



CALIFORNIA STATE UNIVERSITY  
**FULLERTON**

**BACHELOR OF SCIENCE  
IN  
COMPUTER ENGINEERING**

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**BACHELOR OF SCIENCE IN COMPUTER ENGINEERING**  
**Computer Engineering Program**

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# COMPUTER ENGINEERING PROGRAM

## UNDERGRADUATE HANDBOOK

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# INTRODUCTION

The undergraduate program in Computer Engineering at California State University, Fullerton (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 an emphasis on hardware more than software. The topics integrated into the curriculum include digital systems, computer organization and architecture, processor interfacing techniques, HDL design using VHDL and Verilog, 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 a 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 tablets to supercomputers, 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 of 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 (PEOs)

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

- 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, a graduate of the Computer Engineering program must demonstrate:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

## ADVISEMENT

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.

Undergraduate students in the Computer Engineering (CpE) Program are required to attend academic advising at least once a year. To ensure this, advising holds are placed on students' accounts that have CWIDs that end in an odd number during the Fall semester and during the Spring semester for those students that have CWIDs that end in an even number.

For information on how to schedule an appointment, see the [CpE Program Undergraduate Advising](#) website.

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 ECS Dean's office for the specific dates.

### ***Undergraduate Transfers***

#### ***General Education (GE) Transfer Credits***

When accepted for admission, you will receive a "Summary of Evaluation" sheet from the university, showing which General Education (GE) courses are transferred for credit and a checklist of the courses you still need to take.

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## ***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 [assist.org](http://assist.org). If you are transferring from a college not listed on [assist.org](http://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 the official transfer of credits from other institutions and to plan your program of study. For information on how to schedule an appointment, see the [CpE Program Undergraduate Advising](#) website. 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+ or lower 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/IELTS/PTE Examination***

If you have received your degree outside the US, then you are required to present the results of an acceptable English test assessment such as the TOEFL, IELTS, or PTE. You must submit TOEFL/IELTS/PTE scores even if you are a US citizen or have been living and working in the United States for many years since you received your degree. The CSUF policy is based on where you attended school, not your citizenship or how long you have been in the United States.

<b>Test</b>	<b>Minimum Score</b>
<b>TOEFL</b>	550 paper-based/80 internet-based
<b>IELTS</b>	6.5
<b>PTE</b>	58

The English test assessment requirement can be waived if you have completed at least 72 college semester units in a majority English-speaking country (US, UK, Ireland, Canada, New Zealand, and Australia) or graduated from a US institution. You have two options to submit your test score:

1. You can have your test score sent by the testing service to CSU Fullerton (the school code is 4589)

2. Submit an official scorecard along with your supporting documents to ECS Graduate and International Admissions Office

### ***American Language Program (ALP)***

Students who do not meet the minimum TOEFL or IELTS requirement may be eligible to enroll in the American Language Program (ALP), where academic English instruction is provided to prepare students to become successful in a university degree program. Advanced students may take one or more university courses for credit. Conditional admission to CSUF through ALP is available for all undergraduate majors in ECS. Please e-mail [admissions@fullerton.edu](mailto:admissions@fullerton.edu) for more information.

### ***Continuing Students***

You will be required to meet with an academic advisor at least once a year to ensure that you're on the right track. If you fail to visit an advisor at least once a year, a hold will be placed on your registration, and, as a result, you will not be allowed to register until an advisor is consulted.

### ***Academic Notice***

If you are on notice, you will be required to attend an Academic Notice Workshop and meet with your academic advisor twice an academic year (i.e., spring and fall) until you are off academic notice. Until you meet with an advisor and attend the Academic Notice Workshop, a hold will be placed on your account, preventing you from registering. Your advisor will discuss any issues with you that led to your academic notice and review strategies you should take to fix them. Be sure to make your advisement appointment well ahead of time so that your registration is not held up.

### ***Graduation Requirements Check (Grad Check)***

At least a year prior to your expected graduation, you must file an application for a Graduation Requirements Check (a.k.a., Grad Check), which 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**

### ***English and Mathematics Placement Examinations***

All Computer Engineering majors are required to take placement examinations in English (English Placement Test (EPT)) and Mathematics (Mathematics Qualifying Examination (MQE)), except for those who qualify for an exemption. Passing scores in the placement tests are prerequisites to ENGL 101 and MATH 150A, respectively. Contact the ECS Dean's Office 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 ENGL 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, e-mail systems, internet usage, and presentation graphics.

You may sign up for CPSC 120A and CPSC 120L if you have a working knowledge of personal computing fundamentals and applications but no programming experience.

You may sign up for CPSC 121A and CPSC 121L if:

- You have passed CPSC 120; or CPSC 120A and CPSC 120L, or an equivalent course, with C- or better
- Or you took the Advanced Placement (AP) test in Computer Science A and scored at least a 3

You may sign up for CPSC 131 if:

- You have passed CPSC 121; or CPSC 121A and CPSC 121L, or an equivalent course, with C- or better
- Or you took the 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 CpE Program office for additional details. Contact the Computer Science office for a testing appointment.

## ***Advanced Placement (AP) Credits***

Those students who took the AP test may receive credits if the score is 3 or better. Please contact the CpE Program office for more details.

## **DEGREE REQUIREMENTS**

Entering freshmen should have preparation that 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., MATH 125 or PHYS 115), which will not carry credit for the degree (see 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, e-mail systems, internet usage, and presentation graphics. Students without this knowledge may be required to take up to three additional units of coursework beyond those normally required. These additional three units will not carry credit for the degree.

The BS 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

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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 the Upper Division Writing Requirement (EGCP 441 & EGCP 471).

All mathematics and physical science courses required for the degree must be completed with at least a “C-” (1.7) to count as prerequisite courses to engineering courses or as credit towards the degree. All core courses in the major must be passed with a “C-” (1.7) or better.

Transfer students from local community colleges should refer to the website [assist.org](http://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 120A\* - Introduction to Programming (2)
- CPSC 120L\* - Introduction to Programming Laboratory (1)
- CPSC 121A - Object-Oriented Programming (2)
- CPSC 121L - Object-Oriented Programming Laboratory (1)
- CPSC 131 - Data Structures (3)
- CPSC 351 - Operating Systems Concepts (3)
- EGCP 180 - Digital Logic and Computer Structures (3)
- EGCP 280 or EGEE 280 - Microcontrollers (3)
- EGCP 281 EGEE 281 - Designing with VHDL (2)
- EGCP 371 - Modeling and Simulation of Signals and Systems (3)
- EGCP 381 - Computer Design and Organization (4)
- EGCP 401, EGCE 401, or EGEE 401 - Engineering Economics and 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 (2)
- 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)

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

- EGEE 323 - Engineering Probability and Statistics (3)

### ***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 120A and CPSC 120L) 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 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 or EGEE 461 - Low Power Digital IC Design (3)
- EGEE 410 - Electro-Optical Systems (3)
- EGEE 455 - Microelectronics and Nano Devices (3)
- EGEE 465 - Introduction to VLSI Design (3)
- EGEE 480 - Optical Engineering and Communications (3)

#### ***Control Systems and Systems Engineering***

- EGEE 416 - Feedback Control Systems (3)

#### ***Global Positioning Systems (GPS)***

- EGEE 483 - Introduction to Global Positioning Systems (GPS) (3)
- EGEE 483L - Global Positioning System Lab (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 349 - Web Front-End Engineering (3)
- CPSC 431 - Database and Applications (3)
- CPSC 474 - Parallel and Distributed Computing (3)

#### ***Multimedia and Digital Game Development***

- CPSC 386 - Introduction to Game Design and 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 - Introduction to Machine Learning (3)

### ***Hardware Security***

- EGCP 447 - Introduction to Cyber-Physical Systems Security (3)

### ***Current Topics***

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

### ***Free Elective***

- Adviser-approved course (3)

## ***Mathematics and Science Foundation Courses (31 Units)***

### ***Mathematics Requirement (19 units)***

- MATH 150A - Calculus I (4)
- MATH 150B - Calculus II (4)
- MATH 250A - Calculus III (4)
- MATH 250B - Introduction to Linear Algebra and Differential Equations (4)
- MATH 170A - Mathematical Structures I (3)

### ***Science Requirement (12 units)***

- PHYS 225 - Fundamental Physics: Mechanics (3)
- PHYS 226 - Fundamental Physics: Electricity and Magnetism (3)
- PHYS 227 - Fundamental Physics: Waves, Optics, and Modern Physics (1-3)
- PHYS 225L - Fundamental Physics: Laboratory (1)
- PHYS 226L - Fundamental Physics: Laboratory (1)
- PHYS 227L - Fundamental Physics: Laboratory (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 2 courses:

- EGCP 441 - Advanced Electronics for Computer Engineers (4)
- EGCP 471 - Multidisciplinary Projects in Computer Engineering - II (2)

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 (GE) Requirements***

All students at CSUF are expected to complete prescribed units of General Education that are made up of courses outside of their chosen disciplines. Students seeking a degree in Engineering have been provided exceptions from some of the General Education requirements. For this reason, it is important that students take the approved GE courses for Engineering majors that are found in

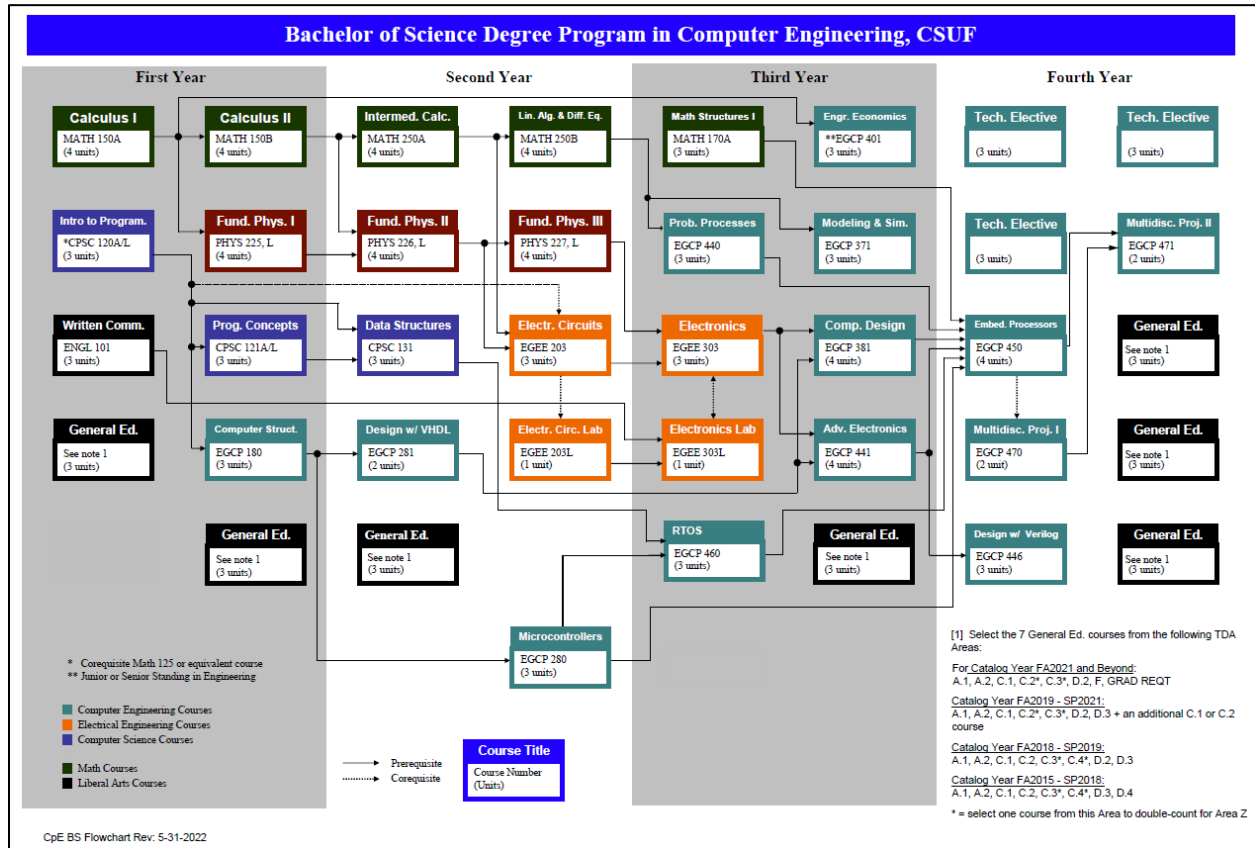
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their Titan Degree Audit (TDA). Additionally, they should confirm the GE courses that are required within their specific programs with their respective advisers.

## 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 below. The flowchart provides the recommended timetable to complete the program in 4 years. This curriculum flowchart is carefully laid out to satisfy the prerequisite requirements.



## 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 CpE 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 CpE 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. For more information, please see the [ECS Academic Internship website](#).

## ***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 the 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 Notice and Disqualification***

A student whose overall GPA and/or semester GPA falls below 2.0 will be placed on academic notice and have their registration placed on hold until the student sees the Program Academic Advisor and attends an Academic Notice Workshop administered by the College of ECS. The student must seek counsel from their adviser and attend the academic notice workshop prior to enrolling in the following semester. Normally, repeating the course and petitioning for exclusion in the GPA calculation will clear the academic notice. Continued academic notice 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:

- Partnership for Applied Computer Engineering (PACE)
- 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)***

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)

Prerequisite: CPSC 120; or CPSC 120A and CPSC 120L

#### ***EGCP 280 - Microcontrollers (3)***

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) (EGCP 280 and EGEE 280 are the same course.)

Prerequisite: EGCP 180 or EGEE 245

#### ***EGCP 281 - Designing with VHDL (2)***

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) (EGCP 281 and EGEE 281 are the same course.)

Prerequisites: CPSC 120; or CPSC 120A and CPSC 120L; or CPSC 121; or CPSC 121A and CPSC 121L; EGCP 180 or EGEE 245

#### ***EGCP 371 - Modeling and Simulation of Signals and Systems (3)***

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.

Prerequisite: MATH 250B

***EGCP 381 - Computer Design and Organization (4)***

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).

Prerequisites: EGCP 281, EGEE 303

***EGCP 401 - Engineering Economics and Professionalism (3)***

Development, evaluation, and presentation of design alternatives for engineering systems and projects using principles of engineering economy and cost-benefit analysis. Engineering profession, professional ethics, and related topics. (Not available for use on graduate study plans.) (EGEE 401, EGCE 401, EGCP 401, and EGME 401 are the same course.)

Prerequisites: MATH 150A; Engineering or Computer Science major; junior or senior standing

***EGCP 441 - Advanced Electronics for Computer Engineers (4)***

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)

Prerequisites: EGCP 281, EGEE 303

***EGCP 446 - Advanced Digital Design using Verilog HDL (3)***

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.

Prerequisite: EGCP 441

***EGCP 447 - Introduction to Cyber-Physical Systems Security (3)***

Hardware trojan detection; physical and invasive attacks; side-channel attacks; intellectual property piracy; circuit obfuscation; passive and active metering; physical unclonable functions; cryptographic algorithms; introduction to cyber-physical systems and IoT security; security threats and vulnerabilities in cyber-physical systems.

Prerequisite: EGCP 281 or graduate standing

***EGCP 450 - Embedded Processor Interfacing (4)***

Techniques of interfacing based on speed, timings, synchronization, interrupts, protocols, noise, and race conditions. Interfacing specifications of the processor data, address and control buses. (2 hours lecture, 4 hours laboratory)

Prerequisites: EGCP 280, EGCP 381, EGCP 441, EGEE 323, CPSC 351, MATH 170A

***EGCP 456 - Introduction to Logic Design in Nanotechnology (3)***

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.

Prerequisite: EGCP 180 or EGEE 245

### ***EGCP 461 - Low Power Digital IC Design (3)***

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. (EGCP 461 and EGEE 461 are the same course.)

Prerequisites: EGCP 180 or EGEE 245; EGEE 303

### ***EGCP 463 - Current Topics in Computer Engineering (3)***

Topics of contemporary interest from the perspective of current research and development in computer engineering. Lectures by guest professionals.

Prerequisites: Engineering or Computer Science major; junior or senior standing

### ***EGCP 470 - Multidisciplinary Projects in Computer Engineering - I (2)***

The first course in the two-course senior design sequence. Student teams develop 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.

Corequisite: EGCP 450

### ***EGCP 471 - Multidisciplinary Projects in Computer Engineering - II (2)***

Second course in the two-course senior design course in which student teams develop a hardware/software project under the supervision of the instructor. Develop design skills, based upon previous and current courses and laboratory experience. (4 hours laboratory)

Prerequisites: EGCP 450, EGCP 470

### ***EGCP 499 - Independent Study (1-3)***

Independent study or research under the direction of a full-time faculty member. May be repeated for a maximum of 6 units. Requires application for independent study approved by the instructor and the Computer Engineering Program Coordinator.

Prerequisite: senior standing

## ***Computer Science (CPSC) Courses***

### ***CPSC 120A - Introduction to Programming (2)***

Introduction to the concepts underlying computer programming to accomplish desired tasks, including: designing and executing programs; sequential nature of programs; using variables and assignment; control flow; input/output; designing and using functions; structured and object-oriented methodologies.

Corequisite: CPSC 120L, MATH 125 or MATH 116

### ***CPSC 120L - Introduction to Programming Laboratory (1)***

Introduction to the concepts underlying computer programming to accomplish desired tasks, including: designing and executing programs; sequential nature of programs; using variables and

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assignment; control flow; input/output; designing and using functions; Structured and object-oriented methodologies.

Corequisite: CPSC 120A, MATH 125 or MATH 116

### ***CPSC 121A - Object-Oriented Programming (2)***

Object-oriented programming paradigm, including classes, objects, member variables and functions, exceptions, inheritance, templates, encapsulation, decoupling and class design best practices. Advanced program design, including iterators, operator overloading, recursion and dynamic memory allocation.

Prerequisite: CPSC 120; or CPSC 120A and CPSC 120L; or passing score on Computer Science Placement Exam. Corerequisite: CPSC 121L.

### ***CPSC 121L - Object-Oriented Programming Laboratory (1)***

Application of object-oriented programming concepts including classes, objects, member variables and functions, exceptions, inheritance, templates, encapsulation, decoupling, and class design best practices. Activities also include advanced program design including iterators, operator overloading, recursion, and dynamic memory allocation.

Prerequisite: CPSC 120; or CPSC 120A and CPSC 120L; or passing score on Computer Science Placement Exam. Corerequisite: CPSC 121A.

### ***CPSC 131 - Data Structures (3)***

Classical data structures: vector, linked list, stack, queue, binary search tree, and graph representations. Worst-case analysis, amortized analysis, and big-O notation. Object-oriented and recursive implementation of data structures. Self-resizing vectors and self-balancing trees. Empirical performance measurement.

Prerequisite: CPSC 121; or CPSC 121A and CPSC 121L or sufficient score on the Computer Science Placement Exam

### ***CPSC 351 - Operating Systems Concepts (3)***

Resource management, memory organization, input/output, control process synchronization and other concepts as related to the objectives of multi-user operating systems.

Prerequisite: CPSC 131 or Computer Science or Computer Engineering graduate standing

### ***CPSC 332 - File Structures and Database Systems (3)***

Fundamental theories and design of database systems, the Structured Query Language (SQL), basic concepts and techniques of data organization in secondary storage. Topics include introduction to database systems, ER model, relational model, index structures and hashing techniques.

Prerequisites: CPSC 131; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 335 - Algorithm Engineering (3)***

Algorithm design using classical patterns: exhaustive search, divide and conquer, randomization, hashing, reduction, dynamic programming, and the greedy method. Asymptotic and experimental efficiency analysis. NP-completeness and decidability. Implementing algorithms to solve practical problems.

Prerequisites: MATH 170B, CPSC 131; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 349 - Web Front-End Engineering (3)***

Concepts and architecture of interactive web applications, including markup, stylesheets and behavior. Functional and object-oriented aspects of JavaScript. Model-view design patterns, templates and frameworks. Client-side technologies for asynchronous events, real-time interaction and access to back-end web services.

Prerequisite: CPSC 131 or Computer Science or Computer Engineering graduate standing

### ***CPSC 362 - Foundations of Software Engineering (3)***

Basic concepts, principles, methods, techniques and practices of software engineering. All aspects of the software engineering fields. Use Computer-Aided Software Engineering (CASE) tools.

Prerequisites: CPSC 131; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 386 - Introduction to Game Design and Production (3)***

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.

Prerequisites: CPSC 121; or CPSC 121A and CPSC 121L; completion of G.E. Category B.4; or Computer Science or Computer Engineering graduate standing

### ***CPSC 431 - Database and Applications (3)***

Database design and application development techniques for a real world system. 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.

Prerequisites: CPSC 332; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 462 - Software Design (3)***

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.

Prerequisites: CPSC 362; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 463 - Software Testing (3)***

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.

Prerequisites: CPSC 362; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 464 - Software Architecture (3)***

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.

Prerequisites: CPSC 362; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 466 - Software Process (3)***

Practical guidance for improving the software development process. How to establish, maintain and improve software processes. Exposure to agile processes, ISO 12207 and CMMI.

Prerequisite: CPSC 362 or Computer Science or Computer Engineering graduate standing

### ***CPSC 471 - Computer Communications (3)***

Introduction to digital data communications. Terminology, networks and their components, common-carrier services, telecommunication facilities, terminals, error control, multiplexing and concentration techniques.

Prerequisites: CPSC 351; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 474 - Parallel and Distributed Computing (3)***

Concepts of distributed computing; distributed memory and shared memory architectures; parallel programming techniques; inter-process communication and synchronization; programming for parallel architectures such as multi-core and GPU platforms; project involving distributed application development.

Prerequisites: CPSC 351; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 481 - Artificial Intelligence (3)***

Using computers to simulate human intelligence. Production systems, pattern recognition, problem solving, searching game trees, knowledge representation and logical reasoning. Programming in AI environments.

Prerequisites: CPSC 335, MATH 338; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 483 - Introduction to Machine Learning (3)***

Design, implement and analyze machine learning algorithms, including supervised learning and unsupervised learning algorithms. Methods to address uncertainty. Projects with real-world data.

Prerequisites: CPSC 335, MATH 338; Computer Science or Computer Engineering major or minor; or Computer Science or Computer engineering graduate standing

### ***CPSC 484 - Principles of Computer Graphics (3)***

Examine and analyze computer graphics, software structures, display processor organization, graphical input/output devices, display files. Algorithmic techniques for clipping, windowing, character generation and viewpoint transformation.

Prerequisites: CPSC 131, MATH 150B, MATH 170B, junior or senior standing; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 486 - Game Programming (3)***

Survey of 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.

Prerequisites: CPSC 386, CPSC 484; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

### ***CPSC 489 - Game Development Project (3)***

Individually or in teams, students design, plan and build a computer game.

Prerequisites: CPSC 486; Computer Science or Computer Engineering major or minor; or Computer Science or Computer Engineering graduate standing

## ***Electrical Engineering (EGEE) Courses***

### ***EGEE 280 - Microcontrollers (3)***

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) (EGCP 280 and EGEE 280 are the same course.)

Prerequisite: EGCP 180 or EGEE 245

### ***EGEE 281 - Designing with VHDL (2)***

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) (EGCP 281 and EGEE 281 are the same course.)

Prerequisites: CPSC 120; or CPSC 120A and CPSC 120L; or CPSC 121; or CPSC 121A and CPSC 121L; EGCP 180 or EGEE 245

### ***EGEE 203 - Electric Circuits (3)***

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.

Prerequisites: PHYS 226, MATH 250A. Corequisite: CPSC 120; or CPSC 120A and CPSC 120L; or EGME 205

### ***EGEE 203L - Electric Circuits Laboratory (1)***

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)

Pre- or corequisite: EGEE 203

### ***EGEE 303 - Electronics (3)***

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.

Prerequisites: PHYS 227, EGEE 203

***EGEE 303L - Electronics Laboratory (1)***

Semiconductor diodes, transistors and elementary electronic circuits through hard-wired breadboarding, CAD electronic simulation and analysis. (3 hours laboratory)

Prerequisites: EGEE 203L, ENGL 101. Corequisite: EGEE 303

***EGEE 323 - Engineering Probability and Statistics (3)***

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.

Prerequisite: MATH 250A or MATH 170B

***EGEE 401 - Engineering Economics and Professionalism (3)***

Development, evaluation and presentation of design alternatives for engineering systems and projects using principles of engineering economy and cost benefit analysis. Engineering profession, professional ethics and related topics. (Not available for use on graduate study plans.) (EGEE 401, EGCE 401, EGCP 401 and EGME 401 are the same course.)

Prerequisites: MATH 150A; Engineering or Computer Science major; junior or senior standing

***EGEE 410 - Electro-Optical Systems (3)***

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.

Prerequisite: EGEE 311

***EGEE 416 - Feedback Control Systems (3)***

Feedback control system characteristics; stability in the frequency and time domains; analysis and design of continuous-time systems using root-locus, Bode and Nyquist plots, Nichols chart and applications.

Prerequisite: EGEE 409; or graduate standing

***EGEE 443 - Electronic Communication Systems (3)***

Principles of amplitude, angular and pulse modulation, representative communication systems, the effects of noise on system performance.

Prerequisites: EGEE 310, EGEE 323

***EGEE 455 - Microelectronics and Nano Devices (3)***

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.

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Prerequisites: EGEE 303, EGEE 311; or graduate standing

***EGEE 460 - Introduction to Cellular Mobile Communications Systems (3)***

Introduction to wireless mobile telecommunications, description and analysis of cellular radio systems, co-channel interference reduction, channel capacity and digital cellular systems.

Prerequisite: EGEE 443; or graduate standing

***EGEE 461 - Low Power Digital IC Design (3)***

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. EGCP 461 and EGEE 461 are the same course.

Prerequisites: EGCP 180 or EGEE 245; EGEE 303

***EGEE 465 - Introduction to VLSI Design (3)***

Computer-aided design of VLSI circuits. MOS device structure, design rules, layout examples and 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.

Prerequisite: EGEE 245, EGEE 303

***EGEE 480 - Optical Engineering and Communications (3)***

Optics review, lightwave fundamentals, integrated optic waveguides, first design of fiber optic system, analog and digital modulation, digital fiber optic system design, baseband coding, digital video transmission, optical emitters and receivers, coherent optical communication, measurements in fiber optic telecommunication.

Prerequisite: EGEE 311, PHYS 227; or graduate standing

***EGEE 483 - Introduction to Global Positioning Systems (GPS) (3)***

Description of Global Positioning Systems (GPS) and Differential Global Positioning Systems (DGPS), GPS navigation, errors. Satellite signals and co-ordinate transform math. Modeling for position and velocity. Application to navigation.

Corequisite: EGEE 409 or EGCP 371

***EGEE 483L - Global Positioning System Lab (2)***

Novatel, Magelon, Ahstek, Collins and Tribel receivers. Computing GPS and GEO stationary satellite positions from ephemeris data available on almanac. Calculate and compensate errors, such as selective availability, ionospheric, tropospheric and satellite ad receiver, in the data. (1 hour lecture, 3 hours laboratory)

Corequisite: EGEE 483

***General Engineering (EGGN) Course***

***EGGN 495 - Professional Practice (1-3)***

Professional engineering work in industry or government. Written report required. May be taken for credit for a maximum of three units. Applicable towards bachelor's degree programs. Not for credit in the graduate program.

Prerequisites: Engineering major; junior or senior standing

### ***Related Courses for Computer Engineering Majors***

#### ***MATH 150A - Calculus I (4)***

Properties of functions. The limit, derivative and definite integral concepts; applications of the derivative, techniques and applications of integration. Six units of credit are given for both MATH 130 and MATH 150A, or for both MATH 135 and MATH 150A. Biology, geology and earth science majors who pass ALEKS must take MATH 130. CBE majors who pass ALEKS must take MATH 135.

Prerequisite: passing score on ALEKS; or passing score or exemption on MQE; or MATH 125 with C (2.0) or better

#### ***MATH 150B - Calculus II (4)***

Techniques of integration, improper integrals and applications of integration. Introduction to differential equations. Parametric equations, sequences and series.

Prerequisite: MATH 150A

#### ***MATH 250A - Calculus III (4)***

Calculus of functions of several variables. Partial derivatives and multiple integrals with applications. Parametric curves, vector-valued functions, vector fields, line integrals, Green's Theorem, Stokes' theorem, the Divergence Theorem, vectors and the geometry of 3-space.

Prerequisite: MATH 150B

#### ***MATH 250B - Introduction to Linear Algebra and Differential Equations (4)***

Introduction to the solutions of ordinary differential equations and their relationship to linear algebra. Topics include matrix algebra, systems of linear equations, vector spaces, linear independence, linear transformations and eigenvalues.

Prerequisite: MATH 250A

#### ***MATH 170A - Mathematical Structures I (3)***

First of two semesters of fundamental discrete mathematical concepts and techniques needed in computer-related disciplines. Logic, truth tables, elementary set theory, proof techniques, combinatorics and Boolean algebra. Must have completed four years of high school mathematics.

#### ***PHYS 225 - Fundamental Physics: Mechanics (3)***

Classical Newtonian mechanics; linear and circular motion; energy; linear/angular momentum; systems of particles; rigid body motion; wave motion and sound.

Prerequisite: MATH 150A with a C- (1.7) or better. Corequisite: PHYS 225L

#### ***PHYS 225L - Fundamental Physics: Laboratory (1)***

Laboratory for PHYS 225. Instructional fee required. (3 hours laboratory)

Corequisite: PHYS 225

### ***PHYS 226 - Fundamental Physics: Electricity and Magnetism (3)***

Electrostatics, electric potential, capacitance, dielectrics, electrical circuits, resistance, emf, electromagnetic induction, magnetism and magnetic materials, and introduction to Maxwell's equations.

Prerequisites: MATH 150B, PHYS 225 with a C (2.0) or better. Corequisite: PHYS 226L

### ***PHYS 226L - Fundamental Physics: Laboratory (1)***

Laboratory for PHYS 226. Instructional fee required. (3 hours laboratory)

Corequisite: PHYS 226

### ***PHYS 227 - Fundamental Physics: Waves, Optics, and Modern Physics (1-3)***

Geometrical and physical optics, wave phenomena; quantum physics, including the photoelectric effect, line spectra and the Bohr atom; the wave nature of matter, Schrodinger's equation and solutions; the Uncertainty Principle, special theory of relativity.

Prerequisite: PHYS 226 with a C (2.0) or better. Corequisite: PHYS 227L, except for Biochemistry, Chemistry and Mechanical Engineering majors, who may enroll for one unit (optics component); all others must enroll for three units

### ***PHYS 227L - Fundamental Physics: Laboratory (1)***

Laboratory for PHYS 227. Instructional fee required. (3 hours laboratory)

Corequisite: PHYS 227

## ***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.

<b>Bachelor of Science in Computer Engineering - Progress Worksheet</b>						
<b>Course</b>	<b>Title</b>	<b>CSUF</b>			<b>Transfer</b>	
		Semester	Grade	Units	Institution	Course #
<b>Core Courses (56 Units)</b>						
CPSC 120A	Introduction to Programming			2		
CPSC 120L	Introduction to Programming Lab			1		
CPSC 121A	Object Oriented Programming			2		
CPSC 121L	Object Oriented Programming Lab			1		
CPSC 131	Data Structures			3		
CPSC 351	Operating Systems			3		
EGCP 180	Digital Logic & Comp.			3		
EGCP/EE 280	Microcontrollers			3		
EGCP/EE 281	Designing with VHDL			2		
EGCP 371	Mod. & Sim. Of Signals			3		
EGCP 381	Comp. Design & Org.			4		
EGCP/CE/EE 401	Engineering Econ & Prof			3		
EGCP 441 <sup>†</sup>	Advanced Electronics			4		
EGCP 446	Adv. Digital Design using Verilog HDL			3		
EGCP 450	Emb. Proc. Interfacing			4		
EGCP 470 <sup>†</sup>	Multidisc. Projects I			2		

<sup>†</sup> Satisfies upper-division writing requirement if a grade of "C" (2.0) or better is earned



EGCP 471	Multidisc. Projects II			2		
EGEE 203	Electric Circuits			3		
EGEE 203L	Electric Circuits Lab			1		
EGEE 303	Electronics			3		
EGEE 303L	Electronics Lab			1		
EGEE 323	Probability & Statistics			3		
<b>Math &amp; Science Course (31 Units)</b>						
MATH 150A	Calculus I			4		
MATH 150B	Calculus II			4		
MATH 250A	Intermed. Calc.			4		
MATH 250B	Lin. Alg. & Diff. Eq			4		
MATH 170A	Mathematical Struct. I			3		
PHYS 225	Fund Phys, Mech			3		
PHYS 225L	Fund Phys, Mech Lab			1		
PHYS 226	Fund Phys, E&M			3		
PHYS 226L	Fund Phys, E&M Lab			1		
PHYS 227	Fund Phys, Modern			3		
PHYS 227L	Fund Phys, Mod Lab			1		
<b>Technical Electives (9 Units; 12 units if CPSC 120 is waived)</b>						
				3		
				3		
				3		
				3		

### ***Disclaimer***

This handbook is intended as a quick reference for BS students of computer engineering. In case of any discrepancies between the contents of this handbook and those of College and/or University documents (University Catalog, for example), the contents of the latest version of relevant College and/or University documents (as applicable) shall take precedence over the contents of this handbook.