BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

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## COMPUTER ENGINEERING PROGRAM

### UNDERGRADUATE HANDBOOK

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Computer Engineering Undergraduate Handbook
Revised: February 10, 2016
INTRODUCTION

The undergraduate program in Computer Engineering at CSUF provides students with a strong theoretical and practical background in both the hardware and the software aspects of computer-based systems, along with the engineering analysis, design, and implementation skills necessary to work between the two. The curriculum is based on an engineering philosophy, with emphasis on hardware more than software. The topics integrated into the curriculum include digital systems, computer organization and architecture, processor interfacing techniques, VHDL design, advanced electronics, and embedded system design. The elective courses required by the program allow students to specialize in key engineering technology and computer science areas. The program also requires two semesters of multidisciplinary senior design project. The computer engineering program is designed to develop an ability to apply design and analysis knowledge to the practice of computer engineering in an effective and professional manner.

The proliferation of embedded systems in an increasing array of industrial products assures a ready market for graduates in the computer engineering discipline. Computer engineers are employed in a wide range of industries including VLSI chip design and manufacturing, autonomous systems, consumer electronics, expert systems, smart devices, digital signal processing (DSP) systems, computer manufacturing from PDAs to super computers, and automatic controls. A majority of products such as airplanes, automobiles, home appliances, consumer electronics, robots etc. use computers and employ computer engineers in their designs. Computer engineers are also needed in the design and implementation of computer networks for business, industrial, and governmental institutions.

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

PROGRAM MISSION STATEMENT

The undergraduate program in Computer Engineering is committed to providing students with a strong theoretical and practical understanding in both the hardware and software aspects of computer-based systems, along with the engineering analysis, design, and implementation skills necessary to solve problems using computer engineering principles and techniques. The program prepares students for productive, dynamic, and rewarding careers in computer engineering and for entry into graduate programs.

PROGRAM EDUCATIONAL OBJECTIVES

The Computer Engineering program has established the following Program Educational Objectives:

A Technical Growth: Graduates will integrate into the local and global computer engineering workforce and contribute to the economy of California and the nation.

B Professional Skills: Graduates will demonstrate the professional skills necessary to be competent employees and assume/undertake leadership roles in their communities and/or profession. Qualified graduates will pursue advanced study if desired.

C Professional Attitude and Citizenship: Graduates will become productive citizens, who make sound engineering or managerial decisions, and have enthusiasm for the profession and professional growth.
STUDENT OUTCOMES

Upon completion of the degree program, graduate of the Computer Engineering program must demonstrate:

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

ADVICEMENT

CSUF offers academic advisement to all students. It gives you the opportunity to review your progress toward your degree and to discuss electives consistent with your career goals.

It is mandatory that you seek advisement at least once a year; otherwise, your registration will be put on hold. Appointments may be scheduled by calling the Computer Engineering Program office. Appointment sign-in sheets for advising are also available in the Computer Engineering Program office.

Be sure to follow the course requirements for your catalog year. Your catalog year is determined by the Admissions Office and is a part of your student records. Typically, this is the year you began college; although occasionally an advisor may approve a later year.

First-Time Freshmen

The College of Engineering and Computer Science (ECS) sponsors orientation sessions for first-year students covering the registration procedures, university policies, general education, and major program requirements. Advisers are available to assist you in selecting your initial coursework. Orientations are scheduled during the Fall and Spring semesters. Please contact the Dean's office, College of Engineering and Computer Science, for the specific dates.

Undergraduate Transfers

General Education Transfer Credits

When accepted for admission, you will receive a SUMMARY OF EVALUATION sheet from the university, showing which general education courses are transferred for credit and a checklist of the courses you still need to take.
Course Equivalency between CSUF and California Colleges

For the most accurate and up-to-date list of articulated courses between CSUF and California colleges, please visit www.assist.org. If you are transferring from a college not listed on www.assist.org, you must see an adviser before enrolling in a class that has a prerequisite, which you believe you have taken at another institution. You need to bring in a copy of your transcript and a course description, to help the adviser in making the evaluation.

Transfer Credits for Courses in the Major

Transfer students from community colleges and other universities must see an adviser during the first semester for official transfer of credits from other institutions and to plan your program of study. Appointments may be scheduled by calling the Computer Engineering Program office. Bring along the catalog with the description of the program and the courses, course outlines, textbooks, lecture notes or other pertinent material that will help your adviser in evaluating the courses you want to transfer for credit. A course with a grade of D will not be accepted for transfer.

Credit By Examination

If you do not have the material to prove the equivalency of a course, you may challenge that course by examination. To challenge a course by examination, get a CREDIT BY EXAMINATION form from the Program office and obtain:

a) the approval of the adviser and the Program Coordinator
b) register for the course and take the Challenge Exam before the third week of the semester from the instructor teaching that course.

Upon successful completion of the examination, the instructor will report the grade of CR. Students who fail the examination must continue the course for credit.

International Students

TOEFL Examination

International students must take the Test of English as a Foreign Language (TOEFL) exam and score no less than 500 (or 173 on the computer-based TOEFL) to gain admission into the program.

American Language Program

International students who want to improve their communication skills in English may take the American Language Program. The program provides intensive practice in listening, speaking, reading, writing and study skills in English. No credit is given for the program. For more details see the University Catalog.

Continuing Students

Visit an advisor at least every 12 months to make sure that you're on the right track. Advising is mandatory at least once a year. If you fail to visit an advisor at least once a year, a hold will be placed on your registration. You will not be allowed to register until an advisor is consulted.
Probation

If you are on probation, it is definitely time to see an advisor. You are also required to attend a Probation Workshop. Until you meet with an advisor and attend the Probation Workshop, a hold will be in place on your file preventing you from registering. Your advisor will discuss with you the problems, which led to your probation, and review strategies you should take to get off probation. Be sure to make your advisement appointment well ahead of time so that your registration is not held up.

Nearing Graduation (One Year)

At least a year prior to your expected graduation, you must file an application for a Graduation Requirements Check. This “Grad Check” is required for graduation.

For information about grad checks, please see the current CSUF Catalog. (Look up Graduation requirements, bachelor’s degree in the index.)

PLACEMENT EXAMINATIONS

All Computer Engineering majors are required to take placement examinations in English and Mathematics. Passing scores in the placement tests are prerequisites to English 101 and Math 150A, respectively. Contact the Dean’s office, College of Engineering and Computer Science, for the examination dates or check your semester Schedule of Classes.

Those students who fail the placement tests are required to take remedial courses. These courses do not carry credit toward your degree objective. The remedial courses are English 99 and Math 125, respectively.

Computer Science Placement Examination

The Computer Engineering degree program assumes that the student has already obtained a working knowledge of personal computing fundamentals and applications, including word processing, spreadsheets, database systems, e-mail systems, the World Wide Web, and presentation graphics.

You may sign up for Computer Science 120 (CPSC 120) if you have working knowledge of personal computing fundamentals and applications, but no programming experience.

You may sign up for CPSC 121 IF:
• You have passed CPSC 120, or equivalent course, with C- or better, OR
• You took the Advanced Placement (AP) test in Computer Science A and scored at least 3.

You may sign up for CPSC 131 IF:
• You have passed CPSC 121, or equivalent course, with C- or better, OR
• You took the Advanced Placement (AP) test in Computer Science AB and scored at least 3.

If none of the above applies to you, then you must take the Computer Science Placement Exam in order to determine which class you should begin with.

Consult the Computer Engineering Program office for additional details. Contact the Computer Science office for a testing appointment.
Advanced Placement Credits

Those students who took advanced placement (AP) test can receive credits if the score is 3 or better. Please contact the Computer Engineering Program office for more details.

DEGREE REQUIREMENTS

Entering freshmen should have a preparation, which includes two years of algebra, geometry, trigonometry, and one year of physics. Students deficient in mathematics or physics must take special preparatory courses, i.e., Mathematics 125 or Physics 115, which will not carry credit for the degree. (See also the Undergraduate Students Section of the University Catalog for Statewide Placement Tests and requirements.)

The degree program assumes that the student has already obtained a working knowledge of personal computing fundamentals and applications, including word processing, spreadsheets, database systems, e-mail systems, the World Wide Web, and presentation graphics. Students without this knowledge may be required to take up to three additional units of course work beyond those normally required. These additional three units will not carry credit for the degree.

The B.S. in Computer Engineering requires 120 semester units. These 120 units include 56 units of required core courses, 9 units of elective courses, 31 units of foundation courses in Mathematics and Science, and 42 units of courses (24 unduplicated units) in General Education.

Minimum Academic Requirements

Courses taken toward the major or toward the requirements in related fields must be taken on a traditional (letter grade) basis, unless the course is offered only on a non-traditional (credit/no credit) basis, or if the course is passed by a challenge examination. Students must maintain at least a 2.0 average in all college-level units attempted, in all units attempted at CSUF, and in all units attempted in the major.

A grade of “C” (2.0) or better is required in courses taken in fulfillment of General Education Categories:
•   A.1 Oral Communication
•   A.2 Written Communication
•   A.3 Critical Thinking
•   B.4 Mathematics (Math 150A & Math 270A)

A grade of “C” (2.0) or better is required in courses taken in fulfillment of the Upper Division Writing Requirement (EGCP 441 & EGCP 471).

Math 150A and Math 270A must be completed with at least a “C” (2.0) grade. All other mathematics and physical science courses required for the degree must be completed with at least a “C-” (1.7) grade to count as prerequisite courses to engineering courses or as credit towards the degree.

All core courses required in the major must be completed with at least a “C-” (1.7) grade to count as credit towards the degree.

Transfer students from local community colleges should refer to the web site www.assist.org for transferrable course information. Your advisor can help you determine these equivalencies, as well as give the required approval. Transfer courses are not officially accepted for use toward the major or as prerequisites until the Program receives transcripts. Student copies of transcripts are acceptable for the Department if they have the official seal, but official school transcripts are required by CSUF for graduation evaluation.
Computer Engineering Core (56 Units)

The core courses cover topic areas of both theoretical and practical interest to all Computer Engineering majors. The required core courses for Computer Engineering majors are:

- CPSC 120* Introduction to Programming ................................................. (3)
- CPSC 121 Programming Concepts ......................................................... (3)
- CPSC 131 Data Structures Concepts ..................................................... (3)
- CPSC 253U Workshop in UNIX ............................................................ (1)
- CPSC 351 Operating Systems Concepts ............................................. (3)
- EGCP 180 Digital Logic and Computer Structures ................................ (3)
- EGCP 280 Microcontrollers .................................................................. (3)
- EGCP 281 Designing with VHDL ......................................................... (2)
- EGCP 371 Modeling and Simulation of Signals and Systems ............ (3)
- EGCP 381 Computer Design and Organization .................................... (4)
- EGCP 401 Engineering Economics & Professionalism ...................... (3)
- EGCP 441 Advanced Electronics for Computer Engineers ............... (4)
- EGCP 446 Advanced Digital Design using Verilog HDL .................. (3)
- EGCP 450 Embedded Processor Interfacing ....................................... (4)
- EGCP 470 Multidisciplinary Projects in Computer Engineering - I ...... (1)
- EGCP 471 Multidisciplinary Projects in Computer Engineering - II ...... (2)
- EGEE 203 Electric Circuits .................................................................. (3)
- EGEE 203L Electric Circuits Laboratory ............................................... (1)
- EGEE 303 Electronics ......................................................................... (3)
- EGEE 303L Electronics Laboratory .................................................... (1)
- EGEE 323 Engineering Probability and Statistics .............................. (3)
- EGEE 410 Electro-Optical Systems ..................................................... (3)
- EGEE 455 Microelectronics and Nano Devices ................................. (3)
- EGEE 456 Introduction to Logic Design in Nanotechnology ............ (3)
- EGEE 460 Introduction to Cellular Mobile Communications Systems ... (3)
- EGEE 465 Introduction to VLSI Design ............................................... (3)
- EGEE 466 Optical Engineering and Communications ....................... (3)
- EGEE 470 Multidisciplinary Projects in Computer Engineering - II ...... (2)
- EGCP 447 Introduction to Hardware Security and Trust ................... (3)
- EGCP 461 Low Power Digital IC Design ........................................... (3)
- EGCP 465 Introduction to VLSI Design ............................................... (3)
- EGCP 480 Optical Engineering and Communications ....................... (3)
- EGCP 456 Introduction to Logic Design in Nanotechnology ............ (3)
- EGCP 455 Microelectronics and Nano Devices ................................. (3)

* CPSC 120 is the first programming course required in the major. This course serves as a prerequisite for CPSC 121. This course is waived if student has passed a similar programming course or if the student passes the placement exam given by the Computer Science department. If CPSC 120 is waived, students are required to take an additional elective course, approved by the academic advisor, to meet the degree requirement of 120 units.

Technical Electives in Computer Engineering (9 Units)

The electives shall constitute a coherent body of study consistent with the student’s professional and educational objectives. Students take 9 units (12 units if student receives a waiver for CPSC 120) of advisor approved elective courses. Students may choose the elective courses from computer engineering, computer science, and electrical engineering. The electives may also include an advisor approved free elective. A recommended list of elective courses is given below. This list is not a comprehensive list of possible elective courses. Courses not on this list may count as electives only with advisor approval.

**Wireless Communication**
- CPSC 433 Data Security and Encryption Techniques .......................... (3)
- CPSC 471 Computer Communications .............................................. (3)
- EGEE 443 Electronic Communication Systems ................................. (3)
- EGEE 460 Introduction to Cellular Mobile Communications Systems ... (3)

**Very Large Scale Integration (VLSI) and Optics**
- EGCP 456 Introduction to Logic Design in Nanotechnology ............ (3)
- EGCP 461 Low Power Digital IC Design ........................................... (3)
- EGCP 465 Introduction to VLSI Design ............................................... (3)
- EGCP 480 Optical Engineering and Communications ....................... (3)
- EGEE 410 Electro-Optical Systems .................................................... (3)
- EGEE 455 Microelectronics and Nano Devices ................................. (3)

**Hardware Security**
- EGCP 447 Introduction to Hardware Security and Trust ................... (3)
Microprocessors and Microcomputer Systems
CPSC 459  Micro-Computer Software Systems ................................................... (3)

Control Systems and Systems Engineering
EGEE 416  Feedback Control Systems ................................................................. (3)
EGEE 424  Computer Simulation of Continuous Systems .................................... (3)
EGEE 425  Introduction to Systems Engineering .................................................. (3)

Global Positioning Systems (GPS)
EGEE 483  Introduction to Global Positioning Systems (GPS) ................................. (3)
EGEE 483L  Global Positioning Systems Laboratory ............................................... (2)

Software Engineering
CPSC 362  Foundations of Software Engineering .................................................. (3)
CPSC 462  Software Design ................................................................................... (3)
CPSC 463  Software Testing .................................................................................. (3)
CPSC 464  Software Architecture ........................................................................... (3)
CPSC 466  Software Process .................................................................................. (3)

Database System Design
CPSC 332  File Structures and Database Systems .................................................. (3)
CPSC 431  Database and Applications ................................................................... (3)
CPSC 473  Web Programming and Data Management ........................................... (3)
CPSC 474  Distributed Computing using Web Service and .NET Remoting ............. (3)

Multimedia and Digital Game Development
CPSC 386  Introduction to Game Design & Production ........................................... (3)
CPSC 484  Principles of Computer Graphics .......................................................... (3)
CPSC 486  Game Programming ............................................................................. (3)
CPSC 489  Game Development Project .................................................................. (3)

Intelligent Systems
CPSC 335  Algorithm Engineering .......................................................................... (3)
CPSC 481  Artificial Intelligence .............................................................................. (3)
CPSC 483  Data Mining and Pattern Recognition .................................................... (3)
EGEE 430  Fuzzy Logic and Control ....................................................................... (3)

Current Topics
EGCP 463  Current Topics in Computer Engineering ............................................ (3)

Free Elective or Independent Study or Internships and Cooperative Education
Choose a maximum of 3 units from the following:
Advisor-approved upper division course ................................................................. (3)
EGCP 499  Independent Study ........................................................................... (1 – 3)
EGGN 495  Professional Practice ........................................................................ (1 – 3)

Mathematics and Science Foundation Courses (31 Units)

Mathematics Requirement (19 Units)
MATH 150A  Calculus .................................................................................................... (4)
MATH 150B  Calculus .................................................................................................... (4)
MATH 250A  Multivariate Calculus ............................................................................. (4)
MATH 250B  Introduction to Linear Algebra and Differential Equations ................... (4)
MATH 270A  Mathematical Structures I ...................................................................... (3)

Science Requirement (12 Units)
Physics 225  Fundamental Physics: Mechanics ......................................................... (3)
Physics 226  Fundamental Physics: Electricity and Magnetism ................................ (3)
Physics 227  Fundamental Physics: Waves, Optics, and Modern Physics ................ (3)
Physics 225L, 226L, 227L  Fundamental Physics: Laboratory .................................... (1, 1, 1)
Upper Division Writing Requirement (3 Units)

The upper-division writing requirement for Computer Engineering majors is met by the report writing portions of the following two courses:

- EGCP 441: 1 unit toward upper-division writing requirement
- EGCP 471: 2 units toward upper-division writing requirement

Written work for EGCP 441 and EGCP 471 must meet professional standards. Both courses must be passed with a grade of “C” or better to satisfy the writing requirement.

General Education Requirements (42 Units; 24 Unduplicated)

Because of the ABET requirements, the general education for the Computer Engineering students are more restrictive and specific than other majors.

Core Competencies
Only Speech Communication 100 (HCOM 100) or Speech Communication 102 (HCOM 102) is acceptable for the oral communication part. The written communication and critical thinking sections are the same as the University requirements.

Scientific Inquiry and Quantitative Reasoning
All the courses under this category are satisfied in the major requirements.

Arts and Humanities
You need three units in Introduction to Arts and three units in Introduction to the Humanities. As a Computer Engineering major, you have a choice between History 110A or 110B to satisfy the requirement in Origins of the World Civilization.

Social Sciences
Three units of upper-division general education requirement are also satisfied by the Social Science part in the major (EGCP 401). Section D.3 – American History, Institutions and Values is the same for all majors. You also need three units in American Government.

Explorations in the Arts and Humanities and Explorations in Social sciences
You need three units of upper-division course in Explorations in the Arts and Humanities and three units of upper-division course in Explorations in Social sciences. You must have a course from C.3 and D.5.

Cultural
At least one of the courses in Sections C.3 and D.5 with an asterisk must be taken to satisfy the cultural diversity requirement.
Recommended General Education Courses

**Area A: Core Competencies** (6 Units)
1. Oral Communication (3 Units)
   HONR 101B, HCOM 100, 102
2. Written Communication (3 Units)
   English 101
3. Critical Thinking
   Not applicable for engineering majors

**Area B: Scientific Inquiry and Quantitative Reasoning** (15 Units)
1. Physical Science (6 Units)
   PHYS 225 and 226
2. Life Science
   Not applicable for engineering majors
3. Laboratory Experience (2 Units)
   PHYS 225L and 226L
4. Mathematics/Quantitative Reasoning (7 Units)
   MATH 150A and 270A
5. Implications & Explorations in Mathematics & Natural Sciences
   Not applicable for engineering majors

**Area C: Arts and Humanities** (12 Units)
1. Introduction to Arts (3 Units)
   Art 101, 201A, 201B, 311, 312, Dance 101, Music 100, 101
2. Introduction to the Humanities (3 Units)
   Any lower division course in this category listed in the current class schedule
3. Explorations in the Arts and Humanities (3 Units)
   Any upper-division course in this category listed in the current class schedule
4. Origins of the World Civilizations (3 Units)
   History 110A or 110B, 210A, 210B

**Area D: Social Sciences** (9 Units)
1. Introduction to the Social Sciences (3 Units)
   EGCP/EGCE/EGEE 401
2. World Civilizations and Cultures
   Not applicable for engineering majors
3. American History, Institutions and Values (3 Units)
   AFRO 190, AMST 201, CHIC 190, HIST 180, 190, HONR 201A
4. American Government (3 Units)
   HONR 201B, POSC 100
5. Explorations in Social Sciences
   Not applicable for engineering majors

**Area E: Lifelong Learning and Self Development**
Not applicable for engineering majors

**Area Z: Cultural** (3 Units)
Take at least one star (*) course in Sections C.3 and D.5
PROGRAM SCHEDULE PREPARATION
Recommended Schedule

In order to finish your coursework within your time schedule, you must plan ahead. You must lay out a semester-by-semester timetable. The 4-year curriculum flowchart for the Bachelor of Science Degree in Computer Engineering is given on the next page. The flowchart provides the recommended timetable to complete the program in four years. This curriculum flowchart is carefully laid out to satisfy the prerequisite requirements.
Bachelor of Science Degree Program in Computer Engineering, CSUF

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- **First Year**
  - *Calculus I*  
    - Math 150A  
      - (4 units)

- **Second Year**
  - *Calculus II*  
    - Math 150B  
      - (4 units)

- **Third Year**
  - *Engr. Probability*  
    - EGEE 325  
      - (3 units)

- **Fourth Year**
  - *Tech. Elective*  
    - (3 units)

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- **Intro to Program**
  - *CPSC 125*  
    - (3 units)

- **Written Comm.**
  - *English 101*  
    - (3 units)

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- **First Year**
  - *Fund. Phys. I*  
    - Physics 225, L  
      - (4 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Electr. Circ. Lab*  
    - EGEE 301L  
      - (1 unit)

- **Fourth Year**
  - *Tech. Elective*  
    - (3 units)

---

- **First Year**
  - *Fund. Phys. I*  
    - Physics 225, L  
      - (4 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. II*  
    - (2 units)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. I*  
    - (1 unit)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. II*  
    - (2 units)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. I*  
    - (1 unit)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. II*  
    - (2 units)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. II*  
    - (2 units)

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- **First Year**
  - *Intro to Program*  
    - *CPSC 125*  
      - (3 units)

- **Second Year**
  - *Fund. Phys. II*  
    - Physics 226, L  
      - (4 units)

- **Third Year**
  - *Comp. Design*  
    - EGCP 381  
      - (4 units)

- **Fourth Year**
  - *Multidisc. Proj. II*  
    - (2 units)

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**Notes:**
- *Corequisite: Math 125 or equivalent course*
- **Junior or Senior Standing in Engineering**

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**Course Title**

**Prerequisite**

**Corequisite**
OTHER INFORMATION

The following are pertinent information and instructions that you may need during your course of study.

Course Prerequisites and Corequisites

It is your responsibility to make sure you satisfy the prerequisites and corequisites before signing up for a course. You will not be given credit if you take a course without satisfying the prerequisites. If you want to take a class for which you do not have the appropriate prerequisites, you need to fill out the “Prerequisite Waiver” petition form and submit it to the Computer Engineering Program office. If you feel you have the necessary background, you may take a challenge examination.

Changing Technical Elective Courses

To request a change, obtain the approval of the adviser and the program coordinator. Once the graduation check is completed, change of course(s) request will be denied unless you have serious and compelling reasons.

Internships and Cooperative Education

Learning takes place in many settings, not just the classroom. When you complete your educational career and are entering the professional job market for the first time, extensive professional experience can be highly beneficial. For this reason, CSUF and the Computer Engineering Program maintain an active internship program as a service to all students interested in obtaining employment while still in school.

Benefits of the internship program in Computer Engineering include:

- Paid work experience in the computer field.
- Job placement assistance from the Internship Office.
- Up to 3 units of technical elective credits.

We encourage you to use the internship program once you reach junior or senior status. To do so, follow these steps:

1) Visit the Center for Internships and Community Engagement located in LH-206. Fill out and turn in the required forms along with your resume.
2) Wait for a position. This wait is three months on average, so be sure to plan in advance!
3) Once you secure a position, visit the Computer Engineering Program office and request enrollment in EGGN 495 – Professional Practice. This class may be repeated any number of times, for up to three units.

Petition for Coursework Overload

The maximum coursework for a semester is 18 units. Students may petition to take more than the maximum units. The adviser and the Program Coordinator must approve petition for course overload.

GPA Calculation for Repeated Courses

Normally, grades of all courses taken at CSUF are included in the calculation of the GPA. However, a student may petition to exclude the failed grades (F or D) of repeated courses. No more than 16 units may be petitioned.
Academic Probation and Disqualification

A student whose overall GPA and/or semester GPA falls below 2.0 will be placed on probation and have his/her registration placed on hold until the student sees the Program Academic Advisor and attends a Probation Workshop administered by the College of ECS. The student must seek counsel from the student's adviser and attend the probation workshop prior to enrolling in the following semester. Normally, repeating the course and petitioning for exclusion in the GPA calculation, will clear the academic probation. Continued probation may result in disqualification from the program.

Student Clubs

As a student member you can enhance your technical knowledge by becoming a member of one or more of the following clubs and by attending their seminars, conferences or symposiums, and subscribing to their technical magazines. Most are affiliated with local, regional, and national chapters, providing excellent opportunities for students to network with professionals in the field. Computer Engineering students are encouraged to become involved in one or more of the following student clubs:

- The IEEE Computer Society
- The Institute of Electrical and Electronics Engineers (IEEE)
- Association for Computer Machinery (ACM)
- Society of Mexican American Engineers & Scientists (MAES)
- National Society of Black Engineers (NSBE)
- Society of Hispanic Professional Engineers (SHPE)
- Society of Women Engineers (SWE)
- Tau Beta Pi (TBP – National Engineering Honor Society)
- Upsilon Pi Epsilon (UPE - International Honors Society for the Computing and Information Disciplines)
COURSE DESCRIPTIONS

Computer Engineering (EGCP) Courses

**EGCP 180**  Digital Logic and Computer Structures  (3 units)
Prerequisite:  CPSC 120
Binary number system and arithmetic, computer codes, Boolean algebra, logic gates, K-map
minimization, sequential circuits, memory devices, state diagram and table, computer architecture,
memory, Arithmetic Logic Unit, and control unit.  (2 hours lecture, 2 hours laboratory)

**EGCP 280**  Microcontrollers  (3 units)
Prerequisite:  EGCP 180
Microcontrollers, microcontroller programming model and instruction set, assembler directives, writing and
debugging microcontroller assembly language routines, microcontroller memory system, microcontroller
communication systems.  (1 hour lecture, 4 hours laboratory)  (Same as EGEE 280)

**EGCP 281**  Designing with VHDL  (2 units)
Prerequisites:  CPSC 120 or 121 and EGCP 180
Introduction to various modeling methods, timings, events, propagation delays and concurrency, the
language constructs, data representations and formats, and physical attributes.  (1 hour lecture, 2 hours
laboratory)  (Same as EGEE 281)

**EGCP 371**  Modeling and Simulation of Signals and Systems  (3 units)
Prerequisite:  Math 250B
Modeling and simulation of physical systems, mathematical description of systems, transfer functions,
poles and zeros, frequency response, continuous and discrete-time convolution, continuous and discrete
Fourier transforms, Laplace and Z transforms, Fast Fourier Transforms, simulation using Matlab.

**EGCP 381**  Computer Design and Organization  (4 units)
Prerequisites:  EGCP 281 and EGEE 303
Computer system, central processing unit (CPU) organization and design, instruction set and addressing
modes, microprogrammed control unit design, cache memory, internal memory, virtual memory,
input/output interfacing, parallel processors, superscalar processors.  (2 hours lecture, 4 hours laboratory)

**EGCP 401**  Engineering Economics & Professionalism  (3 units)
Prerequisites:  Math 150A and Junior or senior standing in Engineering
Development, evaluation and presentation of design alternatives for engineering systems and projects
using principles of engineering economy and cost benefit analysis.  Study of engineering profession,
professional ethics, and related topics.  (Same as EGCE 401 & EGEE 401)

**EGCP 441**  Advanced Electronics for Computer Engineers  (4 units)
Prerequisites:  EGCP 281 and EGEE 303
High speed CMOS, biCMOS, CPLDs, FPGAs, A/D, D/A, transducers and optics; integration of these
devices into complete systems.  (2 hours lecture, 4 hours laboratory)

**EGCP 446**  Advanced Digital Design using Verilog HDL  (3 units)
Prerequisite:  EGCP 441
Fundamentals of Verilog programming; behavioral modeling using Verilog; structural modeling using
Verilog; RTL design using Verilog; Shannon’s decomposition; FPGA architecture; Digital design,
synthesis and implementation using FPGA.

**EGCP 447**  Introduction to Hardware Security and Trust  (3 units)  .........................Elective
Prerequisite:  EGCP 281
Hardware Trojan detection and isolation; physical and invasive attacks; side-channel attacks; physically
unclonable functions; watermarking of Intellectual Property (IP) blocks; passive and active metering for
prevention of piracy; access control.

**EGCP 450**  Embedded Processor Interfacing  (4 units)
Prerequisites:  EGCP 280, 381 and 441, EGEE 323, CPSC 351, Math 270A
Techniques of interfacing based on speed, timings, synchronization, noise, cross-talk, hazards and race
conditions.  Interfacing specifications of the processor data, address, and control buses.  (2 hours lecture,
4 hours laboratory)
EGCP 456 Introduction to Logic Design in Nanotechnology (3 units) ................. Elective
Prerequisite: EGCP 180 or EGEE 245
Survey of promising novel Nanoelectronic technologies and logic primitives for such technologies, applicable basic logic design technique, design models for spatial dimensions, applicable word-level data structures, multilevel circuit design, testability and observability, tolerance and reliable computing. (Same as EGEE 456)

EGCP 461 Low Power Digital IC Design (3 units) ........................................ Elective
Prerequisites: EGCP 180 or EGEE 245 and EGEE 303
Importance of low power design; analysis of power dissipation in digital integrated circuits; circuit-level low-power techniques, logic-level low-power techniques, and system-level low-power techniques. (Same as EGEE 461)

EGCP 463 Current Topics in Computer Engineering (3 units) ........................ Elective
Prerequisites: Junior/Senior standing in computer engineering and consent of the instructor
Exploration of topics of contemporary interest from the perspective of current research and development in computer engineering. Lectures by guest professionals.

EGCP 470 Multidisciplinary Projects in Computer Engineering – I (1 unit)
Corequisite: EGCP 450
1st course in the 2-course senior design sequence. Students in teams will complete a hardware/software project, from conception through implementation and testing, under an instructor's supervision. Teams first explore technology issues related to the projects and then prepare complete design proposals.

EGCP 471 Multidisciplinary Projects in Computer Engineering – II (2 units)
Prerequisites: EGCP 450 and EGCP 470
2nd course in the 2-course senior design course in which students in teams will complete a hardware/software project under the supervision of the instructor. The development of design skill, based upon previous and current courses and laboratory experience, is emphasized. (4 hours laboratory)

EGCP 499 Independent Study (1 – 3 units) .................................................. Elective
Prerequisite: Application for independent study approved by the instructor and the Computer Engineering Program Coordinator
Independent study or research under the direction of a full-time faculty member. May be repeated for a maximum of 3 total units of credit.

Computer Science (CPSC) Courses

CPSC 120 Introduction to Programming (3 units)
Corequisite: Math 125
Introduction to the concepts underlying all computer programming: design and execution of programs; sequential nature of programs; use of assignment, control and input/output statements to accomplish desired tasks; use of functions and arrays. Structured programming methodologies. (1.5 hours lecture, 3 hours laboratory)

CPSC 121 Programming Concepts (3 units)
Prerequisite: CPSC 120 or passing score on Computer Science Placement Exam
Structure of algorithms; functions; strings and data types; pointers and linked structures; classes and objects; recursion; inheritance; polymorphism; exception handling; documentation. Object-oriented programming methodology. (2 hours lecture, 2 hours laboratory)

CPSC 131 Data Structures Concepts (3 units)
Prerequisite: CPSC 121 or sufficient score on the Computer Science Placement Exam
CPSC 253U  Workshop in Unix (1 unit)
Prerequisite: CPSC 121
Workshops in the use of specific operating systems. Offered Credit/No Credit only. (2 hours activity)

CPSC 332  File Structures and Database Systems (3 units) .......................................................Elective
Prerequisite: CPSC 131
The fundamental theories and design of database systems, the Structural Query Language (SQL), and basic concepts and techniques on data organization in secondary storage. Topics include introduction to database systems, ER model, relational model, index structures, and hashing techniques.

CPSC 335  Algorithm Engineering (3 units) ..............................................................................Elective
Prerequisites: CPSC 131, CPSC 253U, Math 250B, and EGEE 323

CPSC 351  Operating Systems Concepts (3 units)
Prerequisite: CPSC 253U
Resource management, memory organization, input/output, control; process synchronization and other concepts as related to the objectives of multi-user operating systems.

CPSC 362  Foundations of Software Engineering (3 units) ......................................................Elective
Prerequisites: CPSC 131 and CPSC 253U
Basic concepts, principles, methods, techniques and practices of software engineering. All aspects of software engineering fields will be covered briefly. Computer-Aided Software Engineering (CASE) tools are used.

CPSC 386  Introduction to Game Design & Production (3 units) ............................................Elective
Prerequisite: CPSC 131
Current and future technologies and market trends in game design and production. Game technologies, basic building tools for games and the process of game design, development and production.

CPSC 431  Database and Applications (3 units) ...........................................................................Elective
Prerequisite: CPSC 332
Database design and application development techniques for a real-world system. Topics include system analysis, requirement specifications, conceptual modeling, logic design, physical design and web interface development. Develop projects using contemporary database management system and web-based application development platform.

CPSC 433  Data Security and Encryption Techniques (3 units) ..................................................Elective
Prerequisites: CPSC 351 and Math 250B
System security and encryption. Current issues in security, encryption and privacy of computer based systems.

CPSC 459  Micro-Computer Software Systems (3 units) ..........................................................Elective
Prerequisite: CPSC 351
The design and implementation of software. Analysis of a micro-computer operating system and work on a team to implement a significant programming assignment.

CPSC 462  Software Design (3 units) .........................................................................................Elective
Prerequisite: CPSC 362
Concepts of software modeling, software process and some tools. Object-oriented analysis and design and Unified process. Some computer-aided software engineering (CASE) tools will be recommended to use for doing homework assignments.

CPSC 463  Software Testing (3 units) .........................................................................................Elective
Prerequisite: CPSC 362
Software testing techniques, reporting problems effectively and planning testing projects. Students apply what they learned throughout the course to a sample application that is either commercially available or under development.
CPSC 464  Software Architecture (3 units)....................................................................................Elective
Prerequisite: CPSC 362
Basic principles and practices of software design and architecture. High-level design, software architecture, documenting software architecture, software and architecture evaluation, software product lines, and some considerations beyond software architecture.

CPSC 466  Software Process (3 units)....................................................................................Elective
Prerequisite: CPSC 362
Practical guidance for improving the software development and maintenance process. How to establish, maintain and improve software processes. Exposure to some common process models, such as CMM, CMMI, PSP and TSP.

CPSC 471  Computer Communications (3 units)....................................................................................Elective
Prerequisite: CPSC 351
Introduction to digital data communications. Terminology, networks and their components, common-carrier services, telecommunication facilities, terminals, error control, multiplexing and concentration techniques.

CPSC 473  Web Programming and Data Management (3 units)....................................................Elective
Prerequisite: CPSC 332
Various techniques for developing Web-based database applications using software engineering methodology. Introduce concept and architecture of Web servers, Web database design techniques, client/server side programming, and Web application tools and techniques.

CPSC 474  Distributed Computing using Web Service and .NET Remoting (3 units) ...........Elective
Prerequisite: CPSC 473
Concepts of distributed computing and Web services, the applications of XML and Web services, distributed applications development techniques with Web services and .NET Remoting.

CPSC 481  Artificial Intelligence (3 units)......................................................................................Elective
Prerequisite: CPSC 335
Use of computers to simulate human intelligence. Topics include production systems, pattern recognition, problem solving, searching game trees, knowledge representation, and logical reasoning. Programming in AI environments.

CPSC 483  Data Mining and Pattern Recognition (3 units)............................................................Elective
Prerequisite: CPSC 335
Classification techniques, discriminant functions, training algorithms, potential function theory, supervised and unsupervised learning, feature selection, clustering techniques, multidimensional rotations and rank ordering relations.

CPSC 484  Principles of Computer Graphics (3 units)..................................................................Elective
Prerequisites: CPSC 131, CPSC 253U, Math 150B, and Math 250B
Examination and analysis of computer graphics; software structures, display processor organization, graphical input/output devices, display files. Algorithmic techniques for clipping, windowing, character generation and viewpoint transformation.

CPSC 486  Game Programming (3 units).....................................................................................Elective
Prerequisite: CPSC 386 and CPSC 484
Data structures and algorithms used for real-time rendering and computer game programming. Build upon existing mathematics and programming knowledge to create interactive graphics programs.

CPSC 489  Game Development Project (3 units)........................................................................Elective
Prerequisite: CPSC 486
Individually or in teams, student design, plan and build a computer game.
Electrical Engineering (EGEE) Courses

EGEE 203  Electric Circuits (3 units)
Prerequisites: Physics 226 and Math 250A. Corequisite: CPSC 120
Units; Ohm’s and Kirchhoff’s laws; mesh and nodal analysis, superposition; Thevenin and Norton theorems; RL and RC transients; phasors and steady state sinusoidal analysis; response as a function of frequency; current, voltage, and power relationships; polyphase circuits.

EGEE 203L  Electric Circuits Laboratory (1 unit)
Prerequisite or Corequisite: EGEE 203
Simple resistive RL and RC circuits, electrical measurement techniques, verification of basic circuit laws through hard-wired breadboarding and CAD circuit simulation. (3 hours laboratory)

EGEE 303  Electronics (3 units)
Prerequisites: Physics 227 and EGEE 203
Characteristics and elementary applications of semiconductor diodes, field-effect transistors and bipolar-junction transistors, and operational amplifiers; mid-frequency small-signal analysis and design of transistors.

EGEE 303L  Electronic Laboratory (1 unit)
Prerequisites: EGEE 203L and English101. Corequisite: EGEE 303
Semiconductor diodes, transistors and elementary electronic circuits through hard-wired breadboarding, CAD electronic simulation and analysis. (3 hours laboratory)

EGEE 323  Engineering Probability and Statistics (3 units)
Prerequisite: Math 250A or 270B
Set theory: axiomatic foundation of probability; random variables; probability distribution and density functions; joint, conditional and marginal distributions; expected values; distribution of functions of random variables; central limit theorem; estimation.

EGEE 410  Electro-Optical Systems (3 units)  Elective
Prerequisites: Physics 226, Math 250B, and EGEE 203
Introduction to electro-optics; optical radiation characteristics and sources; geometrical and physical optics; lasers and electro-optical modulation; quantum and thermal optical radiation detectors; detector performance analysis; electro-optical systems modeling and analysis; application examples.

EGEE 416  Feedback Control Systems (3 units)  Elective
Prerequisite: EGCP 371
Feedback control system characteristics; stability in the frequency domain; analysis and design of continuous-time systems using root-locus, Bode and Nyquist plots and Nichols chart and applications.

EGEE 424  Computer Simulation of Continuous Systems (3 units)  Elective
Prerequisites: CPSC 120 and EGCP 371
Using digital computer for simulation of physical systems modeled by ordinary differential equations; problem formulation, in-depth analysis of two integration methods, and the use of a general purpose system simulation program such as CSSL.

EGEE 425  Introduction to Systems Engineering (3 units)  Elective
Prerequisites: EGCP 180 and EGEE 323
Introduction to systems engineering analysis and the systems approach; introduction to modeling, optimization, design and control; systems requirements analysis; analytical and computational solution methods; information processing; integrated systems.

EGEE 430  Fuzzy Logic and Control (3 units)  Elective
Prerequisite: EGCP 371
Fuzzy logic and systems; comparison of classical sets, relations, and operators with fuzzy sets, relations and operators; fuzzy arithmetic and transformations; classical predicate logic and reasoning versus fuzzy logic and approximate reasoning. Applications to rule-based systems and control systems.
**EGEE 443** Electronic Communication Systems (3 units)..................................................Elective
Prerequisites: EGCP 441 and EGEE 323
Principles of amplitude, angular and pulse modulation, representative communication systems, the effects of noise on system performance.

**EGEE 455** Microelectronics and Nano Devices (3 units)..................................................Elective
Prerequisites: EGEE 303, Math 250B, and Physics 226
Quantum mechanical principles, crystal structure, energy band, carrier transport, carrier generation and recombination, p-n junction, bipolar transistor, MOSFET, MEFET and related devices, basic microwave and optoelectronic technology, crystal growth and fabrication, introduction to nano structure, nano devices and technology.

**EGEE 460** Introduction to Cellular Mobile Communications Systems (3 units)..................Elective
Prerequisite: EGEE 443 or equivalent
Introduction to wireless mobile telecommunications, description and analysis of cellular radio systems, co-channel interference reduction, channel capacity and digital cellular systems.

**EGEE 465** Introduction to VLSI Design (3 units)..............................................................Elective
Prerequisites: EGCP 180 and EGEE 303
Computer aided design of VLSI circuits. MOS device structure, design rules, layout examples, CMOS standard cells. Speed power trade off, scaling, device and circuit simulation. VLSI design software tools. Routing method system design, Design Project. Chip fabrication through MOSIS service, testing.

**EGEE 480** Optical Engineering and Communications (3 units)......................................Elective
Prerequisites: EGEE 203, Math 250B, and Physics 227
Optics review, lightwave fundamentals, integrated optic waveguides, first design of fiberoptic system, analog and digital modulation, digital fiberoptic system design, baseband coding, digital video transmission in optical fiber, optical emitters and receivers, coherent optical communication, measurements in fiber optic telecommunication.

**EGEE 483** Introduction to Global Positioning Systems (3 units)......................................Elective
Prerequisite or Corequisite: EGCP 371

**EGEE 483L** Global Positioning Systems Lab (2 units)......................................................Elective
Prerequisite or Corequisite: EGEE 483
Use and description of Novatel, Magelon, Ahstek, Collins and Tribel receivers. Computation of GPS and GEO stationary satellite positions from ephemeris data available on almanac. Errors such as selective availability, ionospheric, tropospheric, satellite ad receiver will be calculated and compensated in the data. (1 hour lecture, 3 hours laboratory)

**General Engineering (EGGN) Course**

**EGGN 495** Professional Practice (1 – 3 units)...............................................................Elective
Prerequisite: Junior or senior standing in engineering
Professional engineering work in industry or government. Written report required. May be repeated for credit any number of times, for up to three units.
Related Courses for Computer Engineering Majors

MATH 150A & Math 150B  Calculus (4, 4 units)
Prerequisites: passing score ELM (Entry Level Mathematics Exam) or exemption; four years of high school mathematics including college algebra trigonometry, and Math 125 or equivalent or a passing score on the MQE (Mathematics Qualifying Exam) for MATH 150A. MATH150A is the only prerequisite for MATH 150B.
Analytic geometry, functions, limits, differentiation, the definite integral, techniques of integration, applications.

MATH 250A  Multivariate Calculus (4 units)
Prerequisites: MATH 150A, B or equivalent
A continuation of MATH 150. Infinite series, Taylor's theorem, functions of several variables, partial differentiation, multiple integration.

MATH 250B  Introduction to Linear Algebra and Differential Equations (4 units)
Prerequisite: MATH 250A
An introduction to the solutions of ordinary differential equations and their relationship to linear algebra. Topics include matrix algebra, systems of linear equations, vector space, linear independence, linear transformations and eigenvalues.

MATH 270A  Mathematical Structures I (3 units)
Prerequisite: Four years high school mathematics
First of two semesters of fundamental discrete mathematical concepts and techniques needed in computer-related disciplines. Logic, truth tables, elementary set theory, proof techniques, and combinatorics.

PHYS 225  Fundamental Physics: Mechanics (3 units)
Prerequisite: MATH 150A. Concurrent enrollment in PHYS 225L required
Classical Newtonian mechanics; linear and circular motion; energy; linear/angular momentum; systems of particles; rigid body motion; wave motion and sound. (3 hours lecture)

PHYS 226  Fundamental Physics: Electricity and Magnetism (3 units)
Prerequisites: MATH 150B and PHYS 225 or equivalent. Concurrent enrollment in PHYS 226L required
Electrostatics, electric potential, capacitance, dielectrics, electrical circuits, resistance, EMF, electromagnetic induction, magnetism and magnetic materials, and introduction to Maxwell's equations. (3 hours lecture)

PHYS 227  Fundamental Physics: Waves, Optics, and Modern Physics (3 units)
Prerequisite: PHYS 226 or equivalent. Corequisite: enrollment in PHYS 227L laboratory except for Biochemistry, Chemistry and Mechanical Engineering majors who may enroll for 1 unit credit (optics component). All others must enroll for 3 units of credit.
Geometrical and physical optics, wave phenomena; quantum physics, including the photoelectric effect, line spectra and the Bohr atom; the wave nature of matter, Schrödinger's equation and solutions; the Uncertainty Principle, special theory of relativity. (X hours

PHYS 225L, 226L, 227L  Fundamental Physics Laboratory (1, 1, 1 unit)
Concurrent enrollment in the corresponding PHYS 225, 226, 227 lecture required (3 hours laboratory). (Instructional fee required)
Computer Engineering Progress Worksheet

The Computer Engineering Progress Worksheet will assist you to track your progress in the Computer Engineering program. Use this worksheet to keep a record of the courses you have completed and for which you have transfer credits. Keep them up-to-date by entering the grades of the courses you have completed.
### Bachelor of Science in Computer Engineering - Progress Worksheet

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<thead>
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<th>Core Courses (56 Units)</th>
<th>CSUF</th>
<th>Transfer</th>
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<td>Introduction to Programming</td>
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<tr>
<td>CPSC 121</td>
<td>Programming Concepts</td>
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<td></td>
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<td>CPSC 131</td>
<td>Data Structures</td>
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<td>CPSC 253U</td>
<td>Workshop in Unix</td>
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<td>CPSC 351</td>
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<td>EGCP 180</td>
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<td>EGCP/EE 280</td>
<td>Microcontrollers</td>
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<td>EGCP/EE 281</td>
<td>Designing with VHDL</td>
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<td>EGCP 371</td>
<td>Mod. &amp; Sim. Of Signals</td>
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<tr>
<td>EGCP/ICE/EE 401</td>
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<tr>
<td>EGCP 441</td>
<td>Advanced Electronics</td>
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<tr>
<td>EGCP 446</td>
<td>Adv. Digital Design using Verilog HDL</td>
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<td>EGCP 450</td>
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<td>EGEE 203</td>
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<td>EGEE 303</td>
<td>Electronics</td>
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<td>EGEE 303L</td>
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<td>EGEE 323</td>
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### Senior Design Courses

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### Upper Division Writing

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### Math & Science Course (31 Units)

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<td>Math 150B</td>
<td>Analytic Geom &amp; Calc</td>
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<td>Math 250A</td>
<td>Calculus</td>
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<td>Math 250B</td>
<td>Calculus</td>
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<tr>
<td>Math 270A</td>
<td>Mathematical Struct. I</td>
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<tr>
<td>Phys 225</td>
<td>Fund Phys, Mech</td>
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<td>Phys 225L</td>
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<td>Phys 226</td>
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<td>Phys 227L</td>
<td>Fund Phys, Mod Lab</td>
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### Technical Electives (9 Units; 12 units if CPSC 120 is waived)

<table>
<thead>
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<th>Course #</th>
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