Power Systems (3)
Prerequisite: EE 350 with a grade of "C" or better or consent of instructor or graduate standing.
Modeling of power generation, transmission, and distribution systems, load-flow analyses, short-circuit studies, voltage drop and power loss calculations, transient stability and optimal power flow analyses. Application of specialized computer software for power system design and analyses.
(Lecture-problems 3 hours) Letter grade only (A-F).

453. Protection of Power Systems (3)
Prerequisites: EE 310, 350 all with a grade of "C" or better.
Protective relays, instrument transformers, low-voltage and high-voltage circuit breakers, protection of generators and motors, transformer protection and transmission line protection. Relay coordination and commercial power systems. Application of computer programs for protective device coordination. Additional projects required for EE 553.
(Lecture-problems 3 hours) Letter grade only (A-F).

455/555. Space Electric Power Systems (3)
Prerequisites: EE 330 and 350 all with a grade of "C" or better. A comprehensive treatment of characteristics of and requirements from spacecraft power systems, power sources, power conversion and control. Energy storage, electrical equipment, power converters and loads, power management. Future space missions and technological needs. Additional projects required for EE 555.
(Lecture-problems 3 hours) Letter grade only (A-F).

458. Design of Power System Components (3)
Prerequisites: EE 330 and (either EE 450 or EE 452 or EE 453) all with a grade of "C" or better; or graduate standing.
Prerequisite/Corequisite: EE 400D or graduate standing.
Design of electrical, electronic and electromechanical components required for power conversion, control, transmission, distribution, protection and measurements in terrestrial and space electric power systems.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

462. Electromagnetics and Applications to Wireless Systems (3)
Prerequisite: EE 310 with a grade of "C" or better or graduate standing.
Electromagnetic field theory including transmission lines, vector fields, electrostatics and magnetostatics. Maxwell’s equations and plane wave propagation. Waveguides and microstrip-RF circuit principles and devices. Radiation and antenna design. Wireless communication systems including satellite and cell-phone technologies.
Letter grade only (A-F). Not open for credit to students with credit in EE 460 or 464. (Lecture-problems 2 hours, laboratory 3 hours)

464. Electromagnetics and Applications to Electro-Optics (3)
Prerequisite: EE 310 with a grade of "C" or better or graduate standing.
Electromagnetic field theory including transmission lines, vector fields, electrostatics and magnetostatics. Maxwell’s equations and plane wave propagation. Electromagnetic formulation of geometric and Fourier optics. Semiconductor and gas laser applications to fiber-optic communication systems and electro-optic devices.
Not open for credit to students who have credit in EE 460 or 462. (Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

470. Digital Control (3)
Prerequisites: EE 370, EE 370L, and (EE 386 or EE 411) all with a grade of "C" or better, or graduate standing.
Analysis and synthesis of digital control systems. General application of both the Z-transform and the state-space approach for discrete system design.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

471. Design of Control Systems (3)
Prerequisite: EE 370 with a grade of "C" or better or graduate standing.
Prerequisite/Corequisite: EE 400D.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).
474/574. Robot Modeling and Control (3)
Prerequisite: EE 370 with a grade of "C" or better.
Recommended: EE 411 or 511
Basic methodology for analysis and design of robotic manipulators.
Classification of robots. Homogeneous transformations, kinematics, dynamics, trajectory planning and control of robots.
Application of robots in flexible manufacturing. Advanced projects required for EE 574. EE 411 or 511 is recommended as a pre/corequisite.
(Lecture-problems 3 hours) Letter grade only (A-F).

476/576. Neural Networks and Fuzzy Logic (3)
Prerequisite: EE 388 with a grade of "C" or better or consent of instructor.
Additional projects required for EE 576. Not open for credit to students with credit in EE 589/689. (Lecture-problems 3 hours) Letter grade only (A-F).

481/581. Satellite Communication Systems (3)
Prerequisite: EE 482 with a grade of "C" or better.
Basic orbital mechanics, link analysis, multiple access architectures and protocols, FDMA, TDMA, and CDMA systems. Synchronization techniques, modulation and coding techniques. Security and spread spectrum requirements. System design.
Additional projects required for EE 581. (Lecture-problems 3 hours) Letter grade only (A-F).

482. Communication Systems II (3)
Prerequisite: EE 382 with a grade of "C" or better or graduate standing.
Information sources and communication systems. Orthogonal series representation of signals, pulse and digital modulation techniques, band-pass digital communication systems, special topics in communications.
(Lecture-problems 3 hours) Letter grade only (A-F).

483. Digital Image Processing (3)
Prerequisite: EE 386 with a grade of "C" or better or graduate standing.

486. Digital Signal Processing for Multimedia Communications (3)
Prerequisite: EE 386 with a grade of "C" or better or graduate standing.
Discrete-time signals and systems, discrete Fourier transform, fast Fourier transform, spectral estimation, interpolation and decimation, filter design and structures and applications to multimedia communications. Laboratory projects for image processing, FFT receiver, signal detection, digital phase-locked loop.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

488. Communication System Design (3)
Prerequisite/Corequisite: (EE 400D, EE 430, and EE 482), or graduate standing.
Design of Communication systems/subsystems and their implementation in software and hardware. Design of Capstone Senior Project in the area of Communication systems.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

489. Digital Signal Processing Design (3) S
Prerequisites/Corequisites: (EE 400D and 486) or graduate standing.
Design, implementation, and real-time testing of projects such as FIR filters, IIR filters, tone generator, 32-bit addition and multiplication, FFT spectrum analyzer. All projects are simulated in fixed-point arithmetic with MATLAB or C and TMS320C54x assembly code in bit-exact.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

490. Special Problems (1-3)
Prerequisites: Minimum G.P.A. of 2.5 and consent of instructor.
Assigned topics in technical literature or laboratory projects and reports.
May be repeated to a maximum of 6 units. Letter grade only (A-F).

492. Instrumentation and Data Acquisition for Engineering Applications (3)
Prerequisites: (EE 370 and EE 370L) all with a grade of "C" or better, or consent of instructor or graduate standing.
Concepts of instrumentation, data acquisition and computer-based control of industrial systems. Topics include signal conditioning, software and hardware for data acquisition and computer-based control, graphical programming and virtual instrumentation.
(Lecture-problems 2, laboratory 3 hours) Letter grade only (A-F).

GRADUATE LEVEL

502/402. Engineering Modeling and Simulation (3)
Prerequisite: EE 380 with a grade of "C" or better.
Additional projects required for EE 502. (Lecture-problems 3 hours). Letter grade only (A-F).

503. Advanced Systems Engineering (3)
Prerequisite: EE 411 with a grade of "C" or better or equivalent mathematical maturity.
Modeling and analysis, and design of deterministic and stochastic systems. The building blocks of engineering optimization models ranging from network models with special structured, to unstructured linear and nonlinear optimization.
Letter grade only (A-F). (Lecture-problems 3 hours)

504. Introduction to Entrepreneurship for Engineers (3)
Prerequisite: Graduate standing in engineering or computer science.
Core business concepts and issues, essence of leadership. Understanding of finance, marketing, sales, and management issues from practical entrepreneurial perspective through classroom discussion, guest speakers' seminars, case study, and creation of business plan based on student's specific area of interest.
(Lecture-problems 3 hours) Letter grade only (A-F).

505. Advanced Engineering Mathematics for Electrical Engineers (3)
Prerequisite: Consent of instructor.
(Lecture—problems 3 hours) Letter grade only (A-F).

506/606. Theory and Practice of Biomedical Instrumentation (3)
Prerequisites: Graduate standing in engineering or natural sciences and either EE 406 with a grade of "C" or better or consent of instructor.

Master's students register in EE 506; Ph.D. students register in EE 606. Additional projects required for EE 606. (Lecture-problems 3 hours) Letter grade only (A-F).

507./607. Advanced Biomedical Systems (3)
Prerequisites: Graduate standing in engineering or natural sciences and either EE 406 with a grade of "C" or better or consent of instructor.

Novel trends in biotechnology, design and organization of modern hospital systems, and utilization of advanced technologies. Modeling and simulation of physiological and medical systems.

Master's students register in EE 507; Ph.D. students register in EE 607. Additional projects required for EE 607. (Lecture-problems 3 hours) Letter grade only (A-F).

508. Probability Theory and Random Processes (3)
Prerequisite: EE 380 with a grade of "C" or better.

Probability spaces, random vectors and processes, convergence concepts, stationarity and ergodic properties, second-order moments and linear systems, correlation and spectral representations. Some applications of random processes.

(Lecture-problems 3 hours) Letter grade only (A-F).

509. Network Theory (3)
Prerequisite: EE 386 or 410 or 430 all with a grade of "C" or better. Network classifications and study of non-linear circuits. Analysis of linear networks using topological and state-space techniques. Characterization of networks using scattering and other parameters. Tellegen's theorem and its application.

(Lecture-problems 3 hours) Letter grade only (A-F).

510. Circuit Synthesis (3)
Corequisite: EE 509.

Synthesis of passive lumped networks, cascade synthesis (link with filter synthesis), realization of commensurate distributed networks, discrete passive networks.

(Lecture-problems 3 hours) Letter grade only (A-F).

511. Linear Systems Analysis (3)
Prerequisite: EE 411 or 470 all with a grade of "C" or better or equivalent mathematical maturity.


(Lecture-problems 3 hours) Letter grade only (A-F).

514. Advanced Circuit Synthesis and Design (3)
Prerequisite: EE 510 with a grade of "C" or better.

Scattering synthesis in (s-z) domains, wave digital filters. Lossless bounded-real two-pair and orthogonal digital filters with an emphasis on structures suitable for VLSI implementation.

(Lecture-problems 3 hours) Letter grade only (A-F).

526. High Speed Communication Circuits (3)
Prerequisite: EE 430 with a grade of "C" or better or consent of instructor.


(Lecture-problems 3 hours) Letter grade only (A-F).

527./427. Digital Filter Design and Audio Processing (3)
Prerequisite: EE 386 with a grade of "C" or better or consent of instructor.

Digital filter design methods, filter architectures, round-off noise, implementation and applications to audio signal processing. Additional projects required for EE 527.

Not open for credit to students with credit in EE 513. (Lecture-problems 3 hours) Letter grade only (A-F).

528./428. Speech Signal Processing (3)
Prerequisite/Corequisite: EE 486 or consent of instructor.


Additional projects required for EE 528. (Lecture-problems 3 hours) Letter grade only (A-F).

531. CMOS Electronics (3)
Prerequisite: EE 430 with a grade of "C" or better.

Electronic design automation CAD tools, silicon compilers, CMOS design, BiCMOS design (technologies, modeling, device characterization and simulation), CMOS and BiCMOS subcircuits, amplifiers, op-amps and systems.

(Lecture-problems 3 hours) Letter grade only (A-F).

532./632. Analog Signal Processing (3)
Prerequisite: EE 430 with a grade of "C" or better or consent of instructor.

Basic CMOS circuit techniques. Low-voltage and current-mode signal processing. Switched-capacitor (SC) and switched-current (SI) circuits such as amplifiers, integrators, S/H circuits, filters, oscillators, D/A and A/D converters, etc. Advanced techniques for corrections of nonideal behavior. Analysis and simulation projects.

Master's students register in EE 532; Ph.D. students register in EE 632. Additional projects required for EE 632. Letter grade only (A-F). (Lecture-problems 3 hours)

533./633. Quantum and Optical Electronics (3)
Prerequisite: EE 360 or 462 or 464 all with a grade of "C" or better or consent of instructor.

Modern quantum and optical concepts of relevance in lasers, fiber optics, optical technology and semiconductor solid state electronics. Basic theory and applications to state-of-the-art electronics engineering.

Master's students register in EE 533; Ph.D. students register in EE 633. Additional projects required for Ph.D. students. (Lecture-problems 3 hours) Letter grade only (A-F).

534./434. Mixed-Signal IC Design (3)
Prerequisites: (EE 201 and 330) all with a grade of "C" or better or consent of instructor.


Additional projects required for EE 534. (Lecture-problems 2 hours, Laboratory 3 hours) Letter grade only (A-F).

535. VLSI Design (3)
Prerequisite: EE 430 with a grade of "C" or better.

Techniques for designing Very Large Scale Integrated (VLSI) circuits using n-channel metal oxide semiconductors (n-MOS).

Not open for credit to students with credit in EE 520. (Lecture-problems 3 hours) Letter grade only (A-F).

535A./435. Microelectronics (3)
Prerequisites: (EE 201 and 330) all with a grade of "C" or better or consent of instructor.

Theory of microelectronics integrated circuit design, IC fabrication technology, device characterization, modelling, digital and analog simulation tools, physical layout tools, digital standard cell library design, IC digital system designs, I/O pad design, full chip simulation and physical designs.

Letter grade only (A-F). Additional projects required for EE 535A. (Lecture-problems 3 hours)

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536./436. Microfabrication and Nanotechnology (3)
Prerequisites: EE 330; EE 320 or PHYS 254; or MAE 300 all with a grade of "C" or better.
Techniques and technology of miniaturization of electrical, mechanical, optical, and opto-electronic devices in sizes from millimeters to nanometers are presented. Design examples of sensors, microlenses, cantilevers, and micromotors are covered and process fabrication using latest technology demonstrated.
Additional projects required for EE 536. (Lecture-problems 3 hours) Letter grade only (A-F).

540. Advanced Digital System and Computer Architecture (3)
Prerequisite: EE 446 with a grade of "C" or better or equivalent. Strongly recommended: EE 546.
High level computer architectures including studies of network processors, security processing, embedded computers; system design and implementation approaches including ASIC’s, SOC’s, and networks on chip concepts. Simulation and design tools. Project required.
(Lecture-problems 3 hours) Letter grade only (A-F).

545. Computer Communication Networks (3)
Prerequisite: Consent of instructor.
Design and analysis of computer communications networks including their topologies, architectures, protocols, and standards. LAN, WAN environments and access methods. Ethernet, ATM, bridges, routers, gateways and intelligent hubs. TCP/IP and other Networking protocols. Load balancing, traffic monitoring, use of simulation tools.
(Lecture-problems-computer projects 3 hours) Letter grade only (A-F).

546. Advanced Microprocessors and Embedded Controllers II (3)
Prerequisite: EE 446 with a grade of "C" or better or consent of the instructor.
Advanced concepts for embedded controllers, mobile processors, network processors, embedded Internet, and embedded Internet devices. Parallelism, multithreading, pipelining, coherence protocols, interconnection networks, clustering. Simulation and analysis tools. Project required.
(Lecture-problems 3 hours) Letter grade only (A-F).

548./448. Wireless and Mobile Networks and Security in Wireless Networks (3)
Prerequisites: EE 482 with a grade of "C" or better or equivalent.
Wireless and Mobile Ad-hoc Networks and Security. Ad-hoc and geographic routing, source discovery, MAC, IP-mobility, mobility modelling, wired-wireless networks, security aspects. Lab Projects will include use of tools such as OPNET, Ethereal, Sniffer, Scanner, IDS, etc.
Advanced project required for EE 484. (Lecture-problems 3 hours) Letter grade only (A-F).

550. Power Electronics and Applications (3)
Prerequisites: EE 350 and 430 all with a grade of "C" or better.
Power converters: rectifiers, inverters, choppers and cycloconverters. PWM and PFM techniques. Harmonics and filters. Magnetics. Applications in motor controls in industrial systems, energy conversion, HVDC transmission, aircraft and spacecraft power systems.
(Lecture-problems 3 hours) Letter grade only (A-F).

551. Theory and Applications of DC/DC Converters (3)
Prerequisite: EE 550 with a grade of "C" or better or consent of instructor.
Modeling, analysis, design and application of DC/DC switch-mode converters.
(Lec-prob 3 hrs) Letter grade only (A-F).

552. Electric Drives and Applications (3)
Prerequisites: EE 370 and 452 all with a grade of "C" or better or consent of instructor.
Characteristics and applications of small electric machines including stepper motors, brushless DC motors, permanent-magnet synchronous motors and switched-reluctance motors. Motor performance, control and drive-circuit configurations.
(Lecture-problems 3 hours) Letter grade only (A-F).

553./453. Protection of Power Systems (3)
Prerequisites: EE 310 and 350 all with a grade of "C" or better.
Protective relays, instrument transformers, low-voltage and high-voltage circuit breakers, protection of generators and motors, transformer protection and transmission line protection. Relay coordination and commercial power systems. Application of computer programs for protective device coordination. Additional projects required for EE 553.
(Lecture-problems 3 hours) Letter grade only (A-F).

555./455. Space Electric Power Systems (3)
Prerequisites: EE 330 and 350 all with a grade of "C" or better.
A comprehensive treatment of characteristics of and requirements from spacecraft power systems, power sources, power conversion and control. Energy storage, electrical equipment, power converters and loads, power management. Future space missions and technological needs.
Additional projects required for EE 555. (Lecture-problems 3 hours) Letter grade only (A-F).

566. RF and Microwave Electronics (3)
Prerequisite: EE 360 or 462 or 464 all with a grade of "C" or better or consent of instructor.
(Lecture-problems 2 hours, Laboratory 3 hours). Letter grade only (A-F).

574./474. Robot Modeling and Control (3)
Prerequisite: EE 370 with a grade of "C" or better. Recommended: EE 411 or 511.
Basic methodology for analysis and design of robotic manipulators. Classification of robots. Homogeneous transformations, kinematics, dynamics, trajectory planning and control of robots. Application of robots in flexible manufacturing. Advanced projects required for EE 574. EE 411 or 511 is recommended as a pre/corequisite.
(Lecture-problems 3 hours) Letter grade only (A-F).

575./675. Non-Linear Control Systems (3)
Prerequisite: EE 511 with a grade of "C" or better or consent of instructor.
Methodologies and results dealing with stability and robust stabilization of non-linear systems applied to robotics, aerospace, artificial neural networks, etc. Phase plane analysis, limit cycles, Lyapunov stability theory and its extension, Positive real transfer matrix and passivity, feedback linearization and stabilization, tracking, robust control.
Ph.D. students register in EE 675. Advanced projects for EE 675 students. (Lecture-problems 3 hours) Not open for credit to students with credit in EE 775. Letter grade only (A-F).

576./476. Neural Networks and Fuzzy Logic (3)
Prerequisite: EE 386 with a grade of "C" or better or consent of instructor.
500. Statistical Communication Theory (3)
Prerequisites: (EE 482, 505 and 508) all with a grade of "C" or better or consent of instructor.

581./481. Satellite Communication Systems (3)
Prerequisite: EE 482 with a grade of "C" or better.
Basic orbital mechanics, link analysis, multiple access architectures and protocols, FDMA, TDMA, and CDMA systems. Synchronization techniques, modulation and coding techniques. Security and spread spectrum requirements. System design. Additional projects required for EE 581. (Lecture-problems 3 hours) Letter grade only (A-F).

582. Spread Spectrum Communication Systems (3)
Prerequisite: EE 580 with a grade of "C" or better or consent of instructor.
Spread spectrum (SS) techniques. Direct sequence systems, frequency hopped systems. Generation and properties of pseudo random sequences. Electronic jamming and interference. Processing gain, carrier synchronization, code acquisition and tracking, information modulation and coding. Applications include ranging, CDMA etc. (Lecture-problems 3 hours) Letter grade only (A-F).

583./683. Digital Image Processing (3)
Prerequisite: EE 505 with a grade of "C" or better or consent of instructor.

584. Information Theory and Coding (3)
Prerequisites: EE 482 and 508 all with a grade of "C" or better.
Information measures, source coding, Shannon’s first theorem, mutual information and channel capacity, Shannon’s second theorem, coding techniques for reliable information transmission over noisy channels. (Lecture-problems 3 hours) Letter grade only (A-F).

585./685. Advanced Digital Signal Processing (3)
Prerequisite: EE 486 with a grade of "C" or better or consent of the instructor.
Advanced topics in digital signal processing and applications to communication and power line systems, including adaptive filters, FFT-based OFDM transceivers. IEEE standards for green energy communication and optimization. Masters students register in EE 585; Ph.D. students register in EE 685. Additional projects for EE 685. (Lecture-problems 3 hours). Letter grade only (A-F).

586. Real–Time Digital Signal Processing (3)
Prerequisite: EE 486 or CECS 440 all with a grade of "C" or better or consent of instructor.
Digital signal processors architecture and language. Real–time DSP considerations and limitations. Digital filter and signal processing system implementations. (Lecture–problems 3 hours) Letter grade only (A-F).

590. Selected Topics in Electrical Engineering (3)
Prerequisites: Graduate standing in electrical engineering and consent of instructor.
Selected topics from recent advances in electrical engineering. Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in the Schedule of Classes. (Lecture-problems 3 hours)

591. Adaptive Systems (3)
Prerequisite: EE 508 with a grade of "C" or better.
Adaptive systems and their applications to communication, control, and signal processing systems. (Lecture-problems 3 hours) Letter grade only (A-F).

600. Graduate Seminar and Presentation (1)
Prerequisites: Graduate standing and advancement to candidacy.
Lectures by faculty and guests on advanced topics. A report and presentation are required. (Seminar 1 hour) Letter grade only (A-F).

606./506. Theory and Practice of Biomedical Instrumentation (3)
Prerequisites: Graduate standing in engineering or natural sciences; and either EE 406 with a grade of "C" or better or consent of instructor.

607./507. Advanced Biomedical Systems (3)
Prerequisites: Graduate standing in engineering or natural sciences; and either EE 406 with a grade of "C" or better or consent of instructor.
Novel trends in biotechnology, design and organization of modern hospital systems and utilization of advanced technologies. Modeling an simulation of physiological and medical systems. Master’s students register in EE 507; Ph.D. students register in EE 607. Additional projects required for EE 607. (Lecture-problems 3 hours) Letter grade only (A-F).

632./532. Analog Signal Processing (3)
Prerequisite: EE 430 with a grade of "C" or better or consent of instructor.
Basic CMOS circuit techniques. Low-voltage and current-mode signal processing. Switched-capacitor (SC) and switched-current (SI) circuits such as amplifiers, integrators, S/H circuits, filters, oscillators, D/A and A/D converters, etc. Advanced techniques for corrections of nonideal behavior. Analysis and simulation projects. Master’s students register in EE 532; Ph.D. students register in EE 632. Additional projects required for EE 632. Letter grade only (A-F). (Lecture-problems 3 hours)

633./533. Quantum and Optical Electronics (3)
Prerequisite: EE 360 or 462 or 464 all with a grade of "C" or better or consent of instructor.
Modern quantum and optical concepts of relevance in lasers, fiber optics, optical technology and semiconductor solid state electronics. Basic theory and applications to state-of-the-art electronics engineering. Master’s students register in EE 533; Ph.D. students register in EE 633. Additional projects required for Ph.D. students. (Lecture-problems 3 hours) Letter grade only (A-F).
675./575. Non-Linear Control Systems (3)
Prerequisite: EE 511 with a grade of "C" or better or consent of instructor.
Methodologies and results dealing with stability and robust stabilization of non-linear systems applied to robotics, aerospace, artificial neural networks, etc. Phase plane analysis, limit cycles, Lyapunov stability theory and its extension, Positive real transfer matrix and passivity, feedback linearization and stabilization, tracking, robust control.
Ph.D. students register in EE 675. Advanced projects for EE 675 students. (Lecture-problems 3 hours) Not open for credit to students with credit in EE 775. Letter grade only (A-F).

683./583. Digital Image Processing (3)
Prerequisite: EE 505 with a grade of "C" or better or consent of instructor.
Masters students register in EE 583; Ph.D. students register in EE 683. Additional projects required for EE 683. (Lecture–problems 3 hours) Letter grade only (A-F).

685./585. Advanced Digital Signal Processing (3)
Prerequisite: EE 486 with a grade of "C" or better or consent of the instructor.
Advanced topics in digital signal processing and applications to communication and power line systems, including adaptive filters, FFT-based OFDM transceivers. IEEE standards for green energy communication and optimization.
Masters students register in EE 585; Ph.D. students register in EE 685. Additional projects for EE 685. (Lecture-problems 3 hours) Letter grade only (A-F).

697. Directed Research (3)
Prerequisite: Graduate Standing. Advancement to Candidacy is strongly recommended.
Theoretical and experimental problems in electrical engineering requiring intensive analysis culminating in a substantial report.
Letter grade only (A-F).

698. Thesis or Industrial Project (3-6)
Prerequisite: Advancement to Candidacy.
Planning, preparation and completion of a thesis (total 6 units), or industrial project (3 units), in electrical engineering.
Letter grade only (A-F).
Introduction
The Engineering Technology (ET) Programs at CSULB serve society by graduating well-prepared professionals, who are provided with an excellent education in the fundamentals of Engineering Technology through a combination of theory and laboratory practice, and who are able to apply their knowledge and transform their ideas into working systems.

Advisory Council
The Engineering Technology Advisory and Development Council (ETADC), composed of leaders actively engaged in areas of relevant engineering technology, provides information and guidance about industrial developments in methods, materials and techniques. The members make recommendations for changes in curriculum content, methods and/or facilities.

Career Possibilities
**Computer Option:** Hardware and software Computer Applications Engineers • Test Equipment Engineers • Manufacturing Engineers or Technical Sales Engineers in industry and organizations where a combination of hardware and software background is required

**Electronics Option:** Electronic Technician • Calibration Engineer • Construction Inspector • Computer Applications Engineer • Time Study Engineer • Facilities Planner • Field Engineer • Manufacturing Engineering • Operations Research Analyst • Sales Representative • Project Engineer • Associate Electronics Engineer • Product Design Engineer • Process Engineer • Instructor

**Environmental Option:** Air Quality Engineer • Compliance Officer • Environmental Assessment Consultant • Groundwater and Soil Contamination Specialist • Hazardous Materials Manager • Incineration Management Specialist • Natural Resources Manager • On- site Sewage Disposal Director • Permits Compliance Manager • Remedial Design and Construction Manager • Site Assessment Specialist • Technical Writer - Environmental Specialist • Urban-Environmental Studies Planning Director • Waste Management Director

Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.

General Requirements
All students in the BSET, BSEET, or BSCET programs must receive a minimum grade of "C" in each of the prerequisite courses before enrolling in any Engineering Technology course. In addition to any other all-university requirements regarding grade point averages for graduation, student must achieve a minimum of 2.0 average in all Engineering Technology courses.

Bachelor of Science in Engineering Technology

**Option in Technology and Engineering Education (120 units)**

Administered by the Computer Engineering and Computer Science Department.

Faculty Advisor - Roni Allen
CECS Department Office - ECS 540
Faculty Advisor's Office - ECS 525
Faculty Advisor's Telephone -(562) 985-1523

The Option in Technology and Engineering Education is for students preparing to teach technology and programming courses at the middle or high school level. Completion of these courses meets the subject matter competence requirement for the Single Subject Teaching Credential in Industrial and Technology Education (ITE). Students should consult the department’s Industrial and Technology Education advisor to plan their program.

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 111 and 113, and PHYS 100A within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 122, PHYS 100A and B within one calendar year.

Requirements

**Lower Division:**

Take all of the following courses:
- CECS 100 Critical Thinking in Digital Information Age (3)  Prerequisite/Corequisite: ENGL 100 or equivalent.
- CECS 110 Beginning Web Design (3)  Prerequisites: None.
- CECS 174 Programming and Problem Solving (3)  Prerequisite: CECS 100 and MATH 113 (or equivalent) all with a grade of "C" or better.
- CECS 200 Intermediate Web Design (3)  Prerequisite: CECS 110 and MATH 113 (or equivalent) all with a grade of "C" or better.
- CECS 202 The Digital Information Age (3)  Prerequisite: GE Foundation requirements.
- CEM 121 Construction Drawing I (2)  Prerequisites: None.
- CEM 125 Fundamentals of Construction (3)  Prerequisites: None.
- DESN 120A Fundamentals of Design (3)  Prerequisites: None.
ENGR 101 Introduction to Engineering Profession (1)  
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)  
Prerequisite: ENGR 101 with a grade of ”C” or better.

ET 101 Introduction to Engineering Technology (1)  
Prerequisites: None.

ET 170 Engineering Drafting and Design (3)  
Prerequisite: Sophomore standing.

Mae 272 Introduction to Manufacturing Processes (2)  
Prerequisite: MAE 172 with a grade of ”C” or better.

PHYS 100A General Physics (4)  
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 100B General Physics (4)  
Prerequisite: PHYS 100A.

Choose one of the following pairs:

ET 250 Circuit Analysis I (2)  
Prerequisite: PHYS 100B with a grade of ”C” or better.  
Corequisite: ET 250L.

ET 250L Circuit Analysis I Laboratory (1)  
Prerequisite: PHYS 100B with a grade of ”C” or better.  
Corequisite: ET 250.

or

ET 302 Industrial Electricity (2)  
Prerequisite: PHYS 100B with a grade of ”C” or better.  
Corequisite: ET 302L.

ET 302L Industrial Electricity Laboratory (1)  
Prerequisite: PHYS 100B with a grade of ”C” or better.  
Corequisite: ET 302.

Upper Division:

Take all of the following:

CE 426 Transportation Engineering (3)  
Prerequisite: CE 345 with a grade of ”C” or better.  
Corequisite: CE 406.

CECS 310 Computer-Based Learning Resources (3)  
Prerequisite: CECS 200 with a grade of ”C” or better.

CEM 310 Communication in Engineering Profession (3)  
Prerequisites: ENGL 100, COMM 110 all with a grade of ”C” or better and Senior standing.

DESN 368 History and Theory of Design (3)  
Prerequisite: GE Foundation requirements.

ENGR 302I Energy and Environment (3)  
Prerequisites: G.E. Foundation requirements, one or more Exploration courses, and upper-division standing.

ENGR 375 Total Quality & Continuous Improvement (3)  
Prerequisites: GE Foundation requirements, one or more Exploration courses, and upper-division standing.

ET 307 Industrial Safety (2)  
Prerequisite: Junior Standing.

Concentration I:

CECS 401 Programming Robots – For Educators (3)  
Prerequisite: Some programming experience.

CECS 410 Computers and Networks (3)  
Prerequisite: Course design assumes familiarity with computers.

CECS 414 Intro to Network & System Security Issues (3)  
Prerequisites: CECS 174 with a grade of ”C” or better.

ETEC 435 Accessible Electronic and Info Technologies (3)  
Prerequisite: Either ETEC 110, 411, 444 all with a grade of ”C” or better or consent of instructor.

Concentration II:

CE 406 Cost Engineering and Analysis (3)  
Prerequisite: GE Foundation requirements.

ET 244 Machine Tools (1)  
Corequisite: ET 244L.

ET 244L Machine Tools Laboratory (1)  
Corequisite: ET 244.

ET 264 Industrial Tooling (1)  
Prerequisites: ET 170 with a grade of ”C” or better;  
Corequisite: ET 264L.

ET 264L Industrial Tooling Laboratory  
Prerequisites: ET 170 all with a grade of ”C” or better;  
Corequisite: ET 264.

ET 313 QA, Inspection Measurement and Testing (2)  
Prerequisite: ET 311 all with a grade of ”C” or better.  
Corequisite: ET 313L.

ET 313L QA, Inspection Measurement & Testing Lab (1)  
Prerequisite: ET 311 all with a grade of ”C” or better.  
Corequisite: ET 313.

ET 335 Engineering Materials and Processes I (3)  
Corequisite: ET 335L.

Single Subject Teaching Credential in Industrial and Technology Education

In addition to meeting the subject matter competence for the Teaching Credential, prospective students are also required to complete 45 units of professional preparation in the Single Subject Credential Program, including student teaching. Students may begin the professional preparation courses as early as the junior year. With careful planning, it is possible to complete all of the credential program courses, except for student teaching, as an undergraduate. Courses may also be completed as a post-baccalaureate student. Refer to the Single Subject Teacher Education section of this catalog, or the Single Subject Program website (www.ced.csulb.edu/single-subject) for a description of the professional preparation requirements, courses, and application procedures.

Option in Environmental Technology  
(133 units)

Not accepting new students as of Fall 2012.

Prerequisite Core

Lower Division:

Take all of the following courses:

CHEM 111A General Chemistry (5)  
Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination), and a ”C” or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

ENGR 203 Engineering Problem Solving & Analysis (3)  
Prerequisite: MATH 122 with a grade of ”C” or better;  
Corequisite: ENGR 263L.

ENGR 203L Engr Problem Solving & Analysis Lab (1)  
Prerequisite: MATH 122 with a grade of ”C” or better.  
Corequisite: ENGR 203.

ET 101 Introduction to Engineering Technology (1)  
Prerequisites: None.

ET 170 Engineering Drafting and Design (3)  
Prerequisite: Sophomore standing.

ET 202 Probability and Statistics for Technology (3)  
Prerequisite: High school algebra. Corequisite: ET 202L.

ET 202L Probability & Statistics for Technology Lab (1)  
Prerequisites: 2 yrs high school algebra, geometry, and intermediate algebra (or MATH 010) or equivalent. Corequisite: ET 202.
ET 204 Applied Mechanics-Statics (3)
Prerequisites: MATH 120, PHYS 100A all with a grade of "C" or better.

ET 205 Computer Systems and Programming (1)
Corequisite: ET 205L.

ET 205L Computer Systems and Programming Lab (1)
Corequisite: ET 205.

MATH 120 Technical Calculus (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

PHYS 100A General Physics (4)
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 100B General Physics (4)
Prerequisites: PHYS 100A.

Upper Division:
Take all of the following courses:
ECON 300 Fundamentals of Economics (3)
Prerequisites: GE Foundation requirements.

ET 301 Engineering Materials (2)
Prerequisites: CHEM 111A with a grade of "C" or better.
Corequisite: ET 301L.

ET 301L Engineering Materials Laboratory (1)
Prerequisites: CHEM 111A with a grade of "C" or better.
Corequisite: ET 301.

ET 307 Industrial Safety (2)
Prerequisite: Junior Standing.

ET 335 Engineering Materials and Process I (3)
Corequisite: ET 335L.

ET 335L Engineering Materials and Process I Lab (1)
Corequisite: ET 335.

ET 410 Cost Engineering and Analysis (3)
Prerequisites: Economics course, Junior standing.

Select one of the following:
ET 309 Industrial Leadership (2)
Prerequisites: ET 101 with a grade of "C" or better.

ENGR 310 Bus Communication in Engr Profession (3)

Requirements
Lower Division:
Take all of the following courses:
ET 206 Introduction to Environmental Hazardous Materials and Waste Technology (3)
Prerequisites: CHEM 111A, PHYS 100A all with a grade of "C" or better.

ET 209 Environmental Applications of Physics and Organic Chemistry (2)
Prerequisite: CHEM 111A with a grade of "C" or better.

ET 210 Hazardous Material & Waste Management (3)
Prerequisites: CHEM 111A, ET 206 all with a grade of "C" or better.

ET 213 Environmental Health, Safety and Emergency Response (3)
Prerequisites: CHEM 111A, ET 206 all with a grade of "C" or better.

Upper Division:
Take all of the following courses:
ET 319 Environmental Regulations and Compliance (3)
Prerequisites: None.
Select at least 11 units of approved electives in consultation with an advisor from the following courses:
ET 409F, 476; H SC 422

Fieldwork Requirements
Fieldwork experience is required for the BS in Engineering Technology, Option in Environmental Technology, consisting of no less than three months full-time (40 hours/week) (or equivalent part-time) of employment in an approved industry or governmental agency. The student must hold a position equivalent to a technician or higher which affords the opportunity to exercise responsibility usually given to those who have completed two years of college. The fieldwork must be completed prior to graduation, be certified and approved by the faculty of the Department.

Bachelor of Science in Computer Engineering Technology (129 units)
Administered by the Electrical Engineering Department.
Faculty Advisor - I-Hung Khoo
EE Department Office - ECS 561
Faculty Advisor’s Office - ECS 517
Faculty Advisor’s Telephone - (562) 985-5082

This program is available to students interested in the manufacturing of computers and the applications and operations aspects of computer hardware and software.

Degree Progress
Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 111, 113, and PHYS 100A within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 122 and PHYS 100A and B within one calendar year.

Requirements
Lower Division:
Take all of the following courses:
MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

PHYS 100A General Physics (4)
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 100B General Physics (4)
Prerequisites: PHYS 100A.

ENGR 101 Introduction to Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

ENGR 203 Engineering Problem Solving & Analysis (3)
Prerequisite: MATH 122 all with a grade of "C" or better.
Corequisite: ENGR 203L.

ENGR 203L Engr Problem Solving & Analysis Lab (1)
Prerequisite: MATH 122 all with a grade of "C" or better.
Corequisite: ENGR 203.
Upper Division:
Take all the following courses:

**ET 386L Introduction to Microprocessors Lab (1)**
Prerequisite: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 386.

**ET 309 Industrial Communications and Leadership (3)**
Prerequisites: ET 101 with a grade of "C" or better.

**ET 311 Quality Engineering Technology (3)**
Prerequisites: ET 202, 202L all with a grade of "C" or better.

**ET 360 Control Instrumentation (2)**
Prerequisites: ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 360L.

**ET 360L Control Instrumentation Lab (1)**
Prerequisites: ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 360.

**ET 386 Introduction to Microprocessors (2)**
Prerequisite: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 386L.

**ET 386L Introduction to Microprocessors Lab (1)**
Prerequisites: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 386.

**ET 387 Robot Programming and Mechatronics (2)**
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 387.

**ET 387L Robot Programming & Mechatronics Lab (1)**
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 387.

**ET 388 Technical Applications Using Programming Languages (2)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 388L.

**ET 388L Technical Applications Using Programming Languages Lab (1)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 388.

**ET 410 Cost Engineering and Analysis (3)**
Prerequisites: Economics course, Junior standing.

**ET 442 Computer Circuits (2)**
Prerequisites: ET 255, 255L all with a grade of "C" or better.
Corequisite ET 442L.

**ET 442L Computer Circuits Lab (1)**
Prerequisites: ET 255, 255L all with a grade of "C" or better.
Corequisite ET 442.

**ET 486 Data Structures (2)**
Prerequisites: ET 388, 388L all with a grade of "C" or better.
Corequisite: ET 486L.

**ET 486L Data Structures Lab (1)**
Prerequisites: ET 388, 388L all with a grade of "C" or better.
Corequisite: ET 486.

**ET 487 Introduction to Data Communications and Networking (2)**
Prerequisites: ET 286, 286L, 386, 386L or equivalents all with a grade of "C" or better.
Corequisite: ET 487L.

**ET 487L Introduction to Data Communications and Networking Lab (1)**
Prerequisites: ET 286, 286L, 386, 386L or equivalents all with a grade of "C" or better.
Corequisite: ET 487.

**ET 488 Microcomputer Systems (2)**
Prerequisites: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 488L.

**ET 488L Microcomputer Systems Lab (1)**
Prerequisites: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 488.

**ET 489 Computer Interfacing (2)**
Prerequisites: ET 442, 442L, 488, 488L all with a grade of "C" or better.
Corequisite: ET 489L.

**ET 489L Computer Interfacing Lab (1)**
Prerequisites: ET 442, 442L, 488, 488L all with a grade of "C" or better.
Corequisite: ET 489.

**ET 492 Computer Controlled Industrial Systems (2)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 492.

**ET 492L Computer Controlled Industrial Systems Laboratory (1)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 492.

**ET 494 Applied Systems Development Project (2)**
Prerequisites: ET 386, 386L, 487, 487L all with a grade of "C" or better.
Corequisite: ET 494L.

**ET 494L Applied Systems Development Project Lab (1)**
Prerequisites: ET 386, 386L, 487, 487L all with a grade of "C" or better.
Corequisite: ET 494.
Take 3 units of either ET 312 Statistical Quality Control or ET 461 Management of Manufacturing Operations. Take at least 3 units from the following, in consultation with an advisor:

ET 408E or (491, 491L) or (497, 497L).

Fieldwork Requirements

Fieldwork experience is required for the BS in Computer Engineering Technology, consisting of no less than three months full-time (40 hours/week) (or equivalent part-time) of employment in an approved industry or governmental agency. The student must hold a position equivalent to a technician or higher which affords the opportunity to exercise responsibility usually given to those who have completed two years of college. The fieldwork must be completed prior to graduation, to be certified and approved by the faculty of the Department.

Bachelor of Science in Electronics Engineering Technology (129 units)

Administered by the Electrical Engineering Department.

Faculty Advisor - I-Hung Khoo
EE Department Office - ECS 512
Faculty Advisor’s Office - ECS 517
Faculty Advisor’s Telephone - (562) 985-5082

The Electronics Engineering Technology program, prepares the student for a position as a technologist, in such industries as aerospace, computers, communications, biomedical, chemical, power, etc. Students are offered a wide range of training in topics such as instrumentation, controls, microprocessors, microelectronics, biomedical electronics, communications, motors and generators, robotics, computer applications, programming and interfacing. Moreover the program emphasizes written and oral communications skills as well as modern methods of industrial administration and supervision.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 111 and 113, and PHYS 100A within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 122 and PHYS 100A and B within one calendar year.

Requirements

Lower Division:

Take all the following courses:

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

PHYS 100A General Physics (4)
Prerequisite: MATH 109 or 113 or 119A or 120 or 122.

ENGR 101 Introduction to Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

ENGR 203 Engineering Problem Solving & Analysis (3)
Prerequisite: MATH 122 all with a grade of "C" or better.
Corequisite: ENGR 203L.

ENGR 203L Engr Problem Solving & Analysis Lab (1)
Prerequisite: MATH 122 with a grade of "C" or better.
Corequisite: ENGR 203.

ET 101 Introduction to Engineering Technology (1)
Prerequisites: None.

ET 170 Engineering Drafting and Design (3)
Prerequisite: Sophomore standing.

ET 202 Probability and Statistics for Technology (3)
Prerequisite: High school algebra.
Corequisite: ET 202L.

ET 202L Probability & Statistics for Technology Lab (1)
Prerequisites: 2 yrs high school algebra, geometry, and intermediate algebra (or MATH 010) or equivalent.

ET 205 Computer Systems and Programming (1)
Corequisite: ET 205L.

ENGR 203L Engr Problem Solving & Analysis Lab (1)
Prerequisite: PHYS 100A all with a grade of "C" or better.
Corequisite: ET 203L.

ENGR 250 Circuit Analysis I (2)
Prerequisites: ET 202, 202L all with a grade of "C" or better.
Corequisite: ET 250.

ENGR 250 Circuit Analysis I Laboratory (1)
Prerequisite: PHYS 100B all with a grade of "C" or better.
Corequisite: ET 250.

ENGR 252 Circuit Analysis II (2)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 252L.

ENGR 252 Circuit Analysis II Lab (1)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 252.

ENGR 255 Introduction to Digital Electronics (2)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 255.

ENGR 255 Introduction to Digital Electronics Lab (1)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 255L.

ENGR 260 Solid State Electronic I (2)
Prerequisites: ET 252, 252L all with a grade of "C" or better.
Corequisite: ET 260.

ENGR 260 Solid State Electronic I Lab (1)
Prerequisites: ET 252, 252L all with a grade of "C" or better.
Corequisite: ET 260.

ENGR 286 Intro to Object-Oriented Programming (2)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 286L.

ENGR 286L Intro to Object-Oriented Programming Lab (1)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 286.

Upper Division:

Take all the following courses:

ET 309 Industrial Communications and Leadership (3)
Prerequisites: ET 101 with a grade of "C" or better.

ET 311 Quality Engineering Technology (3)
Prerequisites: ET 202, 202L all with a grade of "C" or better.

ET 341 Solid State Electronic II (2)
Prerequisites: ENGR 203, 203L, ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 341L.
Engineering Technology Courses (E T)

LOWER DIVISION

101. Introduction to Engineering Technology (1)
Survey of professional activities and environment of engineering technologist. Covers role of technologist in American industry, the history of technology and the growth and future of those professionals who hold the Bachelor of Science degree in Engineering Technology.
(Lecture-Discussion 1 hour) Credit/No Credit grading only.

170. Engineering Drafting and Design (3)
Graphic communication including freehand sketching. Introduction to blueprinting reading and computer aided drafting. Emphasis on engineering drafting practices; general standards, tolerances, thread series, welding joints, surface finishes, fasteners, structural shapes.
(Lecture 2 hours, laboratory 3 hours) Letter grade only (A-F).

171. Engineering Drawing (Lecture 1 hour, Laboratory 2 hours) Credit/No Credit grading only.

102. Probability and Statistics for Technology (3)
Prerequisite: Sophomore standing.
Statistics and probability theory, sampling, correlation, regression as applied to Engineering Technology.
(Lecture-problems 3 hours) Letter grade only (A-F).

202L. Probability and Statistics for Technology Laboratory (1)
Prerequisites: 2 yrs high school algebra, geometry, and intermediate algebra (or MATH 010) or equivalent.
Laboratory exercises in statistics and probability theory, sampling, correlation, regression as applied to Engineering Technology. Simulation using statistical packages.
(Laboratory 3 hours) Letter grade only (A-F).

204. Applied Mechanics-Statics (3)
Prerequisites: MATH 120, PHYS 100A all with a grade of "C" or better.
Force systems acting on structures, moments, equilibrium, centroids, trusses, beams, cables, frames, machines, friction, section properties, masses, both U.S. and S.I. units of measurements.
(Lecture 2 hrs, activity 2 hrs) Letter grade only (A-F).
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Corequisites</th>
<th>Credits</th>
<th>Lecture Hours</th>
<th>Discussion Hours</th>
<th>Laboratory Hours</th>
<th>Corequisite Comments</th>
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<tr>
<td>205</td>
<td>Computer Systems and Programming (1)</td>
<td>Corequisite: ET 205L.</td>
<td>Overview of computer systems, hardware, and software development. Hardware topics include</td>
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<td>(Lecture-Discussion 3 hours)</td>
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<td>central processing unit and memory, input/output devices, storage mechanism, and</td>
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<td>communication. Software topics include programming languages, operating systems, and systems</td>
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<td>analysis and design.</td>
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<td>205L</td>
<td>Computer Systems and Programming Lab (1)</td>
<td>Corequisite: ET 205.</td>
<td>Laboratory exercises in computer programming to solve problems in business, manufacturing,</td>
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<td>(Lecture-Discussion 3 hours)</td>
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<td>research and simulation. An object-oriented programming language will be used for these</td>
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<td>activities.</td>
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<td>206</td>
<td>Introduction to Environmental Hazardous Materials and Waste Technology (3)</td>
<td>Prerequisites: CHEM 111A, PHYS 100A all with a grade of &quot;C&quot; or better.</td>
<td>Study of industrial processes and generation of waste streams in selected industries.</td>
<td>3</td>
<td>(Lecture-Discussion 3 hours)</td>
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<td>Introduction to concepts of sustainable development, energy conservation, waste minimization</td>
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<td>and waste treatment.</td>
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<td>208</td>
<td>Hazardous Waste Stream Generation, Reduction, Treatment (3)</td>
<td>Prerequisites: CHEM 111A all with a grade of &quot;C&quot; or better.</td>
<td>Study of physical and organic chemistry in environmental science and engineered</td>
<td>3</td>
<td>(Lecture-Discussion 3 hours)</td>
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<td>environmental systems.</td>
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<td>209</td>
<td>Environmental Applications of Physical and Organic Chemistry (2)</td>
<td>Prerequisite: CHEM 111A all with a grade of &quot;C&quot; or better.</td>
<td>Applications of physical and organic chemistry in environmental science and engineered</td>
<td>2</td>
<td>(Lecture-Discussion 2 hours)</td>
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<td>210</td>
<td>Hazardous Material and Waste Management (3)</td>
<td>Prerequisites: CHEM 111A, ET 206 all with a grade of &quot;C&quot; or better.</td>
<td>Study of the requirements of federal, state and local regulations relating to the management</td>
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<td>(Lecture-Discussion 3 hours)</td>
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<td>of hazardous materials and hazardous wastes. Particular focus on compliance with shipping,</td>
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<td>storage, labeling, sampling, and inventory and release reporting requirements.</td>
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<td>212</td>
<td>Hazardous Materials Management Application (3)</td>
<td>Prerequisites: federal, state and local laws and regulations relating to</td>
<td>Compliance with Department of Transportation, Occupation Safety and health</td>
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<td>(Lecture-Discussion 3 hours)</td>
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<td>Hazard Communication, Superfund Amendments and Reauthorization Act, Title III community</td>
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<td>Right to Know etc.</td>
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<td>213</td>
<td>Environmental Health, Safety and Emergency Response (3)</td>
<td>Prerequisites: CHEM 111A, ET 206 all with a grade of &quot;C&quot; or better.</td>
<td>Hands-on instruction in safety and emergency response to chemical and physical exposures in</td>
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<td>(Lecture-Discussion 3 hours)</td>
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<td>industrial and field settings. Acute and chronic health effects produced by exposure to</td>
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260. Solid-State Electronics I (2)
Prerequisites: ET 252, 252L all with a grade of "C" or better. Corequisite: ET 260L.
Analysis and design of solid-state electronic circuits using diodes, bipolar, unijunction and field-effect devices.
(Lecture-Discussion 2 hours) Letter grade only (A-F).

260L. Solid State Electronics I Laboratory (1)
Prerequisites: ET 252, 252L all with a grade of "C" or better. Corequisite: ET 260.
Laboratory exercises in breadboarding and measurements of solid-state circuits utilizing all types of electronic measuring equipment.
(Laboratory 3 hours) Letter grade only (A-F).

264. Industrial Tooling (1)
Prerequisites: ET 170 with a grade of "C" or better. Corequisite: ET 264L.
Design of tools for production. Typical tooling problems include working drawings and hardware.
(Lecture-Discussion 1 hour) Letter grade only (A-F).

264L. Industrial Tooling Laboratory (1)
Prerequisites: ET 170 with a grade of "C" or better. Corequisite: ET 264.
Laboratory experiments in tool design in relation to mass part production.
(Laboratory 3 hours) Letter grade only (A-F).

286. Introduction to Object–Oriented Programming (2)
Prerequisites: ET 205, 205L all with a grade of "C" or better. Corequisite: ET 286L.
Introduction to an object–oriented programming language (C++).
Problem analysis and software development methodology. Emphasis on applications to technology
(Lec–Discussion 2 hrs) Letter grade only (A-F).

286L. Introduction to Object–Oriented Programming Laboratory (1)
Prerequisites: ET 205, 205L all with a grade of "C" or better. Corequisite: ET 286.
Introduction to an object–oriented programming language (C++).
Problem analysis and software development methodology. Emphasis on applications to technology.
Letter grade only (A-F). (Laboratory 3 hours)

UPPER DIVISION

301. Engineering Materials (2)
Prerequisites: CHEM 111A with a grade of "C" or better. Corequisite: ET 301L.
Study of physical and mechanical properties and applications of engineering materials.
Letter grade only (A-F). (Lecture–Discussion 2 hours)

301L. Engineering Materials Laboratory (1)
Prerequisites: CHEM 111A with a grade of "C" or better. Corequisite: ET 301.
Laboratory investigation and experiments in the application of engineering materials. Field trips.
Letter grade only (A-F). (Lab 3 hrs)

302. Industrial Electricity (2)
Prerequisites: PHYS 100B with a grade of "C" or better. Corequisite: ET 302L.
Overview of electrical principles and applications in electrical manufacturing industries including instrumentation and power distribution.
Letter grade only (A-F). (Lecture 2 hours) May not be used for credit for the ECET program.
319. Environmental Regulations and Compliance (3)
Analysis of federal and local administration of environmental laws, including the National Environmental Policy Act of 1969 and litigation of that act in the courts. Special attention paid to California and comparison of the environmental regulation policies of California.
(Lecture–Discussion 3 hours) Letter grade only (A-F).

335. Engineering Materials and Processes I (3)
Corequisite: ET 335L.
Examination of engineering materials and manufacturing processes including the study of: Phase diagrams; heat treatment; metal casting processes; welding and soldering; corrosion; powder metallurgy, electronic fabrication; tribology, friction, wear; lubrication; surface treatment, coating and cleaning.
(Lecture - Discussion 3 hours) Letter grade only (A-F).

335L. Engineering Materials Processes I Laboratory (1)
Corequisite: ET 335.
Laboratory exercises in engineering materials and manufacturing processes including the study of: Phase diagram; heat treatment; casting; metallurgy and electronic manufacturing processes.
(Laboratory 3 hours) Letter grade only (A-F).

341. Solid State Electronics II (2)
Prerequisites: ENGR 203, 203L, ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 341L.
Miller's Theorem, integrated circuits, feedback, operational amplifiers, Fourier series, distortion, modulation, phase-locked loops, linear and non-linear circuits, and breadboarding.
(Lec-Discussion 2 hrs) Letter grade only (A-F).

341L. Solid State Electronics II Laboratory (1)
Prerequisites: ENGR 203, 203L, ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 341.
Laboratory exercises in design and measurement of various circuits using operational amplifiers, comparators, regulators, silicon controlled rectifiers, frequency mixers and phase-locked loops.
(Lab 3 hours) Letter grade only (A-F).

350. Motors and Generators (2)
Prerequisites: ET 252, 252L all with a grade of "C" or better.
Corequisite: ET 350L.
Study of electric rotating machinery, its theories, principles, design and applications in automation industries.
(Lecture-Problems 1 hour) Letter grade only (A-F).

350L. Motors and Generators Laboratory (1)
Prerequisite: ET 252 252L all with a grade of "C" or better.
Corequisite: ET 350.
Laboratory exercises in applications and design of rotating machines. Topics covered are DC machines, servomotor, step motor, and control circuits.
(Laboratory 3 hours) Letter grade only (A-F).

360. Control Instrumentation (2)
Prerequisites: ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 360L.
Application and basic design of analog and digital control instrumentation for industrial processes. Physical and electrical properties of thermal, mechanical and optical transducers with associated signal conditioning.
(Lecture-Problems 2 hours) Letter grade only (A-F).

360L. Control Instrumentation Laboratory (1)
Prerequisites: ET 260, 260L all with a grade of "C" or better.
Corequisite: ET 360.
Laboratory exercises in developing and measuring various control systems utilizing operational amplifiers, transducers, thermocouples, bridges, and various pressure devices.
(Laboratory 3 hours) Letter grade only (A-F).

363. Kinematics of Mechanisms (3)
Prerequisites: ET 170, ET 204 all with a grade of "C" or better.
Mathematical and graphical approaches to analyze the motion of mechanisms, for further machine development, through studies of displacement, velocity and acceleration of mechanical elements.
(Lecture-Discussion 2 hours, Activity 2 hours) Letter grade only (A-F).

365. Fluid Power and Control (2)
Prerequisite: ET 204 with a grade of "C" or better.
Corequisite: ET 365L.
Fundamentals and application of hydraulic, pneumatic and vacuum power as used in current manufacturing plants.
(Lecture–Discussion 2 hours) Letter grade only (A-F).

365L. Fluid Power and Control Laboratory (1)
Prerequisite: ET 204 with a grade of "C" or better.
Corequisite: ET 365.
Demonstration and operation of fluid power systems. Design and selection of components for specific applications. Computer data acquisition and analysis.
(Laboratory 3 hours) Letter grade only (A-F).

386. Introduction to Microprocessors (2)
Prerequisite: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 386L.
Theory and concepts of programming, hardware configuration, and functional capabilities of microcomputer systems including peripheral devices.
(Lecture-Problems 2 hours) Letter grade only (A-F).

386L. Introduction to Microprocessors Laboratory (1)
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 386.
Laboratory exercises in programming microcomputers. Topics included are number systems, microcomputer structure, mnemonics, binary code, peripheral devices operations, stand alone operations, and system operations.
(Laboratory 3 hours) Letter grade only (A-F).

387. Robot Programming and Mechatronics (2)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 387L.
Basic concepts of robot manipulators, robot kinematics, robot programming languages. Applications of industrial robots, machine vision systems. Basic concepts of mechatronic systems: combine hardware, software, interface, and system integration to make an intelligent system. Sensors and actuators for robotics and mechatronic systems.
(Lecture-Problems 2 hours) Letter grade only (A-F).

387L. Robot Programming and Mechatronics Laboratory (1)
Prerequisites: ET 205, 205L all with a grade of "C" or better.
Corequisite: ET 387.
Laboratory exercises in industrial and educational robot operation and applications. Laboratory exercises on mechatronic systems. Robot systems and their computer language instructions will be used. The experiments include teach pendant programming, high level language programming, workcell applications, continuous path programming.
Letter grade only (A-F).
388. Technical Applications Using Programming Languages (2)
Prerequisites: ET 286, 286L all with a grade of "C" or better. Corequisite: ET 388L.
Techniques for design and development of industrial programs that includes composite program design, module coupling/ strength, program testing, top-down structured programming concepts and tools, object oriented programming, and memory management. Concepts are investigated and examined for use in solving complex problems.
(Lecture-problems 2 hours)

388L. Technical Applications Using Programming Languages Laboratory (1)
Prerequisites: ET 286, 286L all with a grade of "C" or better. Corequisite: ET 388.
Techniques for design and development of industrial programs that includes composite program design, module coupling/ strength, program testing, top-down structured programming concepts and tools, object oriented programming, and memory management. Concepts are investigated and examined for use in solving complex problems.
(Lab 3 hours)

390. Applied Computer-Aided Design and Manufacturing (2)
Prerequisites: ET 170, 205, 205L all with a grade of "C" or better. Corequisite: ET 390L.
Roll of the computers in the manufacturing process, application of CAD/CAM systems, hardware and software components for automation, part programming for manufacturing, computer controlled manufacturing equipment, simulation, programming the factory.
(Lecture - Discussion 2 hours) Letter grade only (A-F).

390L. Applied Computer-Aided Design and Manufacturing Laboratory (1)
Prerequisites: ET 170, 205, 205L all with a grade of "C" or better. Corequisite: ET 390.
Use of microcomputer based hardware and software to solve 2D and 3D modeling problems. Computer automation software packages. Also includes part programming and CAD/CAM data exchange exercises.
(Laboratory 3 hours) Letter grade only (A-F).

409. Selected Topics in Engineering Technology (1-3)
Prerequisites: Senior standing in ET, consent of instructor. Advanced work of a technical nature within an area of specialization on an experimental or research basis. Letter grade only (A-F). Topics announced in the Schedule of Classes.
B. Electronics Technology
C. Manufacturing Technology
D. Quality Assurance
E. Computer Technology
F. Environmental Technology

410. Cost Engineering and Analysis (3)
Prerequisites: Economics course, Junior standing. Introduction to the concepts of capital and operations budgets, capital acquisitions, economic evaluations of capital alternatives and factors of the time—value of money in industrial operations and construction industries.
(Lecture–Discussion 3 hours) Letter grade only (A-F).

418. Production Methods and Process Improvement (3)
Prerequisite: ET 410 with a grade of "C" or better. Simplification and improvement of manufacturing operations through the use of production analysis tools for optimum production economy. Also included is the investigation of production automation applications for improving manufacturing process, quality and productivity.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

419. Design of Experiments (3)
Prerequisite: ET 312 with a grade of "C" or better. Advanced statistical analysis applied to quality functions. Comparative and single factor experiments. Factorial designs and multiple regression.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

435. Engineering Materials and Processes II (3)
Prerequisites: ET 335, 335L all with a grade of "C" or better. Corequisite: ET 435L.
Application of engineering materials and manufacturing processes including: rolling; forging; extrusion and drawing; sheet-metal forming; manufacturing of plastics and composites; material removal processes and rapid prototyping.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

435L. Engineering Materials and Processes II Laboratory (1)
Prerequisites: ET 335, 335L all with a grade of "C" or better. Corequisite: ET 435.
Continuation of ET 335L. Laboratory exercises in: welding processes; machining processes; metal forming; manufacturing of composite materials.
(Laboratory 3 hours) Letter grade only (A-F).

441. Theory of Electronic Control (3)
Prerequisites: ET 360, 360L all with a grade of "C" or better. Procedures for the design, preparation, and evaluation of electronic systems that control manufacturing and production processes, simulation analysis for sensing, programming, and actuating operations.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

442. Computer Circuits (2)
Prerequisites: ET 255, 255L all with a grade of "C" or better. Corequisite ET 442L.
Introduction to digital hardware design. Combinational/sequential logic circuits and systems and application of integrated circuits to logic controls. Programmable logic devices, Field-programmable gate array, Circuit synthesis, and analysis.
(Lecture-Problems 2 hours) Letter grade only (A-F).

442L. Computer Circuits Laboratory (1)
Prerequisites: ET 255, 255L all with a grade of "C" or better. Corequisite ET 442.
Laboratory study of digital computer circuits design and implementation. Standard designing and trouble-shooting procedures will be discussed. Topics covered are multivibrator, register, counter, decoder, arithmetic circuits, and memory.
(Laboratory 3 hours) Letter grade only (A-F).

444. Telecommunications (3)
Prerequisites: ET 360, 360L all with a grade of "C" or better. National Communication Network, decibels, transmission units, transmission lines, characteristic impedance, loading systems, lattice networks, PCM, Nyquist Criterion, Bessel functions, coaxial cable, fiber optics, microwave, impedance matching, and Smith chart.
(Lecture-Discussion 3 hours) Letter grade only (A-F).

445. Microelectronics (2)
Prerequisites: ET 350, 350L all with a grade of "C" or better. Corequisite: ET 445L.
Design, processing and applications of monolithic and hybrid microcircuits for analog and digital systems.
(Lecture 2 hours) Letter grade only (A-F).
Engineering Technology Courses (E T)

445L. Microelectronics Laboratory (1)
Prerequisites: ET 350, 350L all with a grade of "C" or better.
Corequisite: ET 445.
Laboratory exercises in the processing of thick-film and thin-film materials, ultrasonic and thermocompression wire bonding and laser resistive trimming. Practical application and equipment utilization is emphasized.
(Laboratory 3 hours) Letter grade only (A-F).

447. Industrial Applications of Electronic Circuits (2)
Prerequisites: ET 341, 341L all with a grade of "C" or better.
Corequisite: ET 447L.
An in-depth study of the applications of important electronic circuit concepts in industry. Analysis of circuits and how they work in industrial applications. Techniques for troubleshooting of design circuits. Biomedical electronic circuits which have industrial applications are emphasized.
(Lecture-Discussion 2 hours) Letter grade only (A-F).

447L. Industrial Applications of Electronic Circuits Laboratory (1)
Prerequisites: ET 341, 341L all with a grade of "C" or better.
Corequisite: ET 447.
Laboratory exercises include constructing circuits which have important applications in industry. Troubleshooting methodology emphasized throughout. Assignments focus on biomedical electronic circuits which have industrial applications.
(Laboratory 3 hours) Letter grade only (A-F).

460. Electronics Project Design and Development (2)
Prerequisites: ET 341, 341L all with a grade of "C" or better and senior standing.
Corequisite: ET 460L.
Laboratory exercises in electronics project design and development. Topics include: product planning, implementation planning, proposal and approvals, prototyping, system integration, packaging, overall testing, and reporting. Formal demonstration, oral presentation on finished product and written report on the final design.
This capstone course is open to Electronics Technology majors only. Letter grade only (A-F). (Lecture-Discussion 2 hours)

460L. Electronics Project Design and Development Laboratory (1)
Prerequisites: ET 341, 341L all with a grade of "C" or better and senior standing.
Corequisite: ET 460.
Laboratory exercises in electronics project design and development. Topics include: product planning, implementation planning, proposal and approvals, prototyping, system integration, packaging, overall testing, and reporting. Formal demonstration, oral presentation on finished product and written report on the final design.
Letter grade only (A-F). (Laboratory 3 hours)

461. Management of Manufacturing Operations (3)
Prerequisite: ET 410 with a grade of "C" or better.
Application of analytical planning and control techniques to the resources of industry including the physical plant, equipment, personnel, inventories and supplies used in the production of products and services.
(Lecture-Discussion 3 hrs) Letter grade only (A-F).

476. Environmental Impact (3)
Prerequisite: BIOL 306 with a grade of "C" or better.
Required components of environmental impact reports and assessments and the processes involved in their preparation.
Special emphasis is placed on the biological portions of EIRs and impact on flora and fauna.
(Lecture–Discussion 3 hours) Letter grade only (A-F).

486. Data Structures (2)
Prerequisites: ET 388, 388L all with a grade of "C" or better.
Corequisite: ET 486L.
Data structures and applications. Choice and implementation of appropriate data structures for applications. Treatment of arrays, lists, stacks, queues, linked lists, trees, and assorted algorithms. Introduction to searching and sorting. File organization techniques.
(Lecture-Problems 2 hours) Letter grade only (A-F).

486L. Data Structures Laboratory (1)
Prerequisites: ET 388, 388L all with a grade of "C" or better.
Corequisite: ET 486.
Laboratory exercises in data structures and applications. A recursive programming language will be used.
(Laboratory 3 hours) Letter grade only (A-F).

487. Introduction to Data Communications and Networking (2)
Prerequisites: ET 286, 286L, 386, 386L or equivalents all with a grade of "C" or better.
Corequisite: ET 487L.
Introduction to data communications fundamentals, peer-to-peer and client/server network models. Hardware and software technology, Protocols, networks, relational database technology, and security. Example applications, tools and development environments, Groupware, middleware. A design project and class presentation is required.
(Lecture-discussion 2 hours) Letter grade only (A-F).

487L. Introduction to Data Communications and Networking Laboratory (1)
Prerequisites: ET 286, 286L, 386, 386L or equivalents all with a grade of "C" or better.
Corequisite: ET 487.
Laboratory and programming exercises introducing the students to data communications and Networking technology. Protocols, networks, relational database technology, and security. Applications using software/hardware tools and development environments.
(Laboratory 3 hours) Letter grade only (A-F).

488. Microcomputer Systems (2)
Prerequisites: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 488L.
Study of available microprocessors and microcomputer systems. Topics cover microcomputer architecture, software structure, assembly language, central processing unit, input/output, memory manipulation, and interfacing applications in Engineering Technology.
(Lecture-problems 2 hours) Letter grade only (A-F).

488L. Microcomputer Systems Laboratory (1)
Prerequisites: ET 386, 386L all with a grade of "C" or better.
Corequisite: ET 488.
Laboratory experience in microcomputer architecture, assembly language programming, and interfacing applications in Engineering Technology. Topics covered are central processing unit function, memory organization, and input/output operation. Available microcomputer systems will be used. Applications in Engineering Technology.
(Laboratory 3 hours) Letter grade only (A-F).

489. Computer Interfacing (2)
Prerequisites: ET 442, 442L, 488, 488L all with a grade of "C" or better.
Corequisite: ET 489L.
Study of theories and techniques that are used in peripheral control and interfacing. Topics covered are serial interfacing, Parallel
interfacing, timing, handshaking, A/D converters, buffering, and UARTs.

**489L. Computer Interfacing Laboratory (1)**
Prerequisites: ET 442, 442L, 488, 488L all with a grade of "C" or better.
Corequisite: ET 489.
Laboratory exercises in computer interfacing applications and design. Available computer system and its assembly language instructions will be used.

(Laboratory 3 hours) Letter grade only (A-F).

**491. Embedded Processors and Systems (2)**
Prerequisites: ET 489, 489L all with a grade of "C" or better.
Corequisite: ET 491L.
Embedded microprocessors, embedded systems, development concepts, principles, and applications. Hardware/software tradeoffs, interfacing issues, memory sizing, timing, code and power optimization issues. Application requirements, platform selection, RISC vs. CISC issues, co-processors vs. ASIC's.

(Lecture-discussion 2 hours) Letter grade only (A-F).

**491L. Embedded Processors and Systems Laboratory (1)**
Prerequisites: ET 489, 489L all with a grade of "C" or better.
Corequisite: ET 491.
Laboratory exercises on embedded system development. Emphasis will be on application requirements, platform selection, interfacing, memory sizing, timing, code and power optimization. Use of development environments and evaluation boards.

(Laboratory 3 hours) Letter grade only (A-F).

**492. Computer Controlled Industrial Systems (2)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 492L.
Concepts of computer-based control of industrial systems and data acquisition. Signals and measurements, noise, resolution, signal conditioning. Software and hardware for data acquisition and control.

(Lecture-discussion, 2 hours) Letter grade only (A-F).

**492L. Computer Controlled Industrial Systems Laboratory (1)**
Prerequisites: ET 286, 286L all with a grade of "C" or better.
Corequisite: ET 492.
Laboratory exercises on computer-based control of industrial systems and data acquisition. Software and hardware for data acquisition and control. Emphasis placed on object-oriented languages and creation of graphical user interfaces for data acquisition, display and control.

(Laboratory, 1 hour) Letter grade only (A-F).

**494. Applied Systems Development Project (2)**
Prerequisites: ET 386, 386L, 487, 487L all with a grade of "C" or better.
Corequisite: ET 494L.
Systems development concepts, principles, and practices to a comprehensive systems development project. Hands-on approach is used to analyze, design and document a realistic system. Actual use of project management, interviewing, forms analysis, structured methods, behavioral dynamics, walk-throughs, report writing, and presentations.

(Lecture-Discussion 2 hours) Letter grade only (A-F).
MECHANICAL AND AEROSPACE ENGINEERING
College of Engineering

Department Chair: Hamid Hefazi
Department Office: ECS - 635
Telephone: (562) 985-1563
Website: http://www.csulb.edu/colleges/coe/mae


Undergraduate Advisors: Jalal Torabzadeh (ME Program Coordinator), Hsun Hu Chen (AE), Parviz Yavari (ET)

General Education Advising: Academic Advising - Horn Center

Graduate Advisors: Joshua Hamel (ME), Hsin-Piao Chen (AE)

Administrative Support Coordinator: Leanne Hayes

Students desiring detailed information should contact the department for referral to one of the faculty advisors.

Career Possibilities
Mechanical Engineer • Aerospace Engineer • Facilities Engineer • Manufacturing • Design Engineer • Sales Engineer • Plant Engineer • Safety Engineer • Tool Engineer • Project Engineer • Utilization/Test Engineer • Automotive Engineer • Production Engineer • Manufacturing Engineer • Standards Engineer • Industrial Engineer • Factory Plant Layout Engineer • Material Schedule • Tool Planner • Safety Engineer • Product Safety Engineer • Production Planner • Statistician • Staff Assistant • Specification Writer • Tooling Quality Assurance Worker • Quality Planning Analyst • Process Engineering • Estimator • Manufacturing Engineering • Quality Engineer • Supervisor • Vendor Quality • Production Engineer • Material Schedule • Quality Control Technician • Configuration Analyst • Quality Manager • Production Manager • Industrial Engineering • Production Safety Engineer • Safety Engineer • Metrologist • Liaison Worker • Methods and Time-Study Engineer • Traffic Control Engineer • Technical Sales Representative • Process Engineer • Estimator • Associate Engineer • Field Engineer (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

Accreditation
The Bachelor of Science in Aerospace Engineering and the Bachelor of Science in Mechanical Engineering are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Advisory Council
The Department of Mechanical and Aerospace Engineering is supported by a professional Advisory and Development Council (ADC) comprised of outstanding engineers and executives from industry and government in Southern California. The role of the ADC is to form a liaison between the University and industry and to help the administration and faculty remain informed of modern engineering practices.

Programs at a Glance
Undergraduate
• Bachelor of Science in Aerospace Engineering (BSAE);
• Bachelor of Science in Mechanical Engineering (BSME);
• *Bachelor of Science in Engineering (BSE) with options in Materials Engineering or Industrial Management Engineering;
• *Bachelor of Science in Manufacturing Engineering Technology.

Graduate
• Master of Science in Aerospace Engineering (MSAE);
• Master of Science in Mechanical Engineering (MSME);
• Master of Science in Engineering (MSE) with an emphasis in Management Engineering;
• Ph.D. in Engineering and Industrial Applied Mathematics (offered jointly with Claremont Graduate University).

Post-Baccalaureate Certificate Programs
• *Certificate in Aerospace Manufacturing
• *Certificate in Heating, Ventilating, and Air-Conditioning (HVAC)
• *Certificate in Industrial Plastics Processing and Design
• *Certificate in Energy Conversion and Power Systems Engineering
* Not accepting new students as of Fall 2012.

Student Organizations
Students have the benefit of joining the student chapters of professional societies:
• AIAA (American Institute for Aeronautics and Astronautics)
• ASME (American Society for Mechanical Engineers)
• SAE (Society of Automotive Engineers)
• SPE (Society of Petroleum Engineers)
• ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers)
• SME (Society of Manufacturing Engineers)
• ASQ (American Society of Quality)
• SWE (Society of Women Engineers)
• Tau Beta Pi, Pi Tau Sigma

As student members of professional societies, students can attend local, regional, national, and international meetings and conferences, participate in student contests, become eligible for sponsored scholarships, interact with professionals from industry, and many other benefits.
Undergraduate Programs

MECHANICAL ENGINEERING PROGRAM

BSME Program Educational Objectives

The goal of the undergraduate program in mechanical engineering is to produce well-rounded engineers prepared for careers in mechanical engineering or related disciplines, utilizing an excellent education in the fundamentals of engineering mathematics, sciences, and design in order to:

- Create innovative solutions responsive to customer needs and meeting societal challenges;
- Apply their knowledge to communicating and translating ideas and plans into working engineering systems;
- Effectively function as a team member and/or leader in global, multi-disciplinary technical environments.

Student Learning Outcomes

The following student learning outcomes have been developed: knowledge of mathematics, science, and engineering; design and conduct experiments and analyze and interpret data; design a system, component, or process to meet desired needs within realistic constraints; function on multi-disciplinary teams; identify, formulate, and solve engineering problems; understanding of professional and ethical responsibilities; communicate effectively; understand the impact of engineering solutions in a global and societal context; knowledge of contemporary issues.

Bachelor of Science in Mechanical Engineering (129 units)

The opportunity to explore a particular area of interest is provided by additional elective courses in the senior year. Several industry and professional society sponsored scholarships and internships are available to upper division mechanical engineering students. Further information is available in the department office.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Minimum of 129 units including University General Education requirements. A grade of "C" or better must be achieved in all prerequisites for all required courses listed below.

Lower Division:

Take all of the following courses:

- CHEM 111A General Chemistry (5)
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).
- CE 205 Analytical Mechanics I (Statics) (3)
  Prerequisite: PHYS 151 all with a grade of "C" or better.
  Prerequisite/Corequisite: MATH 123.
- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- MATH 224 Calculus III (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- ENGR 101 Introduction to Engineering Profession (1)
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122
- ENGR 102 Academic Success Skills (1)
  Prerequisite: ENGR 101 with a grade of "C" or better.
- MAE 101B Introduction to Mechanical Engineering (1)
  Prerequisite: Freshman standing or consent of instructor.
- MAE 172 Engineering Design Graphics I (3)
  Prerequisites: None.
- MAE 205 Computer Methods in MAE (2)
  Prerequisites: MATH 122 with a grade of "C" or better.
- MAE 272 Introduction to Manufacturing Processes (2)
  Prerequisite: MAE 172 with a grade of "C" or better.
- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 123.
  Take one of the following choices:
  - PHYS 152 Electricity and Magnetism (4)
    Prerequisite: PHYS 151 with a grade of "C" or better.
    Prerequisite/Corequisite: MATH 123.
  - or both of the following:
    - EE 210 Electro-Magnetic Foundations in EE (3)
      Prerequisite: PHYS 151 with a grade of "C" or better.
      Corequisites: MATH 123, EE 210L.
    - EE 210L Electro-Magnetic Foundations in EE Lab (1)

Upper Division:

Take all of the following courses:

- CE 335 Fluid Mechanics (3)
  Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.
- CE 336 Fluid Mechanics Laboratory (1)
  Prerequisite: ENGL 100 or equivalent all with a grade of "C" or better.
  Prerequisite/Corequisite: C E 335.
- CE 406 Cost Engineering and Analysis (3)
  Prerequisite: GE Foundation requirements.
- ECON 300 Fundamentals of Economics (3)
  Prerequisites: GE Foundation requirements.
- MATH 370A Applied Mathematics I (3)
  Prerequisites: MATH 123. Not open to Freshmen.
- MAE 300 Engineering Instrumentation & Measurement (2)
  Prerequisites: MATH 224, PHYS 151, 152 all with a grade of "C" or better.
- MAE 305 Numerical Methods in MAE (3)
  Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.
MAE 322 Engineering Materials and Materials Processes (3)
Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.

MAE 330 Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 336 Power Plant Design (3)
Prerequisite: MAE 330 with a grade of "C" or better.

MAE 337 Thermal Engineering Laboratory (2)
Prerequisite: MAE 336 with a grade of "C" or better.

MAE 361 Materials and Properties Laboratory (1)
Prerequisites: ENGL 100 or equivalent, MAE 300, 322, 373 all with a grade of "C" or better.

MAE 371 Analytical Mechanics Dynamics (3)
Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.

MAE 373 Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 all with a grade of "C" or better.

MAE 375 Kinematics & Dynamics of Mechanisms (3)
Prerequisites: MAE 272, 371 all with a grade of "C" or better.

MAE 376 Modeling & Analysis of Dynamic Systems (3)
Prerequisite: MAE 371; MATH 370A all with a grade of "C" or better.

MAE 409 Modern Computational Aspects in Mechanical Engineering (3)
Prerequisites: Senior standing in engineering and consent of instructor.

MAE 431 Heat Transfer Systems Design (3)
Prerequisites: MAE 305, 330; CE 335 all with a grade of "C" or better.

MAE 459 Professional Practice Seminar (1)
Prerequisite: Senior standing or consent of instructor.

MAE 471 Analysis & Design of Machine Components (3)
Prerequisites: MAE 373 and MAE 375 all with a grade of "C" or better.

MAE 472 Design of Mechanical Engineering Systems (3)
Prerequisites: MAE 330, 471 all with a grade of "C" or better.

MAE 476 Mechanical Control Systems I (3)
Prerequisite: MAE 376 with a grade of "C" or better.

MAE 490 Special Topics (3)
Prerequisites: Senior standing in engineering and consent of instructor.

AEROSPACE ENGINEERING PROGRAM

BSAE Program Educational Objectives

The goal of the undergraduate program in aerospace engineering is to produce well-rounded engineers prepared for careers in aerospace engineering or related disciplines, utilizing an excellent education in the fundamentals of engineering mathematics, sciences, and design in order to:
1. Create innovative solutions responsive to customer needs and meeting societal challenges;
2. Apply their knowledge to communicating and translating ideas and plans into working engineering systems;
3. Effectively function as a team member and/or leader in global, multi-disciplinary technical environments.

Student Learning Outcomes

The program aims at achieving the following student learning outcomes: skills in mathematics, physics, and chemistry, and a firm understanding of engineering science fundamentals that enables students to analyze real world problems and propose appropriate solutions to these problems; knowledge of aerospace fundamental disciplines for the analysis and design of components; ability to work in teams and carry out a design from conceptual level to the realization of a manufacturing plan; ability to design and conduct experiments, as well as to analyze and interpret data; an understanding of professional and ethical responsibility; the ability to build on their knowledge and be trained to be lifelong learners; good oral, written and graphical communication skills; training in the role of the engineer in society; awareness of environmental concerns in the engineering profession; and knowledge of contemporary issues.

Bachelor of Science in Aerospace Engineering (127 units)

The curriculum is designed to supplement mathematics, science and basic engineering courses in order to give students the specialization needed in different areas of aerospace engineering. In addition to acquiring technical knowledge, graduates will have completed appropriate courses in communications and in humanistic social studies.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of “C” or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

A grade of "C" or better must be achieved in all of the required courses listed below. A minimum of 128 units is required.

There are two emphases in the BSAE Program: (1) Aeronautics, and (2) Astronautics. Aeronautics focuses on aerospace engineering as it relates to flight in the atmosphere, while Astronautics addresses space flight.

Core Requirements

Lower Division:
Take all of the following courses:

- CE 205 Analytical Mechanics I (Statics) (3)
  Prerequisite: PHYS 151 with a grade of "C" or better. Prerequisite/Corequisite: MATH 123.

- CHEM 111A General Chemistry (5)
  Prerequisites: A passing score on the Chemistry Placement Examination (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

- ENGR 101 Introduction to Engineering Profession (1)
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122
ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

MAE 101A Introduction to Aerospace Engineering (1)
Prerequisites: None.

MAE 172 Engineering Design Graphics (3)
Prerequisites: None.

MAE 205 Computer Methods in Mechanical/Aerospace Engineering (2)
Prerequisites: MATH 122 with a grade of "C" or better.

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

MATH 123 Calculus II (4)
Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)
Prerequisite: A grade of "C" or better in MATH 123 or 222.

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 123.

Take one of the following choices:

PHYS 152 Electricity and Magnetism (4)
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

or both of the following:

EE 210L Electro-Magnetic Foundations in EE Lab (1)

EE 210L Electro-Magnetic Foundations in EE Lab (1)

Upper Division:
Take all of the following courses:

ECON 300 Fundamentals of Economics (3)
Prerequisites: GE Foundation requirements.

MATH 370A Applied Mathematics I (3)
Prerequisites: MATH 123. Not open to Freshmen.

MAE 300 Engineering Instrumentation and Measurement (2)
Prerequisites: MATH 224, PHYS 151, 152 all with a grade of "C" or better.

MAE 305 Numerical Methods in MAE (3)
Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.

MAE 330 Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 333 Engineering Fluid Dynamics (3)
Prerequisites: CE 205, MATH 370A all with a grade of "C" or better.

MAE 334 Aerodynamics I (3)
Prerequisite: MAE 333 with a grade of "C" or better.

MAE 350 Flight Mechanics (3)
Prerequisite: CE 205 with a grade of "C" or better.

MAE 365 Aerospace Structures I (3)
Prerequisite: MAE 373 with a grade of "C" or better.

MAE 371 Analytical Mechanics II (Dynamics) (3)
Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.

MAE 373 Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 with a grade of "C" or better.

MAE 374 Mechanical Properties of Materials Lab (1)
Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor.

MAE 381 Fundamentals of Space Dynamics (3)
Prerequisites: PHYS 152, MATH 370A, and MAE 371 all with a grade of "C" or better.

MAE 390 Aerospace Engineering Seminar (1)
Prerequisite: Upper division standing.

MAE 440 Aerodynamics Laboratory (1)
Prerequisites: MAE 300 and 334 all with a grade of "C" or better.

MAE 452 Propulsion (3)
Prerequisites: MAE 330 and 334 all with a grade of "C" or better.

MAE 465 Aerospace Structures II (3)
Prerequisite: MAE 365 with a grade of "C" or better.

MAE 478 Aerospace Systems Design I (3)
Prerequisites: MAE 334, 365, and 381 all with a grade of "C" or better.
Corequisite: MAE 434, 465, or 481.

MAE 479 Aerospace Systems Design II (3)
Prerequisite: MAE 478 with a grade of "C" or better.

Emphasis in Aeronautics:

Take all of the following courses:

MAE 434 Aerodynamics II (3)
Prerequisite: MAE 334 with a grade of "C" or better.

MAE 451 Aircraft Preliminary Design & Performance (3)
Prerequisite: MAE 334, 350 all with a grade of "C" or better, or consent of instructor.

MAE 453 Stability & Control of Aerospace Vehicles (3)
Prerequisite: MAE 350 or equivalent all with a grade of "C" or better.
Corequisite: MAE 334.

Choose two of the following courses:

MAE 422, 431, 435, 454, 476, 481, 483

Emphasis in Astronautics:

Take all of the following courses:

MAE 481 Space Systems Engineering (3)
Prerequisite: MAE 381 with a grade of "C" or better.

MAE 483 Space Flight and Orbital Mechanics (3)
Prerequisites: MAE 381 with a grade of "C" or better.

Choose three of the following courses:

MAE 422, 431, 434, 435, 451, 454, 453, 476

Bachelor of Science in Engineering
Option in Materials Engineering (135 units)

Not accepting new students as of Fall 2012.

Modern engineering applications in all fields require new materials with properties well beyond those obtainable with the alloys available years ago. New materials, such as composites, ceramics, polymers, semiconductors and their manufacturing processes, are needed for such diverse applications as air transports, undersea deep submergence vessels, magnetic and semiconducting devices. Scientific knowledge in this area has expanded recently at a rate comparable to that experienced by the field of electronics. The materials option is offered to meet the demand for materials oriented engineers.

Course work is directed towards the understanding of the properties of materials in terms of their atomic structure, and emphasis is placed on the behavior of materials in engineering applications. The laboratories have equipment for studies in this field and include facilities for the determination of crystal structure, microscopic and X-ray diffraction, and scanning electron microscope examination of solids, thermal and mechanical treatment and the determination of properties at low and high temperatures.
Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of “C” or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of “C” or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Minimum 135 units including University General Education requirements.

Lower Division:
Take all of the following courses:

- CE 205 Analytical Mechanics I (Statics) (3)
  Prerequisite: PHYS 151 with a grade of "C" or better.
  Prerequisite/Corequisite: MATH 123.
- CH E 200 Chemical Engineering Fundamentals (3)
  Prerequisites: CHEM 111A, MATH 122, PHYS 151 all with a grade of "C" or better.
  Corequisite: CHE 210.
- CHEM 111A General Chemistry (5)
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).
  Prerequisite/Corequisite: CHE 210.
- CHEM 111B General Chemistry (5)
  Prerequisites: CHEM 111A with a grade of "C" or better.
- EE 211 Electric Circuits I (3)
  Prerequisites: (EE 210/210L or PHYS 152) and (MATH 123 or equivalent) all with a grade of "C" or better.
- EE 211L Electric Circuits Laboratory (1)
  Corequisite: EE 211.
- ENGR 101 Introduction to Engineering Profession (1)
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.
- MAE 172 Engineering Design Graphics (3)
  Prerequisites: None.
- MAE 205 Computer Methods in Mechanical/Aerospace Engineering (2)
  Prerequisites: MATH 122 with a grade of "C" or better.
- MAE 272 Introduction to Manufacturing Processes (2)
  Prerequisite: MAE 172 with a grade of "C" or better.
- MATH 122 Calculus I (4)
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- MATH 123 Calculus II (4)
  Prerequisite: A grade of "C" or better in MATH 122.
- MATH 224 Calculus III (4)
  Prerequisite: A grade of "C" or better in MATH 123 or 222.
- PHYS 151 Mechanics and Heat (4)
  Prerequisite/Corequisite: MATH 122.
- PHYS 152 Electricity and Magnetism (4)
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:
Take all of the following courses:

- CE 406 Cost Engineering and Analysis (3)
  Prerequisite: GE Foundation requirements.
- CH E 415 Occupational and Environ Safety Engineering and Management (3)
  Prerequisite: CHEM 327 with a grade of "C" or better or consent of instructor.
- ECON 300 Fundamentals of Economics (3)
  Prerequisites: GE Foundation requirements.
- EE 420 Solid State Electronic Devices (3)
  Prerequisite: PHYS 254 with a grade of "C" or better or graduate standing.
- MAE 322 Engineering Materials and Materials Processes (3)
  Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.
- MAE 330 Engineering Thermodynamics I (3)
  Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.
- MAE 361 Materials and Properties Lab (1)
  Prerequisites: ENGL 100 or equivalent, MAE 300, 322, 373 all with a grade of "C" or better.
- MAE 371 Analytical Mechanics II (Dynamics) (3)
  Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.
- MAE 373 Mechanics of Deformable Bodies (3)
  Prerequisite: CE 205 all with a grade of "C" or better.
- MAE 374 Mechanical Properties of Materials (1)
  Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor.
- MAE 375 Kinematics and Dynamics of Mechanisms (3)
  Prerequisites: MAE 272, 371 all with a grade of "C" or better.
- MAE 409 Modern Computational Aspects in ME (3)
  Prerequisites: Senior standing in engineering and consent of instructor.
- MAE 459 Professional Practice Seminar (1)
  Prerequisite: Senior standing or consent of instructor.
- MAE 490 Special Topics (3)
  Prerequisites: Senior standing in engineering and consent of instructor.
- MATH 370A Applied Mathematics I (3)
  Prerequisites: MATH 123 with a grade of "C" or better. Not open to Freshmen.

Take approved engineering elective courses.

For more information on admission to this program, please contact Dr. Jalal Torabzadeh, Undergraduate Advisor, Mechanical Engineering Program.

Option in Industrial Management Engineering (135 units)

Not accepting new students as of Fall 2012. An interdisciplinary degree in which both the College of Business Administration and the College of Engineering provide courses which enable students to have a technical engineering background, plus a good foundation in business and management practices. The option consists of core engineering courses through the junior year, with the addition of business courses in accounting, business law, management, inventory practices and operations research. The elective structure is such that the student may specialize in either engineering, or a combination of both engineering and business.
Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.
Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Lower Division:

Take all of the following courses:

- **ACCT 201 Elementary Financial Accounting (3)**
  Prerequisites: None.
- **BLAW 220 Intro to Law and Business Transactions (3)**
  Prerequisites: None.
- **CE 205 Analytical Mechanics I (Statics) (3)**
  Prerequisite: PHYS 151 all with a grade of "C" or better.
  Prerequisite/Corequisite: MATH 123.
- **CHEM 111A General Chemistry (5)**
  Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).
- **EE 211 Electric Circuits I (3)**
  Prerequisites: (EE 210/210L or PHYS 152) and (MATH 123 or equivalent) all with a grade of "C" or better.
- **EE 211L Electric Circuits Laboratory (1)**
  Corequisite: EE 211.
- **ENGR 101 Introduction to Engineering Profession (1)**
  Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.
- **MAE 172 Engineering Design Graphics (3)**
  Prerequisites: None.
- **MAE 205 Computer Methods in Mechanical/Aerospace Engineering (2)**
  Prerequisites: MATH 122 with a grade of "C" or better.
- **MATH 122 Calculus I (4)**
  Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.
- **MATH 123 Calculus II (4)**
  Prerequisite: A grade of "C" or better in MATH 122.
- **MATH 224 Calculus III (4)**
  Prerequisite: A grade of "C" or better in MATH 123 or 222.
- **PHYS 151 Mechanics and Heat (4)**
  Prerequisite/Corequisite: MATH 122.
- **PHYS 152 Electricity and Magnetism (4)**
  Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:

Take all of the following courses:

- **BLAW 320 Legal and Regulatory Environment Business (3)**
  Prerequisites: None.
- **CE 406 Cost Engineering and Analysis (3)**
  Prerequisite: GE Foundation requirements.
- **ECON 300 Fundamentals of Economics (3)**
  Prerequisites: GE Foundation requirements.
- **IS 310 Business Statistics (3)**
  Prerequisite: MATH 114.
- **MAE 305 Numerical Methods in MAE (3)**
  Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.
- **MAE 310 Safety and Reliability in Systems Design I (3)**
  Prerequisites: MAE 205; MATH 370A all with a grade of "C" or better, or consent of instructor.
- **MAE 322 Engineering Materials/Materials Processes (3)**
  Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.
- **MAE 330 Engineering Thermodynamics I (3)**
  Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.
- **MAE 371 Analytical Mechanics II (Dynamics) (3)**
  Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.
- **MAE 373 Mechanics of Deformable Bodies (3)**
  Prerequisite: CE 205 with a grade of "C" or better.
- **MAE 376 Modeling and Analysis of Dynamic Systems (3)**
  Prerequisite: MAE 371; MATH 370A all with a grade of "C" or better.
- **MAE 459 Professional Practice Seminar (1)**
  Prerequisite: Senior standing or consent of instructor.
- **MAE 476 Mechanical Control Systems I (3)**
  Prerequisite: MAE 376 with a grade of "C" or better.
- **MATH 370A Applied Mathematics I (3)**
  Prerequisites: MATH 123 all with a grade of "C" or better.
- **Mgmt 300 Principles of Management and Operations (3)**
  Recommended: IS 310.

Choose one of the following courses:

**SCM 411, MGMT 412, MGMT 413**

Take approved electives to total at least 135 units.

For more information on admission to this program, please contact Dr. Jalal Torabzadeh, Undergraduate Advisor, Mechanical Engineering Program.

**Bachelor of Science in Manufacturing Engineering Technology (133 units)**

Not accepting new students as of Fall 2012.

The BSMET is designed to provide a solid technical foundation for its graduates, which will enable them to perform well in a variety of employment situations. The program focuses on the applications of current manufacturing and quality assurance technologies to solve real-world problems by offering a broad curriculum which covers current trends in industry.

The BSMET degree will prepare students for career positions as: manufacturing engineering technologist, manufacturing management, manufacturing process engineering technologist, line supervisor, research and development technologist, industrial/technical representative, industrial/technical sales, production technologist, or quality assurance technologist. Students have the opportunity to prepare for mid-management or
supervisory positions, as well as technical positions, sales, service or research.

BSMET students are offered a wide range of training opportunities in topics such as: materials, manufacturing processes, quality control, and different production environments. Moreover, the program emphasizes written and oral communication skills as well as modern methods of industrial administration and supervision. The program is designed to meet ABET criteria for accredited programs in engineering technology.

The BSMET program has been developed to accommodate students who may wish to transfer credits earned at other colleges or approved technical or military schools. It is recommended that prior to submitting an application for admission, prospective students should contact the BSMET Advisor to discuss admission requirements.

There are two emphases in the BSMET Program: (1) Manufacturing Processes and (2) Quality Assurance.

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student’s performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of “C” or better must be achieved in MATH 111 and 113, and PHYS 100A within one calendar year.

Transfer Students: A grade of “C” or better must be achieved in MATH 122 and PHYS 100A&B within one calendar year.

Core Requirements

Lower Division:

Take all of the following courses:

CHEM 111A General Chemistry (5)
Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a “C” or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of “C” or better in MATH 111 and 113, or a grade of “C” or better in MATH 117.

ENGR 101 Introduction to Engineering Profession (1)
Prerequisites/Corequisite: MATH 111 or MATH 113 or MATH 122

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of “C” or better.

ENGR 203 Engineering Problems and Analysis (3)
Prerequisite: MATH 122 all with a grade of “C” or better.
Corequisite: ENGR 203L

ENGR 203L Engineering Problems & Analysis Lab (1)
Prerequisite: MATH 122 all with a grade of “C” or better.
Corequisite: ENGR 203.

PHYS 100A General Physics (4)
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122 all with a grade of “C” or better.

PHYS 100B General Physics (4)
Prerequisites: PHYS 100A with a grade of “C” or better.

ET 101 Introduction to Engineering Technology (1)
Prerequisites: None.

ET 170 Engineering Drafting and Design (3)
Prerequisite: Sophomore standing.

ET 202 Probability and Statistics for Technology (3)
Prerequisite: High school algebra.
Corequisite: ET 202L.

ET 202L Probability & Statistics for Technology Lab (1)
Prerequisites: 2 yrs high school algebra, geometry, and intermediate algebra (or MATH 010) or equivalent.

ET 204 Applied Mechanics-Statics (3)
Prerequisites: MATH 120, PHYS 100A all with a grade of “C” or better.

ET 205 Computer Systems and Programming (1)
Corequisite: ET 205L.

ET 205L Computer Systems & Programming Lab (1)
Corequisite: ET 205.

ET 244 Machine Tools (1)
Corequisite: ET 244L.

ET 244L Machine Tools Laboratory (1)
Corequisite: ET 244.

ET 250 Circuit Analysis (2)
Prerequisite: PHYS 100B all with a grade of “C” or better.
Corequisite: ET 250L.

ET 250L Circuit Analysis Laboratory (1)
Prerequisite: PHYS 100B all with a grade of “C” or better.
Corequisite: ET 250.

ET 264 Industrial Tooling (1)
Prerequisites: ET 170 all with a grade of “C” or better.
Corequisite: ET 264L.

ET 264L Industrial Tooling Laboratory (1)
Prerequisites: ET 170 all with a grade of “C” or better.
Corequisite: ET 264.

Upper Division:

Take all of the following courses:

ECON 300 Fundamentals of Economics (3)
Prerequisites: GE Foundation requirements.

ET 301 Engineering Materials (2)
Prerequisites: CHEM 111A all with a grade of “C” or better.
Corequisite: ET 301L.

ET 301L Engineering Materials Laboratory (1)
Prerequisites: CHEM 111A all with a grade of “C” or better.
Corequisite: ET 301.

ET 304 Applied Mechanics Strength of Materials (3)
Prerequisite: ET 204 with a grade of “C” or better.

ET 307 Industrial Safety (2)
Prerequisite: Junior Standing.

ET 309 Industrial Communications and Leadership (3)
Prerequisites: ET 101 with a grade of “C” or better.

ET 311 Quality Engineering Technology (3)
Prerequisites: ET 202, 202L all with a grade of “C” or better.

ET 312 Statistical Quality Control (3)
Prerequisite: ET 311 with a grade of “C” or better.

ET 313 QA, Inspection Measurement and Testing (2)
Prerequisite: ET 311 with a grade of “C” or better.
Corequisite: ET 313L.

ET 313L QA, Inspection Measurement & Testing Lab (1)
Prerequisite: ET 311 all with a grade of “C” or better.
Corequisite: ET 313.

ET 335 Engineering Materials and Processes I (3)
Corequisite: ET 335L.
ET 335L Engineering Materials Processes I Lab (1)
  Corequisite: ET 335.
ET 390 Applied Computer-Aided Design/Manufacturing (2)
  Prerequisites: ET 170, 205, 205L all with a grade of "C" or better.
  Corequisite: ET 390L.
ET 390L Applied Computer-Aided Design and Manufacturing Laboratory (1)
  Prerequisites: ET 170, 205, 205L all with a grade of "C" or better.
  Corequisite: ET 390.
ET 410 Cost Engineering and Analysis (3)
  Prerequisites: Economics course, Junior standing.
ET 418 Production Methods and Process Improvement (3)
  Prerequisite: ET 410 with a grade of "C" or better.
ET 435 Engineering Materials and Processes II (3)
  Prerequisites: ET 335, 335L all with a grade of "C" or better.
  Corequisite: ET 435L.
ET 435L Engineering Materials & Processes II Lab (1)
  Prerequisites: ET 335, 335L all with a grade of "C" or better.
  Corequisite: ET 435.
ET 461 Management of Manufacturing Operations (3)
  Prerequisite: ET 410 with a grade of "C" or better.
ET 498 Manufacturing Engr Tech Capstone Project (3)
  Prerequisite: Senior standing.

**Emphasis in Manufacturing Processes**

This emphasis offers students a wide range of training in topics such as materials, manufacturing processes and different production environments. Written and oral communication skills and modern methods of industrial administration and supervision are emphasized. Program is designed to meet ABET criteria for accredited programs in engineering technology.

**Requirements**

**Upper Division:**

Take all of the following courses:

- ET 363 Kinematics of Mechanisms (3)
  Prerequisites: ET 170, ET 204 all with a grade of "C" or better.
- ET 365 Fluid Power and Control (2)
  Prerequisite: ET 204 with a grade of "C" or better.
  Corequisite: ET 365L.
- ET 365L Fluid Power and Control Laborator (1)
  Prerequisite: ET 204 with a grade of "C" or better.
  Corequisite: ET 365.

Take 4 units of electives from the following courses:

- ET 409C, 387, 387L

**Emphasis in Quality Assurance**

This objective of this emphasis is placed on specific job skills required of entry level professionals in the manufacturing industries including oral and written communication, and management principles. The program is applications-oriented. Designed to meet ABET criteria for accredited programs in engineering technology.

**Requirements**

**Upper Division:**

Take the following course:

- ET 419 Design of Experiments (3)
  Prerequisite: ET 312 with a grade of "C" or better.

Take 2 units of electives from the following courses:

- ET 409D, BLAW 220

**Fieldwork Requirements**

Fieldwork experience is required for the BS in Manufacturing Engineering Technology, consisting of no less than three months of full-time (40 hours/week or equivalent part-time) employment in an approved industry or governmental agency. The student must hold a position equivalent to a technician or higher which affords the opportunity to exercise responsibility usually given to those who have completed at least two years of college. The fieldwork must be completed prior to graduation, then certified and approved by the program advisor.

**Certificate in Aerospace Manufacturing**

Not accepting new students as of Fall 2012.

This 19-units certificate is designed to give students and working engineers an educational opportunity to focus on the complex and dynamic issues related to aerospace manufacturing.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirements**

1. Consent of the Program Director.
2. Preparation of a Program Planner.
3. Satisfactory completion of the required courses as listed below.
4. Fulfillment of the Graduation Writing Assessment Requirement (GWAR).
5. Completion of a Bachelor of Science degree in an approved major. The Certificate may be awarded concurrently with or subsequent to a baccalaureate degree.

**Required Courses**

The Certificate Program requires a minimum of 19 units:

- MAE 408 Systems Engineering and Integration (3)
  Prerequisite: Senior standing or consent of instructor.
- ENGR 511 Quality Assurance in Manufacturing (3)
  Prerequisites: CE 40 with a grade of "C" or better or consent of instructor, and graduate standing.
- ENGR 574 Adv Manufacturing Technology and Processes (3)
  Prerequisites: Consent of instructor and graduate standing.

Students should consult with the program director to assess any needed prerequisites.

**Certificate in Heating, Ventilating, and Air-Conditioning Engineering**

Not accepting new students as of Fall 2012.

This 21-unit certificate is designed to prepare engineering and science students to design various HVAC systems. Students may also earn this certificate in conjunction with a bachelor's degree. Contact the Department of Mechanical and Aerospace Engineering for more information.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirements**

1. Consultation with the Program Director and preparation of a Program Planner;
2. Satisfactory completion of the required courses, as listed below;
3. Approval of a special project and its satisfactory completion (MAE 491);
4. Completion of a Bachelor of Science degree in an approved major. The Certificate may be awarded concurrently with or subsequent to the baccalaureate degree.

**Required Courses**

The HVAC Certificate Program requires a minimum of 21 semester units, as indicated below:

- Take all of the following:
  - MAE 300 Engineering Instrumentation and Measurement (2)
    Prerequisites: MATH 224, PHYS 151, 152 all with a grade of "C" or better.
  - MAE 330 Engineering Thermodynamics I (3)
    Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.
  - MAE 431 Heat Transfer Systems Design (3)
    Prerequisites: MAE 305, 330; CE 335 all with a grade of "C" or better.
  - MAE 438 Heating, Ventilating, Air Conditioning, and Refrigeration (3)
    Prerequisites: MAE 330, CE 335.
  - MAE 490E Special Topics: HVAC Systems Design and Equipment (3)
    Prerequisites: MAE 330, CE 335 all with a grade of "C" or better.
  - MAE 491 Special Problems (3)
    Prerequisite: Senior standing.
  - CE 336 Fluid Mechanics Laboratory (1)
    Prerequisite: ENGL 100 or equivalent all with a grade of "C" or better.
    Prerequisite/Corequisite: C E 335.

- Take one of the following:
  - MAE 333, CE 335

**Certificate in Industrial Plastics Processing and Design**

Not accepting new students as of Fall 2012.

This certificate is an interdisciplinary program sponsored by the Mechanical and Aerospace Engineering and Chemical Engineering Departments. Study includes industrial production processes, material testing procedures, economics of the polymers industry and degradation of polymers. Students complete an individual project, consisting of the design of an item, choice of proper polymeric material for the particular application, choice of the processing operation and construction of the necessary molding tools and testing of the completed product. Contact the Department of Mechanical and Aerospace Engineering.

**Requirements**

1. A bachelor's degree in engineering. The certificate may be awarded concurrently with the degree.
2. Satisfactory completion of 22 units minimum from the courses listed below:

- **Polymeric Processing:**
  - Take all the following courses:
    - CHE 200 Chemical Engineering Fundamentals (3)
      Prerequisites: CHEM 111A, MATH 122, PHYS 151 all with a grade of "C" or better
      Corequisite: CHE 210
    - MAE 471 Analysis Design of Machine Components (3)
      Prerequisites: MAE 373 and MAE 375 all with a grade of "C" or better.
  - Take one of the following courses:
    - MAE 472, MAE 476
    - Take a minimum of 3 units in either of the following:
      - CHE 490 Special Problems (1-3)
        Prerequisite: Consent of instructor.
      - MAE 491 Special Problems (1-3)
        Prerequisite: Senior standing.

**Properties of Polymers:**

- MAE 373 Mechanics of Deformable Bodies (3)
  Prerequisite: CE 205 with a grade of "C" or better.
- MAE 374 Mechanical Properties of Materials Lab (1)
  Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor.

3. Approval of the certificate committee for admission to the certificate program. An advisor will be appointed to you at that time.
4. The advisor's approval of your completion of the special project.

**Certificate in Energy Conversion and Power Systems Engineering**

Not accepting new students as of Fall 2012.

The 27-unit certificate program is an undergraduate program designed to prepare students to become proficient in the analysis and design of power generating systems, such as direct conversion, coal burning, hydraulic, nuclear, solar, wind, and various other types of power plants.

Please be aware that this program is not eligible for Financial Aid unless pursued concurrently with a degree program.

**Requirements**

1. Consultation with program advisors in Electrical or Mechanical and Aerospace Engineering Departments and preparation of a program planner;
2. Complete all of the following core courses:
   - CE 335 Fluid Mechanics (3)
     Prerequisites: MATH 224 and CE 205 all with a grade of "C" or better.
   - EE 350 Energy Conversion Principles (3)
     Prerequisites: (EE 202 or equivalent) and EE 211 and 211L all with a grade of "C" or better, or consent of instructor.
   - EE 452 Computer Applications in Power Systems (3)
     Prerequisite: EE 350 with a grade of "C" or better or consent of instructor or graduate standing.
   - MAE 330 Engineering Thermodynamics I (3)
     Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.
   - MAE 336 Power Plant Design (3)
     Prerequisite: MAE 330 with a grade of "C" or better.
   - MAE 431 Heat Transfer Systems Design (3)
     Prerequisites: MAE 305, 330; CE 335.
3. Completion of 9 units from the following list of electives:
   - EE 360, 453, 455, 458, 550, 551, 552, 553; MAE 490, 538;
4. Completion of a Bachelor of Science degree in an approved major. This certificate may be awarded concurrently with or subsequently to baccalaureate degree.

**GRADUATE PROGRAMS**

The goal of the Master's programs in mechanical and aerospace engineering, the MSAE and MSAE degrees, is to provide students with the advanced engineering education needed to enhance their careers and pursue doctoral studies.
Admission to the MSAE or MSME degree programs requires a minimum GPA of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted.

Master of Science in Mechanical Engineering

This program involves modern computational and experimental methods knowledge and skills which are of immediate practical importance. This knowledge is communicated in the advanced courses and used in the conduct of a thesis or project. The areas of emphasis within the MSAE program include:

- Dynamics, Vibration, Control, and Robotics
- Fluid and Thermal Sciences
- Materials
- Mechanics
- Design and Manufacturing

Further information may be obtained from the Department of Mechanical and Aerospace Engineering’s website: http://www.csulb.edu/colleges/coe/mae.

To be considered for admission, the graduate applicant must have earned a bachelor’s degree from an accredited institution, have been in good standing at the last institution attended, and have a grade point average (GPA) of at least 2.7 for the last 60 (semester) or 90 (quarter) upper-division major units attempted. The general Graduate Record Examination (GRE) is required.

Prerequisites

1. A bachelor’s degree in an accredited curriculum in Mechanical Engineering, or other appropriate discipline, with a minimum grade point average of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted.
2. Students must consult with the MSME graduate advisor prior to enrolling in any courses for their program.
3. Failure to attempt to fulfill the Graduation Writing Assessment Requirement (GWAR) during the first semester in the program will prevent registration in engineering courses in subsequent semesters.

Note: Before being admitted a qualified student without a mechanical engineering undergraduate degree MUST provide a written statement to the MSME graduate advisor that he/she understands that all deficiencies must be removed before attempting graduate-level courses.

Requirements

**PLAN I**

Completion of a minimum of 30 units beyond the bachelor’s degree in upper-division and graduate courses approved by the student’s Department Graduate Study Committee, including:

1. Eighteen units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved upper-division or graduate courses from approved areas;
3. Completion of six units of MAE 698-Thesis and submission of a written thesis.

**PLAN II**

Completion of a minimum of 36 units beyond the bachelor’s degree in upper-division and graduate courses approved by the student’s Department Graduate Study Committee, including:

1. Twenty-four units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved upper-division or graduate courses from approved areas;
3. Completion of six units of MAE 697-Directed Research.

Advancement to Candidacy

Prior to formally starting their thesis or project (registering for MAE 697 or 698), students must apply for Advancement to Candidacy. Students applying for Advancement to Candidacy must:

1. Have completed ALL undergraduate deficiencies with grades of “C” or better;
2. Have attained an overall grade point average (GPA) of 3.0;
3. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
4. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
5. Have fulfilled the Graduation Writing Assessment Requirement (GWAR). This requirement can also be met by presenting evidence that the student met the requirement while an undergraduate at CSULB or at certain CSU campuses.
6. Have their program of studies approved by the faculty coordinating their area of emphasis, the ME program graduate advisor, and department chair.

Master of Science in Aerospace Engineering

This program involves modern computational and experimental methods and provides the essential information which will permit students to acquire the knowledge and skills which are of immediate practical importance. This knowledge is communicated in the advanced courses listed in the MAE curriculum and used in the conduct of a thesis or project. The areas of emphasis within the MSAE program include:

- Space Systems Engineering
- Aerodynamics and Aircraft Systems Engineering
- Computational Fluid Dynamics
- Aerospace Structures and Materials

Both graduate and undergraduate programs benefit from the advice of an advisory committee comprised of senior staff from aerospace companies, government agencies, and universities. Further information may be obtained from the Department of Mechanical and Aerospace Engineering’s website: http://www.csulb.edu/colleges/coe/mae.

To be considered for admission, the graduate applicant must have earned a bachelor’s degree from an accredited institution, have been in good standing at the last institution attended, and have a grade point average (GPA) of at least 2.7 for the last 60 (semester) or 90 (quarter) upper-division major units attempted. The general Graduate Record Examination (GRE) is required.

Prerequisites

1. A bachelor’s degree in an accredited curriculum in Aerospace or Mechanical Engineering with a minimum grade point average of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted. Applicants with a lower
GPA may be admitted, subject to the successful completion of appropriate deficiencies assigned by the graduate advisor.

2. A bachelor's degree in engineering, mathematics, science or other appropriate discipline, with the requirement that essential undergraduate prerequisites in engineering be satisfied.

3. Graduate students must consult with the graduate advisor for information concerning procedures and requirements for appropriate approval of their courses of study prior to enrolling in their graduate programs.

Requirements

**PLAN I**

Completion of a minimum of 30 units beyond the bachelor's degree in upper-division and graduate courses approved by the student's Department Graduate Study Committee, including:

1. Eighteen units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved upper-division or graduate courses from appropriate areas;
3. Completion of six units of MAE 698 Thesis and submission of a written thesis.

**PLAN II**

Completion of a minimum of 36 units beyond the bachelor's degree in upper-division and graduate courses approved by the student's Department Graduate Study Committee, including:

1. Twenty-four units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved upper-division or graduate courses from approved areas;
3. Completion of six units of MAE 697-Directed Research.

**Advancement to Candidacy**

Prior to formally starting their thesis or project (registering for MAE 697 or 698), students must apply for Advancement to Candidacy. Students applying for Advancement to Candidacy must:

1. Have completed ALL undergraduate deficiencies with grades of "C" or better;
2. Have attained an overall grade point average (GPA) of 3.0;
3. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
4. Have fulfilled the Graduation Writing Assessment Requirement (GWAR). This requirement can also be met by presenting evidence that the student met the requirement while an undergraduate at CSULB or at certain CSU campuses.
5. Have their program of studies approved by the faculty coordinating their area of emphasis, the AE program graduate advisor, and department chair.

**Master of Science in Engineering**

Admission to the MSE graduate program requires a minimum GPA of 2.7 in the last 60 upper-division units attempted. For requirements, see the description in the College of Engineering section of this catalog.

The Mechanical and Aerospace Engineering Department administers two emphases under the Master of Science in Engineering. The other prerequisites and requirements are the same as for the MSAE and MSME programs.

**Management Engineering Emphasis**

A special management perspective is required for the successful generation of technical products and services. In order to plan, design, direct and control technical projects, technical managers must be capable of inspiring and developing professional personnel. They must be able to integrate planning, manufacturing and budgetary concerns of the project and be able to easily communicate with general management.

This emphasis primarily admits students with a traditional engineering background. It emphasizes the management of engineering-based endeavors and does not require undergraduate business courses as prerequisites for graduate work. An individualized program is developed according to student’s undergraduate degree, area of interest, or industrial application; interdisciplinary approaches are encouraged.

**Ph.D. in Engineering and Industrial Applied Mathematics**

For requirements, see the description in the College of Engineering section of this catalog.

### Courses (MAE)

#### LOWER DIVISION

**101A. Introduction to Aerospace Engineering (1)**

Role of various types of engineering specialties in the development of an actual aerospace vehicle product. Current social, ethical and environmental issues in Aerospace Engineering solutions. Life-long learning skills using resources from professional societies and Internet are also emphasized.

Letter grade only (A–F). (Lecture-problem 1 hour)

**101B. Introduction to Mechanical Engineering (1)**

Prerequisite: Freshman standing or consent of instructor. Introduction to mechanical engineering as a profession. Past, present, and future trends and related professional opportunities and challenges. Introduction to mechanical engineering curriculum studies. Social, economical, cultural, legal and ethical issues related to mechanical engineering and its applications.

Letter grade only (A–F)

**172. Engineering Design Graphics (3)**

Graphics concepts and visualization. Graphic expressions using CAD software, emphasis on industrial practice involving part and assembly drawings for actual products, standards, tolerances, surface finishes, and other attributes on drawings, production drawings, projects involving complete design of systems and subsystems.

Letter grade only (A–F). (Lecture-problems 2 hrs., design laboratory 3 hrs)

**205. Computer Methods in Mechanical and Aerospace Engineering (2)**

Prerequisites: MATH 122 with a grade of "C" or better. Application of computer programming to engineering problem solving. Structured approach to problems. Input-output concepts for both numerical and graphical results.

Letter grade only (A–F). (Lecture-problems 1 hour, laboratory 3 hours)
272. Introduction to Manufacturing Processes (2)
Prerequisite: MAE 172 with a grade of "C" or better.
Manufacturing processes, properties of materials; metals production; foundry, casting, heat treatment; welding, powder metallurgy, plastics, metrology; working metals, press work; machine tool elements, numerical control; metal cutting/turning; drilling, boring, milling; shaping planning, sawing broaching; grinding, sanding; gears, gear-cutting, threads, thread-cutting.
Letter grade only (A-F). (Lecture-problems 1 hour, laboratory 3 hours)

UPPER DIVISION

300. Engineering Instrumentation and Measurement (2)
Prerequisites: MATH 224, PHYS 151, 152 all with a grade of "C" or better.
Statistical analysis of experimental data, uncertainty analysis, various statistical distributions and test of goodness of fit, correlation coefficient and multivariable regression. Engineering instrumentation include types of passive/active transducers, electronics for instrumentation, computer-based data acquisition, and experiments on pressure, temperature, force measurements.
Letter grade only (A-F). (Lecture-problems 1 hour, Laboratory 3 hours)

305. Numerical Methods in Mechanical and Aerospace Engineering (3)
Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-problems 3 hours)

310. Safety and Reliability in Systems Design I (3)
Prerequisites: MAE 205; MATH 370A all with a grade of "C" or better, or consent of instructor.
Intro probabilistic design analysis; safety and reliability, tools to assess adequacy of designs; identification of critical elements and practical design guidance; compliance with the requirements. Coherent use of concepts, tools, and programs to produce reliable, safe system designs. Group projects.
Letter grade only (A-F). (Lecture-problems 3 hours) Not open for credit to students with credit in ME 390.

322. Engineering Materials and Materials Processes (3)
Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-problems 3 hours)

330. Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.
Laws of thermodynamics. Properties of liquids, gases and vapors. Sources of energy and conversion to work. Introduction to heat transfer and psychrometry.
Letter grade only (A-F). (Lecture-problems 3 hours)

333. Engineering Fluid Dynamics (3)
Prerequisites: CE 205, MATH 370A all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-problems 3 hours)

334. Aerodynamics I (3)
Prerequisite: MAE 333 with a grade of "C" or better.
Letter grade only (A-F). (Lecture-problems 3 hours).

336. Power Plant Design (3)
Prerequisite: MAE 330 with a grade of "C" or better.
Design of power production systems, including steam power plants, gas turbines and auxiliary power units. Survey of alternate power sources including wind, solar, geothermal, ocean thermal and biomass. Group and/or individual design projects.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

337. Thermal Engineering Laboratory (2)
Prerequisite: MAE 336 with a grade of "C" or better.
Thermodynamics, heat transfer and fluid flow property measurements, measurement of heating value of fuels, energy and performance analysis of thermal systems, including internal combustion engines, power and heat generating systems, refrigeration and air-conditioning systems, and heat exchangers.
(Lecture-problems 1 hour, Laboratory 3 hours) Letter grade only (A-F).

350. Flight Mechanics (3)
Prerequisite: CE 205 with a grade of "C" or better.
Turbojets: level and other flights in the vertical plane, turning flight in the horizontal plane. Piston props: level and other flights in the vertical plane, turning flight in the horizontal plane. Performance analysis and design examples.
(Lecture-problems 3 hours). Letter grade only (A-F).

361. Materials and Properties Laboratory (1)
Prerequisites: ENGL 100 or equivalent, MAE 300, 322, 373 all with a grade of "C" or better.
Study of the effects of thermal processing and mechanical processing on the properties and microstructures of metals, alloys, and other materials. Determination of material properties using tensile test, torsion test, and beam test. Study of the statistical nature and reliability of test results.
(Laboratory 3 hours) Letter grade only (A-F).

365. Aerospace Structures I (3)
Prerequisite: MAE 373 with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

371. Analytical Mechanics II (Dynamics) (3)
Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.
Newton's Laws and the principles of work and energy and impulse and momentum applied to the study of particle and rigid body motion. Engineering application with emphasis on plane motion problems. Individual and/or group projects involving in-depth numerical analysis.
(Lecture-problems 3 hours) Letter grade only (A-F).

373. Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 with a grade of "C" or better.
Application of the principles of mechanics to the design of structural and machine members and connections; stress analysis of beams and columns. Properties and strength of engineering materials. Design projects.
(Lecture-problems 3 hours) Letter grade only (A-F).
374. Mechanical Properties of Materials Laboratory (1)
Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor.
Physical and mechanical properties of engineering materials and their relationship to structural elements; accuracy of measurements; statistical analysis of experimental data; professional laboratory reports.
(Laboratory 3 hours) Letter grade only (A-F).

375. Kinematics and Dynamics of Mechanisms (3)
Prerequisites: MAE 272, 371 all with a grade of "C" or better.
Fundamentals of linkages, cams, gears and gear trains. Velocity and acceleration analysis of machines leading to dynamic loading of machine parts; dynamic analysis and balancing of rotating machines; internal combustion engine balancing. Individual design projects.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

376. Modeling and Analysis of Dynamic Systems (3)
Prerequisite: MAE 371; MATH 370A all with a grade of "C" or better.
Modeling and analysis of dynamic systems including mechanical, electrical, electro-mechanical, and hydraulic systems. Use of complex algebra and Laplace transforms. Mathematical modeling of dynamic systems in state-space. Linear systems analysis in time and frequency domains. Introduction to feedback control systems.
(Lecture—problems 3 hours) Letter grade only (A-F).

381. Fundamentals of Spacecraft Dynamics (3)
Prerequisites: PHYS 152, MATH 370A, and MAE 371 all with a grade of "C" or better.
(Lecture-problems 3 hours). Letter grade only (A-F).

390. Aerospace Engineering Seminar (1)
Prerequisite: Upper-division standing.
Introduction to effective communication techniques and oral presentations. Guest speakers from industry cover topics such as an engineer's professional practice, social responsibilities, ethical and legal issues, as well as latest developments in Aerospace Engineering. Students write reports regarding these presentations.
(Seminar 1 hour) Letter grade only (A-F).

408./508. Systems Engineering and Integration (3)
Prerequisite: Senior standing or consent of instructor.
Introduction to tools and methods employed by systems engineers in aerospace industry. Development of system functions, requirements, verification and validation, and interfaces in the context of integrated product teams and the product life cycle. Trade studies and risk management.
(Lecture-Projects 3 hours) Letter grade only (A-F).

409. Modern Computational Aspects in Mechanical Engineering (3)
Prerequisites: Senior standing in engineering and consent of instructor.
Computational aspects of Mechanical Engineering. Subjects include finite element analysis of structures, fluids, or heat transfer; boundary element analysis.
May be repeated to a maximum of 6 units with consent of department. (Lecture-problems 3 hours.) Letter grade only (A-F).

A. Finite Element Methods I

B. Introduction to Computational Fluid Dynamics and Heat Transfer
Classification of partial differential equations and boundary conditions, finite difference and finite volume formulations, grid generation, stability analysis, numerical methods for inviscid flows, viscous laminar flows, compressible flows, conduction and convection heat transfer.

442./542. Composite Materials (3)
Prerequisite: MAE 373 with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

431. Heat Transfer Systems Design (3)
Prerequisites: MAE 305, 330; CE 335 all with a grade of "C" or better.
Analysis of heat transfer by conduction, convection and radiation. Investigation of steady state and transient heat transfer systems. Computer methods. Individual-group design projects problems in heat transfer such as electronic packaging, heat exchangers, heat engines, refrigerators, and thermal systems analysis.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

434. Aerodynamics II (3)
Prerequisite: MAE 334 with a grade of "C" or better.
Compressible flows. Subsonic and supersonic flows around airfoils and wings. Two-dimensional, incompressible boundary layers. Introduction to computational fluid dynamics (CFD). Aerodynamic design considerations. Projects are assigned and written reports are required.
(Lecture-problems 3 hours). Letter grade only (A-F).

435./535. Computational Fluid Dynamics I (3)
Prerequisites: MATH 370A, MAE 333 all with a grade of "C" or better.
Numerical methods for elliptic, parabolic, and hyperbolic equations, finite difference and volume methods, analysis of consistency, stability, and convergence, panel method, modeling and computation of boundary layer flows, full potential equation, grid generation, application to inviscid and viscous subsonic, transonic/supersonic flows.
(Lecture-Problems 3 hours) Letter grade only (A-F).

438. Heating, Ventilating, Air Conditioning, and Refrigeration (3)
Prerequisites: MAE 330, CE 335 all with a grade of "C" or better.
Basic HVAC system calculations. Thermodynamics and psychometrics, design conditions and load estimating, residential and non-residential heating and cooling load calculations, energy estimating methods, duct and pipe sizing, and life cycle costs.
(Lecture-Problems 3 hours) Letter grade only (A-F).

440. Aerodynamics Laboratory (1)
Prerequisites: MAE 300 and 334 all with a grade of "C" or better.
Experimental techniques in aerodynamics, wind tunnel measurements, use of Pitot tube, hot wire and Laser Doppler Velocimetry systems, flow visualization techniques, calibration of transducers. Computer controlled data acquisition and analysis. Projects are assigned and written reports and oral presentations are required.
Letter grade only (A-F). (Laboratory 3 hours)

451./551. Aircraft Preliminary Design and Performance (3)
Prerequisite: MAE 334, 350 all with a grade of "C" or better, or consent of instructor.
Complete aircraft preliminary design, including mission definition, specifications, and regulations. Preliminary takeoff weight and weight empty for a mission. Aircraft geometric characteristics are developed. Detailed aerodynamic data are estimated and used to calculate aircraft performance. Individual projects required for MAE 551.
The design project is conducted in teams for MAE 451 and individually for MAE 551. (Lecture-Design Project 3 hours) Letter grade only (A-F).
452. Propulsion (3)
Prerequisites: MAE 330 and 334 all with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

453. Stability and Control of Aerospace Vehicles (3)
Prerequisite: MAE 350 or equivalent all with a grade of "C" or better.
Corequisite: MAE 334.
(Lecture-problems 3 hours) Letter grade only (A-F).

454./554. Avionics Systems (3)
Prerequisite: MAE 453 with a grade of "C" or better.
Avionics systems requirements definition and design. Systems used for guidance and navigation. Components of avionics systems (software, integrated circuits, devices, etc.). Integration of optics and electronics. Testing and certification.
(Lecture-Problems 3 hours) Letter grade only (A-F).

459. Professional Practice Seminar (1)
Prerequisite: Senior standing or consent of instructor.
Professional, social and moral responsibilities of engineers. Examination of ethical and legal issues, including intellectual property rights and regulatory codes and practices. Students are encouraged to participate in professional societies and attend professional seminars. Licensure is emphasized.
(Lecture-Problems 1 hour) Letter grade only (A-F).

465. Aerospace Structures II (3)
Prerequisite: MAE 365 with a grade of "C" or better.
(Lecture-problems 3 hours). Letter grade only (A-F).

471. Analysis and Design of Machine Components (3)
Prerequisite(s): MAE 373 and MAE 375 all with a grade of "C" or better.
Application of the principles of mechanics and physical properties of materials to the proportioning of machine elements, including consideration of function, safety, production and economic factors. Group and/or individual design projects of mechanical systems and/or subsystems.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

472. Design of Mechanical Engineering Systems (3)
Prerequisites: MAE 330, 471 all with a grade of "C" or better.
Capstone design course. Design experience includes conceptual design, literature review and analysis. Final design includes: drawings, manufacturing and assembly of prototype. Emphasis placed on identifying realistic constraints simulating industrial situations which affect design choices. Teamwork and interaction is encouraged.
(Lecture-Problems 2 hours, Design Laboratory 3 hours) Letter grade only (A-F).

474./574. Computer-Aided Manufacturing (3)
Prerequisites: MAE 322, 490A all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-Problems 2 hours, Laboratory 3 hours)

476. Mechanical Control Systems I (3)
Prerequisite: MAE 376 with a grade of "C" or better.
(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

478. Aerospace System Design I (3)
Prerequisites: MAE 334, 365, and 381 all with a grade of "C" or better.
Corequisite: MAE 434, 465, or 481.
A capstone design experience which integrates aspects of aerospace systems design. Student teams complete a design during the two-semester course sequence. In the first semester course, the teams define the requirements and then work through the complete design in the second semester (MAE 479).
Letter grade only (A-F). (Lecture-Design Project 2 hours, Laboratory 3 hours)

479. Aerospace Systems Design II (2)
Prerequisite: MAE 478 with a grade of "C" or better.
Continuation of Aerospace Systems Design I (MAE 478). The projects assigned in teams in MAE 478 are completed. Manufacturing is included when appropriate. Regular design reviews (oral presentations and written reports) are essential components in grading.
(Lecture-Design Project 1 hour, Laboratory 3 hours) Letter grade only (A-F).

481. Spacecraft Systems (3)
Prerequisite: MAE 381 with a grade of "C" or better.
Systems engineering approach to spacecraft design. Spacecraft systems engineering and spacecraft power subsystem. Radiative and conductive heat transfer. Thermal control subsystem. Telecommunications. Command and data handling. Team projects including spacecraft subsystem design are assigned. Written reports and oral presentations are required.
(Lecture-Problems 3 hours) Letter grade only (A-F).

483. Space Flight and Orbital Mechanics (3)
Prerequisites: MAE 381 with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

490. Selected Topics in Mechanical and Aerospace Engineering (3)
Prerequisites: Senior standing in engineering and consent of instructor.
Selected topics from recent advances in mechanical and aerospace engineering. Content may vary from semester to semester. May be repeated to a maximum of 6 units with different topics.
(Lecture-problems 3 hours) Letter grade only (A-F).

A. CAD/CAM
Prerequisites: MAE 172; 272 or 350; 322 or 365; and 373; upper-division standing or consent of instructor.
Fundamentals of computer-aided design/computer-aided manufacturing (CAD/CAM). Creating, reading, and understanding databases for solid models. Assemblies and sub-assemblies. Design and analysis of mechanisms with linkages,
501. Engineering Analysis I (3)  
Prerequisite: MAE 501 with a grade of "C" or better. 
Linear algebra, matrix computations, systems of differential 
equations, eigenvalue problems, iterative solution of systems 
of algebraic equations, numerical methods for ordinary 
and partial differential equations, systems of nonlinear equations, 
opimization. 
(Lecture-problems 3 hours) Letter grade only (A-F).

502. Engineering Analysis II (3)  
Prerequisite: MAE 501 with a grade of "C" or better. 
Differential equations, series solutions of differential equations 
(special functions), boundary-value problems and characteristic 
function representation, Laplace transforms, Fourier analysis, 
partial differential equations, formulating and solving problems 
in engineering for systems of differential equations and partial 
differential equations, complex analysis. 
(Lecture-problems 3 hours) Letter grade only (A-F).

506. Management of Engineering Technology and Innovation (3)  
Prerequisite: Graduate engineering standing. 
Analysis of the principles and theory of engineering administrative 
organizations, information systems, decision making tools, strategies and administrative policy 
formulations. 
(Lecture-problems 3 hours) Letter grade only (A-F).

507. Engineering Project Management (3)  
Prerequisite: Graduate engineering standing. 
Theory and philosophies of project management, principles of 
teamwork and communication, team behavior, decision making, 
and risk management. Projects assigned, written reports and oral 
presentations are required. 
(Lecture-problems 3 hours) Letter grade only (A-F).

508. Systems Engineering and Integration (3)  
Prerequisite: Senior standing or consent of instructor. 
Tools and methods employed by systems engineers in aerospace 
industry. Development of system functions, requirements, 
verification and validation, and interfaces in context of integrated 
product teams and the product life cycle. Trade studies and risk management. Projects assigned, written reports and oral 
presentations are required. 
(Lecture-problems 3 hours) Letter grade only (A-F).

512. Computer Aided Design in Mechanical Engineering (3)  
Prerequisites: MAE 490A, 501, 502. (Master's students register in MAE 512 or 612; Ph.D. students register in MAE 612) all with a 
grade of "C" or better. 
(Lecture-problems 3 hours) Letter grade only (A-F).

521. Engineering Metallurgy II (3)  
Prerequisite: MAE 322 with a grade of "C" or better. 
Properties and uses of structural steels; heat treatable steels; 
titanium alloys; nickel and cobalt base alloys; refractory metals; 
other high-strength steels; stainless steels; and metal matrix 
composite materials. Designing for fracture resistance. 
(Lecture-problems 3 hours) Letter grade only (A-F).

522. Composite Materials (3)  
Prerequisite: MAE 373 with a grade of "C" or better. 
Stress-strain relations for anisotropic materials. Classical 
lamination theory, Strength and failure theories for laminates and 
laminates. Micromechanics. Applications of composite structures. 
Additional projects will be required for MAE 522. 
(Lecture-problems 3 hours) Letter grade only (A-F).

527. Metals and Plastics Manufacturing Processes (3)  
Prerequisite: MAE 322 with a grade of "C" or better. 
Theory of metal forming and plastics processing. Includes metal 
forming and rolling, metal and plastics extrusion, plastics injection 
molding, casting. Discussion of appropriate manufacturing 
methods. 
(Lecture-problems 3 hours) Letter grade only (A-F).

529. Structural Analysis of Composite Laminates (3)  
Prerequisite: MAE 522 with a grade of "C" or better or consent of 
instructor. 
Beams, columns and rods of composite materials. Bending, 
vibration and buckling analysis of composite laminates. Shells of 
composite materials. Joining of composite material structures. 
(Lecture-Problems 3 hours) Letter grade only (A-F).
531. Advanced Heat Transfer (3)
Prerequisites: MAE 431, 501 all with a grade of "C" or better.
Advanced topics in conduction and convection heat transfer, analytical and numerical solutions to multidimensional heat conduction equations in various geometries. Solutions to laminar and turbulent convective heat transfer problems. External and internal flows, free and forced convection, and mass transfer from external surfaces. Applications in thermal systems design.
(Lecture-problems 3 hours) Letter grade only (A-F).

532. Combustion I (3)
Prerequisites: MAE 336, 431 all with a grade of "C" or better.
Fundamentals of combustion engineering: fuels; chemical thermodynamics and chemical kinetics; premixed and diffusion flames; ignition and extinction; Hugoniot curves; flammability and explosion limits; pollutant formation and control; applications in spark-, and charged-ignition internal combustion engines; gas-fired and oil-fired furnaces.
(Lecture-Problems 3 hours) Letter grade only (A-F).

533. Gas Dynamics (3)
Prerequisites: MAE 333 or equivalent all with a grade of "C" or better.
Incompressible and compressible flows, Prandtl-Meyer flow, shock expansion theory, method of characteristics, nozzle flow, flow in ducts with friction and heat transfer, solutions of linearized potential equation with applications, slender body theory, similarity rules, transonic flow, shock wave/boundary layer interactions.
(Lecture-Problems 3 hours) Letter grade only (A-F).

534. Computational Fluid Dynamics I (3)
Prerequisites: MATH 370A, MAE 333 all with a grade of "C" or better.
Numerical methods for elliptic, parabolic, and hyperbolic equations, finite difference and finite volume methods, analysis of consistency, stability, and convergence, panel method, modeling and computation of boundary layer flows, etc.
Additional projects will be required for MAE 535. (Lecture-Problems 3 hours) Letter grade only (A-F).

537. Advanced Fluid Dynamics I (3)
Prerequisites: CE 335, MAE 431 all with a grade of "C" or better.
Dynamics of ideal, real and compressible flows, potential flow, vortex flow, the Navier Stokes equations, integral and differential equations for laminar flow, exact solutions for laminar flow, steady and unsteady compressible flows.
(Lecture-problems 3 hours) Letter grade only (A-F).

538. HVAC Systems, Energy Rating, and LEEDS (3)
Prerequisites: MAE 330, CE 335 all with a grade of "C" or better.
Building envelope and environment, HVAC equipment and systems, lighting, green design and energy rating systems, and LEEDS.
Additional projects required for MAE 538. (Lecture-Problems 3 hours) Letter grade only (A-F).

551. Aircraft Preliminary Design and Performance (3)
Prerequisites: MAE 334, 350 all with a grade of "C" or better, or consent of instructor.
Complete aircraft preliminary design, including mission definition, specifications and regulations. Preliminary takeoff weight and weight empty for a specific mission. Aircraft geometric characteristics are developed. Detailed aerodynamic data are estimated and used to calculate aircraft performance. The design project is conducted in teams for MAE 451 and individually for MAE 551.
(Lecture-Design Project 3 hours) Letter grade only (A-F).

553. Advanced Flight Dynamics and Control (3)
Prerequisite(s): MAE 502 or equivalent all with a grade of "C" or better.
Introduces the design and analysis of flight control systems. Topics include linear and nonlinear flight dynamics, state space modeling, stability analysis, modern control system design and simulation.
(Lecture-problems 3 hours) Letter grade only (A-F).

554. Avionics Systems (3)
Prerequisite: MAE 553 with a grade of "C" or better.
Avionics systems requirements definition and design. Systems used for guidance and navigation. Components of avionics systems (software, integrated circuits, devices, etc.). Integration of optics and electronics. Testing and certification.
(Lecture-Problems 3 hours) Letter grade only (A-F).

563. Linear Finite Element Analysis (3)
Prerequisite: MAE 409A with a grade of "C" or better.
Finite element (FE) forms of differential equations. Isoparametric concepts. Dynamic response of damped elastic structures, modal and direct integration analysis. Automatic mesh generation using solid modeling using IDEAS, automatic adaptation to popular software such as: STRUDL, NASTRAN, ANSYS, and ABAQUS. FE fluid flow and heat transfer analysis.
(Lecture-problems 3 hours) Letter grade only (A-F).

567. Advanced Mechanics of Deformable Bodies (3)
Prerequisites: MAE 373, 374, 471 all with a grade of "C" or better or consent of instructor.
Analysis of stress and deflection in unsymmetrical bending, shear center for beams, curved beams. Stress concentration, deformation beyond the elastic limit. Energy method; Castigliano's Theorem; Rayleigh-Ritz technique.
(Lecture-problems 3 hours) Letter grade only (A-F).

568. Creep and Fatigue (3)
Prerequisites: MAE 322, 373 all with a grade of "C" or better, or consent of instructor.
Phenomena of creep and fatigue; effect on stress distribution in structural elements; buckling caused by creep; effects of space environment on fatigue; cumulative fatigue damage at normal and elevated temperatures.
(Lecture-problems 3 hours) Letter grade only (A-F).

572. Structural Design Optimization (3)
Prerequisite: MAE 373 with a grade of "C" or better or consent of instructor.
Structural optimization using calculus of variations. Method of Lagrange multipliers, unconstrained and constrained optimization, fast reanalysis techniques, sequential approximate optimization, sensitivity calculations of structural response, variational sensitivity analysis, approximation techniques, optimal design of laminated composite materials etc.
(Lecture-Problems 3 hours) Letter grade only (A-F).

573. Modern Control of Dynamic Systems (3)
Prerequisite: MAE 476 with a grade of "C" or better.
Advanced topics in analysis and design of modern control systems in mechanical engineering. Topics include state space, Riccati and Lyapunov equations, Linear Quadratic Regulator (LQR), Kalman filter, etc. Optimization via calculus of variations, Pontryagin's minimum principle. Control of distributed-parameter systems with applications to structural dynamics.
Letter grade only (A-F). (Lecture-problems 3 hours)

574. Computer-Aided Manufacturing (3)
Prerequisites: MAE 322, 490A all with a grade of "C" or better.
Letter grade only (A-F). (Lecture-Problems 2 hours, Laboratory 3 hours).
575. Robot Modeling and Control (3)
Prerequisites: MAE 371, MATH 370A all with a grade of "C" or better.
(Lecture–problems 3 hours) Letter grade only (A–F).

576. Engineering Vibrations (3)
Prerequisite: MAE 376 with a grade of "C" or better.
Fundamentals of mechanical vibrations, types of oscillatory motions. Single-Degree-of-Freedom (SDOF) and Multiple-Degree-of-Freedom (MDOF) systems. Free and forced vibrations, damping, vibration isolation, vibration measuring instruments, Modal analysis. Lagrange’s equations. Introduction to Finite Element Method and modal testing.
(Lecture–problems 3 hours) Letter grade only (A–F).

578. Haptic Systems for Virtual Reality and Teleoperation (3)
Prerequisites: MAE 501; MAE 376 or 490B and 476 or equivalent all with a grade of "C" or better.
The course introduces haptic systems, which involve virtual and teleoperated environments that are displayed through force and/or tactile feedback. Topics covered include: human haptic sensing and control, design of haptic interfaces, teleoperation, modeling of virtual environments, control and stability issues.
(Lecture–Problems 3 hours) Letter grade only (A–F).

581. Space Vehicle Design (3)
Prerequisite: Graduate engineering standing or consent of instructor.
Space environments and their impact on spacecraft design. Space mission design. Payloads and communications. Integration of attitude determination and control, thermal, propulsion, configuration, telemetry, power, structures, and data handling subsystems.
(Lecture-Problems 3 hours) Letter grade only (A–F).

582. Rocket and Spacecraft Propulsion (3)
Prerequisite: Graduate engineering standing or consent of instructor.
(Lecture-Problems 3 hours) Letter grade only (A–F).

583. Astrodynamics (3)
Prerequisite: MAE 502 or equivalent all with a grade of "C" or better, or consent of instructor.
(Lecture-problems 3 hours) Letter grade only (A–F).

585. Spacecraft Attitude Determination and Control (3)
Prerequisite: MAE 501 or equivalent all with a grade of "C" or better, or consent of instructor.
Control systems. Spacecraft attitude dynamics and control. Stabilization methods and maneuvers. Impact of flexible structures.
(Lecture-Problems 3 hours) Letter grading only (A–F).

590. Selected Topics in Mechanical and Aerospace Engineering (1-3)
Prerequisites: MAE 501, 502 all with a grade of "C" or better, and other prerequisites as related to the topics offered, or consent of instructor.
Selected topics from recent advances in mechanical or aerospace engineering.
Letter grade only (A–F). May be repeated to a maximum of 6 units with different topics in different semesters. Topics announced in the Schedule of Classes. (Lecture-problems 3 hours).

612./512. Computer Aided Design in Mechanical Engineering (3)
Prerequisites: MAE 490A, 501, 502. (Master’s students register in MAE 512 or 612; Ph.D. students register in MAE 612) all with a grade of "C" or better.
Computer graphics in CAD/CAM. Includes geometrical transformations, viewing in three dimensions, modeling and object hierarchy, representation of 3D shapes, shading models and imaging databases and data transfer. Additional projects required for MAE 612.
(Lecture-problems 3 hours) Letter grade only (A–F).

631. Thermal Radiation (3)
Prerequisite: Consent of instructor.
Fundamentals of thermal radiation, properties of matter, radiative exchange in enclosures, equation of transfer for radiative transfer in absorbing, emitting, scattering media, gas radiation, and solutions for gas flows.
(Lecture-problems 3 hours) Letter grade only (A–F).

632. Combustion II (3)
Prerequisites: MAE 501, 532 all with a grade of "C" or better.
Advanced topics in combustion: conservation equations for multi-component reacting systems; detonations and deflagrations; laminar and turbulent flames; flammability limits; ignition and extinction, combustion and radiation and their interactions.
(Lecture-problems 3 hours) Letter grade only (A–F).

633. Hypersonic Flow (3)
Prerequisite: MAE 533 with a grade of "C" or better.
Hypersonic shock and expansion-wave relations, similarity concepts, Newtonian theory and modified Newtonian theory, nonlinear small-disturbance theory, blunt body flows, hypersonic viscous/inviscid interactions, aerodynamic heating, real gas effects, waveriders, atmospheric reentry.
(Lecture-Problems 3 hours) Letter grade only (A–F).

635./735. Computational Fluid Dynamics II (3)
Prerequisite: MAE 535 with a grade of "C" or better.
Computational methods for solving Euler and Navier-Stokes equations, implicit and explicit schemes, upwind differencing and artificial diffusion, multi-grid techniques and convergence acceleration, unstructured grid techniques, turbulence modeling, application to inviscid and viscous subsonic, transonic, and supersonic flows, inverse problems and aerodynamic shape optimization.
(Lecture-Problems 3 hours) Letter grade only (A–F).

637. Advanced Fluid Dynamics II (3)
Prerequisites: MAE 431, 501, 537 all with a grade of "C" or better.
Transition to turbulent flow, wall bounded and free turbulent shear flows, numerical methods for turbulent flow, turbulence modeling.
(Lecture-problems 3 hours) Letter grade only (A–F).

638. Engineering Calculation Methods for Turbulent Flow (3)
Prerequisite: MAE 537 with a grade of "C" or better or consent of instructor.
(Lecture-problems 3 hours) Letter grade only (A–F).
642. Aeroelasticity (3)
Prerequisites: MAE 533, 576 all with a grade of "C" or better, or consent of instructor.
Letter grade only (A-F). (Lecture-problems 3 hours)

639. Turbulence (3)
Prerequisites: MAE 532, 537 all with a grade of "C" or better.
Nature of turbulent flows, dynamics of turbulence, statistical description, homogeneous turbulence and spectral dynamics characteristics of turbulent shear flows.
(Lecture-problems 3 hours) Letter grade only (A-F).

663./763. Nonlinear Optimized Structures (3)
Prerequisite: MAE 563, or consent of instructor. (Master’s students register in MAE 663, Ph.D. students register in MAE 763) all with a grade of "C" or better.
Analysis, optimization of frame with automatic mesh generation using I-DEAS, with popular software such as: STRUDL, NASTRAN etc. Generation, idealization of complex structures. Sensitivity, Buckling analysis etc. Required topics for Ph.D. students: advanced numerical methods for flutter and random analysis.
(Lecture-problems 3 hours) Letter grade only (A-F).

669. Design of Composite Structures (3)
Prerequisite: MAE 522 all with a grade of "C" or better or consent of instructor.
(Lecture-Problems 3 hours) Letter grade only (A-F).

671. Random and Nonlinear Vibrations (3)
Prerequisite: MAE 576 with a grade of "C" or better.
Characterization and transmission of random vibration; failure due to random vibration. Classification of nonlinear problems; exact, graphical and approximate solutions, singular points, stability.
Letter grade only (A-F). (Lecture-problems 3 hours)

672. Stress Analysis in Design (3)
Prerequisite: MAE 567 with a grade of "C" or better or consent of instructor.
Modes of failure and failure criteria. Stability of mechanical models, elastic bars and frames by kinetic and energy approaches; design of columns, beam columns and framed columns. Plastic collapse and limit analysis. Experimental methods of stress analysis.
(Lecture-problems 3 hours) Letter grade only (A-F).

673. Theory of Elasticity and Plasticity (3)
Prerequisite: MAE 567 with a grade of "C" or better.
(Lecture-problems 3 hours) Letter grade only (A-F).

675. Modal Analysis (3)
Prerequisite: MAE 576 with a grade of "C" or better.
A thorough coverage of modal analysis techniques. Digital signal processing, including Fast Fourier Transform, Hilbert Transform, Structural Dynamics Theory, complex modes, state space, damping, nonsymmetries, modal parameter estimation techniques, and application of modal measurement methods suitable for practical vibration analysis problems.
Letter grade only (A-F). (Lecture-Problems 3 hours)

678. Robust Control (3)
Prerequisites: MAE 476 (or an equivalent undergraduate course in classical control systems and state-space design methods), MAE 502 (or an equivalent course in linear algebra and matrix theory) all with a grade of "C" or better. Experience in basic programming and MATLAB are highly recommended.
Introduces robust analysis and design for multivariable feedback control systems with uncertain dynamics or unknown parameters. Topics include: uncertainty modeling; robust stability; robust performance; mu synthesis; H infinity control; and applications of linear matrix inequalities.
Letter grade only (A-F). (Lecture-Problems 3 hours)

690. Selected Topics in Mechanical and Aerospace Engineering (1-3)
Prerequisites: MAE 501, 502 all with a grade of "C" or better, and other prerequisites as related to the topics offered, or consent of instructor.
Selected topics from recent advances in mechanical or aerospace engineering.
Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics in different semesters. Topics announced in the Schedule of Classes. (Lecture-problems 3 hours).

691. Directed Studies (1-3)
Prerequisite: Graduate Standing in a Mechanical and Aerospace Engineering graduate program.
The study of information in the engineering and scientific literature on a current topic in mechanical or aerospace engineering under the direction of a faculty member. Submission of a final written report based on the literature surveyed.
Requires consultation with the respective program’s graduate advisor and submission of an Agreement for Independent Study form as a contract for the project and submission of a Directed Studies permission form each semester of enrollment. Instructor permission is required. May be repeated to a maximum of 3 units in different semesters. Letter grade only (A-F).

697. Directed Research (1-6)
Prerequisite: Consent of instructor; Directed Research Permission and Agreement for Independent Study forms required each semester of enrollment.
Theoretical and experimental problems in MAE requiring extensive research and analysis.
May be repeated to a maximum of 6 units in different semesters. Not open for credit to students enrolled in MAE 698. Letter grade only (A-F).

698. Thesis (1-6)
Prerequisites: Graduate standing in a Mechanical and Aerospace Engineering graduate program and Advancement to Candidacy for the degree.
Planning, preparation, and completion of a thesis on a suitable topic in mechanical and aerospace engineering, following the library’s prescribed format. The graduate advisor for the respective program and the thesis supervisor must be consulted prior to registration.
Submission of an Agreement for Independent Study form as a contract for the project and submission of a Thesis permission form are required for each semester of enrollment. Instructor permission is required. May be repeated to a maximum of 6 units in different semesters. Not open for credit to students who are enrolled in MAE 697. Letter grade only (A-F).

735./635. Computational Fluid Dynamics II (3)
Prerequisite: MAE 535 with a grade of "C" or better.
Methods for solving Euler and Navier-Stokes equations, implicit and explicit schemes, upwind differencing and artificial diffusion, multi-grid techniques and convergence acceleration, unstructured grid techniques, turbulence modeling, application to inviscid and viscous subsonic, transonic, and supersonic flows, etc.
Additional projects required for MAE 735. (Lecture-Problems 3 hours) Letter grade only (A-F).
763/663. Nonlinear Optimized Structures (3)
Prerequisite: MAE 563, or consent of instructor. (Master’s students register in MAE 663, Ph.D. students register in MAE 763) all with a grade of "C" or better
Analysis, optimization of frame with automatic mesh generation using I-DEAS, with popular software such as: STRUĐL, NASTRAN etc. Generation, idealization of complex structures. Sensitivity, Buckling analysis etc. Required topics for Ph.D. students: advanced numerical methods for flutter and random analysis.
(Lecture-problems 3 hours) Letter grade only (A-F).

795. Advanced Directed Studies (4)
Prerequisites: Master of Science degree or equivalent and formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics.
Exploration of theoretical and experimental (if applicable) engineering problems in great depth with an emphasis on mathematical modeling and analysis. Students must present the findings in a formal report. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required.
Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Studies permission form are required each semester of enrollment. May be repeated to a maximum of 8 units in different semesters. Letter grade only (A-F).

797. Advanced Directed Research (4)
Prerequisites: Master of Science degree or equivalent and formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics. Exploration of theoretical and experimental (if applicable) engineering problems in great depth, with emphasis on mathematical modeling and analysis. Students must present the findings in a formal report and a seminar. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required.
Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Research permission form are required each semester of enrollment. May be repeated to a maximum of 8 units in different semesters. Letter grade only (A-F).

798. Doctoral Dissertation (4-12)
Prerequisite: Enrollment is limited to students formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics who have passed the preliminary examinations and research tool tests on completion of at least 48 units of course work. A written dissertation proposal containing an outline of the research to be undertaken must be submitted with references to relevant source material. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required. Student may only embark upon the doctoral dissertation after having received a positive recommendation.
Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Research permission form are required each semester of enrollment. Students must enroll in a minimum of 4 units per semester. May be repeated to a maximum of 12 units in different semesters. Letter grade only (A-F).