CALIFORNIA STATE UNIVERSITY

FULLERTON

MASTER OF SCIENCE
IN
COMPUTER ENGINEERING

Department of Electrical & Computer Engineering

College of Engineering & Computer Science
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MS-COMPUTER ENGINEERING HANDBOOK
TABLE OF CONTENTS

DISCLAIMER

This handbook is intended as a reference for helping graduate students pursuing the MS degree program in Computer Engineering. In case of any discrepancies between the contents of this handbook and those of College and/or University documents (e.g., University Catalog), the contents of the latest version of relevant College and/or University documents (as applicable) shall take precedence over the contents of this handbook.

INTRODUCTION

This handbook summarizes useful information pertaining to the Master of Science (MS) degree program in Computer Engineering. This degree program is offered by the department of Electrical and Computer Engineering (ECE).

Over the past decade, there has been a rapid increase in demand for Computer Engineers in various fields ranging from the area of mobile devices (iPad, iPhone, etc.) to high-performance computing systems needed for e-prescription and electronic health record-keeping. This trend only continues to grow.

The department is committed to providing exciting academic programs. It strives to combine the best facilities along with a driven faculty and an innovative curriculum to prepare students for the great engineering challenges of the 21st century.

The MS degree program in Computer Engineering is designed to provide students with a strong understanding of the hardware design and practical applications of computer-based systems. Students in the program must complete all the requirements for the MS degree with a total of 30 semester units. The courses in contemporary and highly evolving Computer Engineering areas provide students with extensive hardware design and modeling experience, exposure to state-of-the-art Electronic Design Automation (EDA) tools, and the ability to design and analyze today's modern computer systems. Students are also encouraged to take approved graduate elective courses in Electrical Engineering and/or Computer Science from the respective departments to expand their background. After completion of the degree program, graduates will have extensive theoretical knowledge and practical background in all aspects of computer-based systems, along with in-depth knowledge in engineering analysis, design, implementation, and testing. The program will prepare students for engineering jobs that require computer software and hardware skills.

The Master's degree program in Computer Engineering is open to students who have earned a bachelor's degree in Computer Engineering or a related discipline.

ADMISSION REQUIREMENTS

General Requirements

In order to meet the minimum requirements for admission, you must have completed a four-year college course of study and hold an acceptable baccalaureate degree from an institution accredited by a regional accrediting association, be in good academic standing at the last college or University

attended, and have attained a minimum/cumulative grade point average of 2.50 (4.0-point system) from your coursework.

At the time of admission into the MS program, students should have the following:

- Minimum GPA of 2.5 for applicants who graduated from domestic (US) institutions with undergraduate degrees in engineering or computer science
- Minimum GPA of 2.5 for applicants who graduated from ABET-accredited international institutions with undergraduate degrees in engineering or computer science
- Minimum GPA of 3.0 for applicants who graduated from domestic (US) institutions with undergraduate degrees other than engineering or computer science
- Minimum GPA of 3.0 for applicants with undergraduate degrees in engineering or computer science from non-ABET accredited international institutions

NOTE*: You are considered under the international admission requirements if you have received your degree outside the US – regardless of your visa status or if you are currently living in the US.*

Additional Information for International Students

TOEFL/IELTS/PTE Examination

If your native language is not English or if your education was not in a majority English-language speaking country, you must submit TOEFL (Test of English as a Foreign Language) or IELTS (International English Language Testing System) scores before your application can be processed.

Test	Minimum Score
TOEFL	80 on the internet-based version
IELTS	6.5
PTE	58

You must submit TOEFL/IELTS 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.

You have two options to submit your test score:

1. You can have your test score sent by the testing service to CSUF (the school code is 4589)
2. Or you can submit an official scorecard along with your supporting documents to the following:

International Admissions

2600 Nutwood Avenue, Suite 950

Fullerton, CA 92831. USA

Additional Graduate Admissions Information

Additional information regarding graduate admissions in the College of Engineering and Computer Science (ECS) can be obtained at the following website: http://www.fullerton.edu/ecs/future/graduate-admission.php

IMPORTANT POLICIES, FORMS, AND EVENTS

Graduate Advising Policies

Students are expected to read this handbook completely before meeting with the graduate advisor.

Besides meeting the graduate advisor to develop the Study Plan, Computer Engineering graduate students may meet the graduate adviser to discuss prerequisites and deficiencies and progress toward degree completion. Students must be able to produce a physical hardcopy of their Graduate Department Recommendation (GDR) form during advising sessions.

Graduate advising is available during instructional weeks of the fall and spring semesters only. This does not include final exam weeks.

Graduate advising is **not available** during holidays, breaks, recess, intersession, and summer. Student emails pertaining to graduate advising, course scheduling, prerequisites, etc., that are sent during these periods may not receive a response until the subsequent regular semester (fall/spring) has started. Students should plan early so that they can avail themselves of the services before the start of the final exam week of a regular semester (fall/spring).

Graduate advising is **not available via email**. Students must meet the graduate adviser during scheduled advising sessions. Email may not be used as a substitute for attending advising sessions. Emails used in lieu of attending graduate advising sessions will not be entertained. Students should send emails for follow-up purposes only if needed.

Attendance

Students are expected to attend all their classes, **including classes in the first week of a semester/session**. Failure to attend the first day of class may result in the student being dropped from the course.

Graduate Department Recommendation (GDR) form

Students must retain the GDR form received at the time of admission. All conditions and deficiencies/prerequisites listed on the form must be completed unless a waiver is granted by the graduate advisor. However, the courses taken toward meeting such deficiencies/prerequisites do not earn credit toward the degree. Students must be able to produce their physical hardcopy GDR form during advising sessions.

Catalog Year

A student is governed by the policies, procedures, and regulations specified in the University Catalog for the academic year in which the student starts the program, **not** the academic year in which admission to the program was offered or accepted. For example, if a student has been accepted into the program for the term starting in the fall 2023 semester, then the effective catalog year for that student will be the 2023-24 academic year catalog, even if the student accepted admission in the previous academic year. Students are urged to read relevant sections of the specific University Catalog pertaining to them and make themselves familiar with the information in the Catalog. In case of any discrepancy between the contents of this handbook and those in the relevant University Catalog, the contents of the Catalog take precedence over the handbook.

New Student Orientation (NSO)

Newly admitted computer engineering graduate students are urged to attend the New Student Orientation (NSO), which is typically held before the start of the semester. It is an excellent opportunity to meet with the Vice-Chair, Chair, or Graduate Advisor. Important policies and course offerings are typically discussed during the NSO.

Communication of Policies, Procedures, and Deadlines

Graduate students may receive communication from various individuals and/or campus offices regarding various policies, procedures, and deadlines pertaining to graduate students. These include, but are not limited to, the office of the Department of Electrical and Computer Engineering (ECE), Graduate Advisor, Vice-Chair, Chair, Office of Graduate Studies (OGS), members of the graduate committee, ECS Dean's office, Admissions and Records (A&R), and International Student Services (ISS). The modes of communication may include emails, text messages, memos, letters, or phone calls. Computer Engineering graduate students are expected to follow instructions and follow up on such communication in a timely manner.

DEGREE REQUIREMENTS

In order to obtain the M**S** degree in Computer Engineering, a student must complete 30 semester units of coursework beyond the Bachelor's degree, which will be included in a formal Study Plan.

Residence Requirement

A minimum of 21 semester units required by the program must be taken in residence at CSUF. Residence units are granted for courses taken at the University during regular sessions of fall and spring and any special session.

Only courses taken at CSUF during or after the official start term of the student's MS degree in the Computer Engineering program are considered "in-residence." The start term is the semester

in which the MS program of the student starts, not the semester/term in which the student accepted admission.

Continuous Enrollment

Students are required to maintain continuous enrollment every fall and spring. Unless a leave of absence is granted, a graduate student who fails to maintain continuous enrollment needs to reapply for admission and meet any new admissions requirements and any new degree completion requirements at the time of re-entry.

Students who have enrolled in all Study Plan coursework and are working on the culminating experience should register in GRAD 700 to maintain continuous enrollment. Registration in GRAD 700 is necessary until the degree is granted.

Study Plan

****IMPORTANT**:

- Students are permitted to take **only one** ***approved*** 400-level elective as part of the Computer Engineering MS degree program, irrespective of your exit option.
- **Students must take only those approved elective courses that they intend to use to earn their degree.**

In the first week of classes of the first regular semester of enrollment (fall/spring), a hardcopy Study Plan must be submitted to the graduate advisor during the graduate advising session along with supporting documentation. Email submissions will **not** be accepted. Possible outcomes are either the acceptance of the Study Plan or rejection. In case of rejection, it is the student's responsibility to meet with the graduate advisor and submit a new study plan. Students are urged to plan early to complete this process in a timely manner.

The Study Plan must be approved by the Computer Engineering graduate advisor. Courses taken towards meeting the undergraduate degree requirements or towards meeting deficiencies/prerequisites cannot be used towards earning credit for the MS degree.

Changes in Study Plan

****IMPORTANT**:

- Students are permitted to take **only one** ***approved*** 400-level elective as part of the Computer Engineering MS degree program, irrespective of your exit option.
- **Students must take only those approved elective courses that they intend to use to earn their degree.**

If a graduate student needs to make a change in the approved Study Plan, a request should be made to the student's departmental Graduate Program Advisor. A hardcopy Request for Change of Study Plan form must be submitted to the graduate advisor during regular graduate advising sessions. **Requests must be made prior to registration for any coursework to be substituted or added. No course may be removed from the Study Plan after a student has taken it.**

Changes in Study Plans may also be required because of outdated coursework or grade-point average deficiencies.

Core Courses

Out of the 30 semester units required for the MS degree, 12 units must be comprised of required core courses. Students are advised to take core/required courses as soon as they are offered so that they can plan for timely graduation. These courses are listed below:

- EGCP 447 - Introduction to Cyber-Physical Systems Security (3 units)
- EGCP 463 - Current Topics in Computer Engineering (3 units)
- EGCP 520 - Advanced Computer Architecture (3 units)
- EGCP 540 - Computer Arithmetic Structures (3 units)

Culminating Experience

The culminating experience can be met through any one of the following options: Thesis, Project, or Comprehensive Examination. These culminating experience options are outlined below:

Option 1 (Thesis)

In addition to the 12 units of core courses, this option requires 12 units of approved elective courses (out of which a maximum of 3 units may be at 400-level), and the culminating experience met through 6 units of Thesis (EGCP 598). The 6 units must be taken in 3-unit intervals.

Thesis calls for multiple responsibilities and requirements on the part of the student. These include, but are not limited to:

- Identifying a thesis advisor who is interested in the area of research the thesis is focused on.
- Developing a thesis topic, the set of research outcomes, and a list of mutually agreed-upon deliverables and timelines.
- Meeting with the thesis advisor at a frequency determined by the advisor and at mutually agreed-upon times.
- Following the advisor's guidance and advice regarding the progression, development, and writing of the thesis.
- Adhering to the thesis writing guidelines and timelines of the University.

- Completing the thesis document and thesis defense to the satisfaction of the thesis committee.
- Submitting the thesis to the University by the appropriate deadlines.

On average, the time commitment for thesis ranges from two to three semesters.

Before enrolling in the thesis, a thesis proposal must be submitted to the supervising full-time faculty member of the department and graduate adviser no later than **March 15** if the student wishes to enroll in thesis in the following fall semester. On the other hand, if the student wishes to enroll for thesis in the spring semester, then the thesis proposal must be submitted to the supervising full-time faculty member of the department and graduate adviser no later than **October 15**.

To enroll in the thesis, a student shall first choose a faculty advisor and then, in consultation with the faculty advisor, choose a thesis committee consisting of 3 faculty members, including the faculty advisor. The thesis should cover original research and be prepared according to the university guidelines. The thesis committee will judge the research competence of the student during the thesis defense. The student is also required to complete an oral defense, a demo (if applicable), and a final thesis report by the deadlines set for the spring semester of the 4th year. The thesis defense is announced in advance and is open to the university community.

Option 2 (Project)

In addition to the 12 units of core courses, this option requires EGCP 543 Advanced Cyber-Physical Systems Security (3 units), 12 units of approved elective courses (out of which a maximum of 3 units may be at 400-level), and the culminating experience met through 3 units of project.

The project (EGCP 597) course is designed to replicate a full spectrum of design processes that are involved in a medium-sized computer engineering project in industry. The experience includes a creative design effort with realistic socio-economic constraints and the development of skills such as feasibility study, project planning, design formulation, time budgeting, task division among team members, oral, written, and visual communication to document and disseminate the design adequately to others. The project requires students to think independently, research, and brainstorm different project concepts before settling on a project that meets several criteria set forth by the Computer Engineering program. Students are provided with systematic faculty guidance during the project to ensure a well-rounded experience.

Project calls for multiple responsibilities and requirements on the part of the student. These include, but are not limited to:

- Identifying a project advisor who is interested in the area of the project that the student is proposing.
- Developing a project topic, the set of project outcomes, the project implementation plan, and a list of mutually agreed-upon deliverables and timelines.
- Meeting with the project advisor at a frequency determined by the advisor and at mutually agreed-upon times.

- Following the advisor's guidance and advice regarding the progression, development, implementation, and presentation of the project.
- Adhering to the project report writing guidelines and agreed-upon timelines.
- Developing the project report in consultation with and to the satisfaction of the advisor.
- Developing and submitting the project report to the satisfaction of the project committee.
- Completing the project presentation and Q&A to the satisfaction of the project committee.

On average, the time commitment for a project ranges from one to two semesters.

Before enrolling in the project, a project proposal must be submitted to the supervising full-time faculty member of the department and the graduate adviser no later than **March 15** if the student wishes to enroll in project in the following fall semester. On the other hand, if the student wishes to enroll for project in the spring semester, then the project proposal must be submitted to the supervising full-time faculty member of the department and graduate adviser no later than **October 15.**

The project option requires the presentation of project work, a demo (as applicable), and a question-and-answer session that may include questions related to the core courses as well as the project work. The presentation, demo, and question and answer session shall be done in the presence of the supervising faculty member and one or more members of the department graduate committee.

Option 3 (Comprehensive Examination)

In addition to the 12 units of core courses, this option requires EGCP 543-Advanced Cyber-Physical Systems Security (3 units), EGCP 548-Real-Time Audio and Language Processing (3 units), 12 units of approved elective courses (out of which a maximum of 3 units may be at 400-level), and the culminating experience met through a comprehensive examination.

The comprehensive exam is normally conducted as a one-day written exam and is based on the set of core courses specified for this exit option, which also includes EGCP 543 and EGCP 548. Normally, the comprehensive exam will be based on three courses selected from the set of six core courses (including EGCP 543 and EGCP 548). Students will be informed of the day and time of the comprehensive exam at least one week in advance. The exam can be up to three hours long (not including breaks/overheads) and may be held on any day except Sunday. Students must plan their schedules accordingly.

To pass the comprehensive exam, a student must pass all courses included in the comprehensive exam. Otherwise, the result will be a "fail." A student who fails the comprehensive exam in a given semester cannot graduate that semester. However, a student who fails the comprehensive exam in a given semester can appear for the comprehensive exam in the subsequent regular semester (fall/spring). It **should be noted,** though, that the comprehensive exam of a subsequent semester may be based on different courses as compared to the comprehensive exam of the previous semesters (i.e., any three out of the six core courses may be selected for the comprehensive exam of a subsequent semester).

Approved Technical Elective Courses

****IMPORTANT**:

- Students are permitted to take **only one** ***approved*** 400-level elective as part of the Computer Engineering MS degree program, irrespective of your exit option.
- **Students must take only those approved elective courses that they intend to use to earn their degree.**

The technical electives shall constitute a coherent body of study consistent with the student's professional and educational objectives. All Computer Engineering MS students are required to complete 12 units of approved elective courses (out of which **a maximum of 3 units may be at 400-level)**, regardless of the culminating experience option that the student chooses.

Prerequisites for Electives: Prior to enrolling in any approved elective course, Computer Engineering graduate students are urged to ensure that they meet all the prerequisite requirements for that course. It is the student's responsibility to ensure that he/she has the background knowledge and preparation required to enroll and successfully complete the course.

A list of approved elective courses is given below. Course prefixes are designated as EGCP for computer engineering courses, EGEE for electrical engineering courses, and CPSC for computer science courses.

The department may offer, from time to time, additional computer engineering elective courses that are not listed here. Information about these courses may be obtained from the department office.

If a student wishes to utilize a course that is not on the list below to meet the elective requirements for the MS degree in computer engineering, then prior approval from the graduate advisor is required before enrolling in that course. Examples include EGCP 597, EGCP 598, EGCP 599, and any other newly introduced elective course related to computer engineering. EGCP 599 also requires prior approval after consulting with supervising faculty and the graduate adviser. The deadlines to seek approval are the same as specified for Thesis (EGCP 598) and Project (EGCP 599).

Requests related to course scheduling and approvals for EGCP 597, EGCP 598, and EGCP 599 are not considered during holidays, breaks, recess, intersession, and summer. Students are strongly encouraged to plan well in advance.

- EGCP 440 - Implementation of Probabilistic Processes on Embedded Systems (3 units)
- EGCP 441 - Advanced Electronics for Computer Engineers (4 units)
- EGCP 446 - Advanced Digital Design using Verilog HDL (3 units)
- EGCP 450 - Embedded Processor Interfacing (4)
- EGCP 456 - Introduction to Logic Design in Nanotechnology (3 units)

- EGCP 460 - Real-Time Operating Systems for Embedded Systems (3 units)
- EGCP 461 - Low Power Digital IC Design (3 units)
- EGCP 541 – Mixed-Signal IC Design (3 units)
- EGCP 542 – VLSI Testing and Design for Testability (3 units)
- EGCP 543 - Advanced Cyber-Physical Systems Security (3 units)[1]
- EGCP 548 - Real-Time Audio and Language Processing (3 units)[1]
- EGCP 556 – Advanced Nanoelectronics (3 units)
- EGCP 565 - Rapid Prototyping for Internet of Things (3 units)
- EGEE 404 - Introduction to Microprocessors and Microcomputers (3 units)
- EGEE 406 – Design Applications with Microcontroller and FPGA (3 units)
- EGEE 410 - Electro-Optical Systems (3 units)
- EGEE 416 - Feedback Control Systems (3 units)
- EGEE 420 - Introduction to Digital Filtering (3 units)
- EGEE 442 - Electronic Circuits (3 units)
- EGEE 443 - Electronic Communication Systems (3 units)
- EGEE 445 - Digital Electronics (3 units)
- EGEE 448 - Digital Systems Design with FPGA (3 units)
- EGEE 455 - Microelectronics and Nano Devices (3 units)
- EGEE 460 - Introduction to Cellular Mobile Communications Systems (3 units)
- EGEE 465 - Introduction to VLSI Design (3 units)
- EGEE 480 - Optical Engineering and Communications (3 units)
- EGEE 483 - Introduction to Global Positioning Systems (GPS) (3 units)
- EGEE 483L - Global Positioning System Lab (2 units)
- EGEE 510 - Optics & Electromagnetics in Communications (3 units)
- EGEE 518 - Digital Signal Processing I (3 units)
- EGEE 522 - Spread Spectrum Communications (3 units)
- EGEE 523A - VLSI and Nano Technology and Devices (3 units)
- EGEE 523B - CMOS VLSI Design (3 units)
- EGEE 526 - Digital Control Systems (3 units)
- EGEE 529 - Principles of Neural Systems (3 units)
- EGEE 537 - Satellite Communications (3 units)
- EGEE 557 - Microprogramming and Embedded Microprocessors (3 units)
- EGEE 558B - Microprocessors and Systems Applications II (3 units)
- EGEE 559 - Introduction to Robotics (3 units)
- EGEE 580 - Analysis of Random Signals (3 units)
- EGEE 582 - Linear Estimation Theory (3 units)
- CPSC 431 - Database and Applications (3 units)
- CPSC 449 - Web Back-End Engineering (3 units)
- CPSC 452 - Cryptography (3 units)
- CPSC 454 - Cloud Computing and Security (3 units)
- CPSC 455 - Web Security (3 units)

[1] If not taken for culminating experience

- CPSC 458 - Malware Analysis (3 units)
- CPSC 462 - Software Design (3 units)
- CPSC 463 - Software Testing (3 units)
- CPSC 464 - Software Architecture (3 units)
- CPSC 466 - Software Process (3 units)
- CPSC 471 - Computer Communications (3 units)
- CPSC 474 - Parallel and Distributed Computing (3 units)
- CPSC 479 - Introduction to High Performance Computing (3 units)
- CPSC 481 - Artificial Intelligence (3 units)
- CPSC 483 - Introduction to Machine Learning (3 units)
- CPSC 484 - Principles of Computer Graphics (3 units)
- CPSC 485 - Computational Bioinformatics (3 units)
- CPSC 486 - Game Programming (3 units)
- CPSC 489 - Game Development Project (3 units)
- CPSC 515 - Mobile Computing (3 units)
- CPSC 531 - Advanced Database Management (3 units)
- CPSC 533 - Applied Algorithms (3 units)
- CPSC 535 - Advanced Algorithms (3 units)
- CPSC 541 - Systems and Software Standards and Requirements (3 units)
- CPSC 542 - Software Verification and Validation (3 units)
- CPSC 543 - Software Maintenance (3 units)
- CPSC 544 - Advanced Software Process (3 units)
- CPSC 545 - Software Design and Architecture (3 units)
- CPSC 546 - Modern Software Management (3 units)
- CPSC 547 - Software Measurement (3 units)
- CPSC 549 - Web Application Frameworks (3 units)
- CPSC 552 - Cyber Forensics (3 units)
- CPSC 558 - Advanced Computer Networking (3 units)
- CPSC 559 - Advanced Blockchain Technologies (3 units)
- CPSC 566 - Advanced Computer Graphics (3 units)
- CPSC 583 - Expert Systems Design Theory (3 units)
- CPSC 585 - Artificial Neural Networks (3 units)
- EGGN 403 - Computer Methods in Numerical Analysis (3 units)

Elective courses other than those listed in the list of electives may be allowed after graduate adviser approval.

Time Limit for Completion

All requirements for the graduate degree, including all coursework on the student's Study Plan, normally should be completed within 5 years. This time limit begins with the semester of the earliest course used on the student's Study Plan and consists of a total of 10 consecutive semesters. When individual circumstances warrant, this time limit may be extended for up to 2 years (4 additional consecutive semesters).

A student may request an extension of the five-year time limit by requesting the graduate adviser at least one year prior to the expiration of the original five-year limit. The request must contain a full explanation of the circumstances that prevented completion of the degree requirements within the normal five-year limit. The student must also review the policies related to extension and coursework. If the student's request is satisfactory, the graduate adviser can then submit the Time Limit Extension Petition to the University. The student's extension request may be approved or denied by the University. Approvals for an extension must be obtained prior to the expiration of the five-year limit.

Applying for Graduation

Students must apply for a graduation check and pay the graduation and diploma fee prior to the deadline.

The last date to file the application is listed in the Registration Guide for each regular semester and is posted on the Graduate Studies website:

https://www.fullerton.edu/graduate/academics/deadlines.php

Students who fail to complete requirements as planned must update the application for a graduation check and do so by the appropriate deadline. A fee is required to change the graduation date. The forms for changing the graduation date are on the Graduate Studies website: Forms and Documents - Graduate Studies | CSUF

Graduation and Commencement

The effective date of graduation will be the last day of the specific term in which requirements are completed.

Commencement ceremonies are held only at the end of the spring semester. Once you have completed the graduation check process (i.e., filed for graduation check and paid the graduation fee), you are eligible to participate in the commencement ceremonies appropriate to your graduation date. Students completing requirements at the end of the fall and spring semesters and during the following summer may participate in those ceremonies.

Information concerning commencement activities is sent to students from the college dean's office, usually in April of each year. Check the University's website for further details about commencement events and procedures. Arrangements for cap, gown, and hood purchases are to be made in the campus bookstore at Titan Shops.

GRADE POINT AVERAGE (GPA) REQUIREMENTS

Grade Point Average (GPA) is measured on a 0-4.0 scale and is calculated by dividing the total number of grade points accumulated by the number of units attempted. For a 3-unit course, the relation between the various letter grades and grade points is as follows:

- A+ 12 points (4 points per unit x 3 units = 12 points for 3 units)
- A 12 points

- A- 11.1 points
- B+ 9.9 points
- B 9 points
- B- 8.1 points
- C+ 6.9 points
- C 6 points
- C- 5.1 points
- D+ 3.9 points
- D 3 points
- D- 2.1 points
- F 0 points

The "+/-" grading system may not be used in some courses. In such courses, the possible letter grades are A, B, C, D, and F.

A GPA of at least 3.0 is required for graduation with a graduate degree. This grade point average applies to (1) **all 400-level and 500-level courses attempted from any department or program subsequent to admission to a degree program, including any courses transferred from another institution** (*Graduate GPA*); and (2) all courses required on the graduate study plan, including transfer courses (*Study Plan GPA*). Both the Graduate GPA and Study Plan GPA must be maintained at 3.0 or higher on a 4.0 scale.

To earn credit, each individual course on the Study Plan must be completed with a grade of "C" or better.

A master's degree student may request a change in the Study Plan in order to raise the Study Plan grade point average by:

1. adding no more than six units of approved coursework, or
2. repeating no more than six units of coursework in which a "C" (2.0) or lower was earned, or
3. a combination of 1. and 2. not to exceed six units.

Requests to add courses to the Study Plan, repeat courses, or add courses to raise the overall grade point average must be approved by the Graduate Program Advisor and the Associate Vice President for Academic Programs (or designee) prior to registration. When a course is added or repeated, the original course remains on the Study Plan and on the student's transcript, and both grades are used in calculating the student's grade point average.

REPEATED COURSES, ACADEMIC NOTICE, AND DISQUALIFICATION

Repeated Courses

For Master's degree students, if a grade less than "C" is received in a Study Plan course, the course must be repeated and passed with a grade of "C") or better. A course may be repeated only once. If a course is repeated, both grades are included when computing the student's Study Plan and cumulative Cal State Fullerton grade point average. Repetition of a course carries no additional unit credit toward the degree; however, the additional units are included in the cumulative units shown on the Cal State Fullerton transcript.

In extenuating circumstances, the student may petition the Associate Vice President for Academic Affairs (or designee) to add another course to the approved program with the unit value equivalent to that of the course in which the unsatisfactory grade was received.

Academic Notice

A student enrolled in a graduate degree program will be placed on academic notice if either the graduate GPA or the Study Plan GPA falls below 3.0. A graduate student may also be placed on academic notice for reasons other than graduate and/or Study Plan grade point average. This is known as administrative-academic notice. The reasons for this may include repeated withdrawal, failure to progress toward an educational objective, non-compliance with an academic requirement, failure to demonstrate a level of professional competence or fitness commensurate with the standards of the student's discipline, or inappropriate behavior as defined in the Student Bill of Rights and Responsibilities and in the Academic Dishonesty sections of this Catalog (see "University Regulations").

Master's degree students will be allowed two semesters on academic notice before being subject to disqualification. Students will remain on administrative-academic notice contingent upon conditions required for their continuing in the program. The Graduate Studies Office maintains a list of students on academic notice and subject to disqualification.

Disqualification

The Associate Vice President, Academic Programs (or designee), in consultation with the student's Graduate Program Advisor, will disqualify a master's student who is on

probation if the student does not, or cannot, raise the Study Plan and graduate grade point average to 3.0 by the completion of the second regular semester following the semester in which the grade point average fell below the minimum 3.0 standard.

If a student's grade point average becomes so low that it cannot be raised to 3.0 within the prescribed limits of coursework, the student will be disqualified from the graduate degree program.

Students placed on probation for reasons other than grade point average will be disqualified if:

1. the conditions for removal of administrative-academic notice are not met within the period specified
2. the student becomes subject to academic probation while on administrative-academic notice or
3. the student is removed from administrative-academic probation and subsequently becomes subject to administrative-academic notice for the same or similar reasons as originally placed on academic notice.

TRANSFER CREDIT POLICY

Graduate students may request to apply a limited amount of transfer coursework toward unit requirements for a graduate degree. The use of transfer coursework on a student's Study Plan is subject to the following provisions.

I. Each course being transferred must:
   a. Have been taken at an accredited College or University
   a. Be acceptable for credit toward a graduate degree at the institution where the coursework was taken
   b. Have been completed with a grade of "B" (3.0) or better
   c. Not have been used in meeting the requirements for another earned degree (either graduate or undergraduate)
   d. Have been completed during the 12 months immediately prior to the student's graduation from the undergraduate program if the courses were CSUF courses taken as a CSUF undergraduate student;
   e. And have been completed within the student's five-year time period that is required for completion of the requirements for the graduate degree at CSUF

2. A minimum of 21-semester units required by the program must be taken in residence at CSUF. Residence units are granted for courses taken at the University during regular sessions of fall and spring and any special session. A student who is admitted into the MS program in Computer Engineering at CSUF after attending another CSUF program, from within the same department or outside, may be able to transfer a limited amount of coursework from the previously enrolled program. However, the maximum amount of coursework that may be transferable is 9 units, including any computer engineering courses completed before the student's official start term in the MS Computer Engineering program, subject to the rules indicated in part 1 above.

3. Any transfer of coursework is not automatic. The student must petition the graduate advisor or Vice-Chair requesting for transfer. Transfer of coursework is completed only upon approval by the department and the University.

4. If a CSUF undergraduate student completes a 500-level graduate course or a 400-level course that is allowed to be on the graduate study plan and receives credit towards the undergraduate program, then such a course cannot be used to get credit toward the MS degree program at CSUF. If the course used to receive undergraduate credit is listed as a core course for the MS program, then the student must petition the graduate adviser to substitute a different course in lieu of the course used to obtain credit towards the

undergraduate program. In the case that the course is listed as an elective, a different approved elective must be taken. The rules specified in the aforementioned parts of this section still apply.

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 may get involved in one or more of the following several 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

The approved courses included in the MS in Computer Engineering graduate curriculum are given below. **Note** that **only one 400-level approved elective is allowed**. **Students must take only those approved elective courses that they intend to use to earn their degree.**

Computer Engineering (EGCP) Courses

EGCP 440 - Implementation of Probabilistic Processes on Embedded Systems

Prerequisite: MATH 250B; or graduate standing.

Continuous random variables, probability distributions and density functions, the law of large numbers, and the central limit theorem, sample mean and variance, estimating distributions, correlation, regression, and hypothesis testing implemented on Embedded Systems. (3 units)

EGCP 446 Advanced Digital Design using Verilog HDL

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. (3 units)

EGCP 447 Introduction to Cyber-Physical Systems Security

Prerequisite: EGCP 281

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. (3 units)

EGCP 450 Embedded Processor Interfacing

Prerequisite: EGCP 280, EGCP 381, EGCP 441, EGEE 323, CPSC 351, MATH 270A

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) (4 units)

EGCP 456 Introduction to Logic Design in Nanotechnology

Prerequisites: EGCP 180 or EGEE 245

Promising novel nanoelectronic technologies and logic primitives for such technologies, applicable basic logic design technique, design models for spatial dimensions, applicable world-level data structures, multilevel circuit design, testability and observability, tolerance and reliable computing. (Same as EGEE 456) (3 units)

EGCP 460 - Real-Time Operating Systems for Embedded Systems

Prerequisites: CPSC 131, EGCP 280 or EGEE 280.

Fundamentals of Real-Time Operating Systems (RTOS) for embedded systems, including thread communication and synchronization, real-time scheduling, memory and process management, file systems and management, and commercially-available RTOS. (3 units)

EGCP 461 Low Power Digital IC Design

Prerequisites: EGCP 180 or EGEE 245; 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) (3 units)

EGCP 463 Current Topics in Computer Engineering

Prerequisites: junior/senior standing in computer engineering and consent of instructor

Topics of contemporary interest from the perspective of current research and development in computer engineering. Lectures by guest professionals. (3 units)

EGCP 520 Advanced Computer Architecture

Prerequisite: EGCP 381

Performance analysis and evaluation, limitations of scalar pipelines, superpipelined, superscalar and VLIW processing, parallelism in programs, memory and I/O systems, out-of-order execution,

branch prediction, register and memory data flow techniques, Tomasulo's algorithm, COTS hardware accelerators, CUDA, GPU programming architecture. (3 units)

EGCP 540 Computer Arithmetic Structures

Prerequisite: EGCP 381 or EGEE 407

Suitability of signed binary number systems for high-speed arithmetic, normalized and denormalized binary floating-point representation formats, high-speed algorithms, implementations and design tradeoffs for fast arithmetic operations addition, subtraction, multiplication and division, floating point arithmetic. (3 units)

EGCP 541 Mixed-Signal IC Design

Prerequisite: EGCP 441

IC design techniques for: Op-amps, phase-locked loops (PLL), high-speed RF circuits, high- speed broadband circuits, clock/data recovery (CDR) circuits, analog and optical signal processing circuits, CMOS digital camera technologies. (3 units)

EGCP 542 VLSI Testing and Design for Testability

Prerequisite: EGCP 441

Fault model, equivalence and dominance, combinational and sequential circuit test generation, design for testability (DFT), test compression, memory testing and diagnosis, boundary scan, testing analog circuits, mixed-signal testing strategies, logic and mixed signal Built-In Self-Test (BIST). (3 units)

EGCP 543 Advanced Cyber-Physical Systems Security

Prerequisites: EGCP 447

Secure cyber-physical design and implementation; cryptographic hardware primitives; cryptographic modules; trusted platforms; reverse engineering of cryptographic modules using passive/active attacks; and cryptanalytic techniques, countermeasures against reverse engineering, threats to cyber-physical systems in various domains, such as network and IoT. (3 units)

EGCP 548 Real-Time Audio and Language Processing

Prerequisites: CSPC 121

Introduction to designing, developing, and implementing audio and language processing algorithms, in real-time, on dedicated processors. (3 units)

EGCP 556 Advanced Nanoelectronics

Prerequisite: EGCP 456

Novel nanoelectronic devices, CAD Analysis of nanoelectronic devices, Advanced MOSFETs—SOI, FinFETs, SiGe, carbon nanotubes and ribbons, nanowires, quantum devices: RTD, tunnel FET, qubits, nanomemory, DRAM, flash, M/F RAM, spin torque devices. (3 units)

EGCP 565 - Rapid Prototyping for Internet of Things

Prerequisite: CPSC 121

Introduction to Internet of Things (IoT), IoT network architecture and design, application protocols for IoT, data and analytics for IoT, integration of embedded devices in web-based, distributed applications, and prototyping IoT devices. (3 units)

EGCP 570 - Introduction to Digital VLSI Logic Design and Computer Organization

Prerequisites: EGCP 180, EGEE 245; or Computer Engineering or Electrical Engineering graduate standing.

Introduction to digital VLSI design (MOSFETs, logic design, timing issues), FPGA design with HDL, computer architecture (CPU structure and function, instruction set). (3 units)

EGCP 597 Project

Prerequisite: Consent of graduate advisor and program coordinator. Classified graduate students only.
Project proposal must be approved prior to last day of class instruction of the preceding semester. (3 units)

EGCP 598 Thesis

Prerequisite: consent of graduate advisor and program coordinator. Classified graduate students only. Thesis proposal must be approved prior to last day of class instruction of the preceding semester. (6 units)

EGCP 599 Independent Graduate Research

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. It may be repeated for a maximum of 3 total units of credit. (1 - 3 units)

Electrical Engineering (EGEE) Courses - Approved Electives

EGEE 404 Introduction to Microprocessors and Microcomputers

Prerequisite: EGEE 245L, EGEE 280; or graduate standing.

Hardware and software concepts in microprocessors, processor family chips, system architecture, CPU, input/output devices, interrupts and DMA, memory (ROM, RAM), electrical and timing characteristics, assembly language programming. (3 units)

EGEE 406 - Design Applications with Microcontroller and FPGA

Prerequisites: EGEE 245, EGEE 245L, EGEE 280; or graduate standing.

Digital system application design using microcontrollers, FPGAs and CPLDs including programming hardware interfacing, A/D conversion, CLB, logic arrays, interconnections, testing and simulations. (3 units)

EGEE 410 Electro-Optical Systems

Prerequisite: EGEE 311

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. (3 units)

EGEE 416 Feedback Control Systems

Prerequisite: EGEE 409

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. (3 units)

EGEE 420 - Introduction to Digital Filtering

Prerequisite: EGEE 409

Discrete-time signals and systems; solution of difference equations; Fourier transform for a sequence; Z-transform; discrete Fourier transform; FIR and IIR realizations; design of digital filters. (3 units)

EGEE 442 - Electronic Circuits

Prerequisite: EGEE 310 or graduate standing.

Power amplifiers and tuned amplifiers; RF amplifiers; modulation and detection circuits; oscillators; and operational amplifier applications. (3 units)

EGEE 443 Electronic Communication Systems

Prerequisites: EGEE 310 and 323 or equivalent

Principles of amplitude, angular and pulse modulation, representative communication systems, the effects of noise on system performance. (3 units)

EGEE 445 - Digital Electronics

Prerequisites: EGEE 245, EGEE 303; or graduate standing.

RC circuits, attenuators, compensation and scope probe. Logic circuits: DTL, TTL, STTL, LSTTL and ECL. Fanout, noise-immunity, switching speed, power consumption, input-output characteristics. Design and analysis of MOS logic circuits; PMOS, NMOS and CMOS gates, flip-flops, shift registers and memory circuits. (3 units)

EGEE 448 - Digital Systems Design with FPGA

Prerequisites: EGEE 245, EGEE 281, EGEE 303.

Basic concepts and characteristics of digital systems, traditional logic design, LSI/VLSI logic design with VHDL, combinational and sequential logic, and their applications; timing and control, race conditions and noise, microcomputers, computer-aided programming, development systems, microcomputer system hardware design, input/output devices. (3 units)

EGEE 455 Microelectronics and Nano Devices

Prerequisites: EGEE 303 and 311

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. (3 units)

EGEE 460 Introduction to Cellular Mobile Communications Systems

Prerequisite: EGEE 443

Introduction to wireless mobile telecommunications, description and analysis of cellular radio systems, co-channel interference reduction, channel capacity and digital cellular systems. (3 units)

EGEE 465 Introduction to VLSI Design

Prerequisites: EGEE 245 and 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. (3 units)

EGEE 480 Optical Engineering and Communications

Prerequisites: EGEE 311 and PHYS 227

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 in optical fiber, optical emitters and receivers, coherent optical communication, measurements in fiber optic telecommunication. (3 units)

EGEE 483 Introduction to Global Positioning Systems (GPS)

Corequisite: EGEE 409 or EGCP 371

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. (3 units)

EGEE 483L - Global Positioning System Lab

Corequisite: EGEE 483

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.(2 units)

EGEE 510 Optics and Electromagnetics in Communications

Prerequisite: EGEE 480

Plane-wave propagation and reflection from multiple layers; two- and three-dimensional boundary value problems; waveguides and resonant cavities; radiation from apertures and antennas;

electromagnetic properties of materials, gases and plasmas; significant coverage of engineering applications. (3 units)

EGEE 518 Digital Signal Processing

Prerequisite: EGEE 420

Discrete Fourier transform; fast Fourier transform; Chirp Z-transform; discrete time random signals; floating-point arithmetic; quantization; finite word length effect in digital filters; spectral analysis and power spectrum estimation. (3 units)

EGEE 522 Spread Spectrum Communications

Prerequisites: EGEE 443 and 580

Introduction to Spread Spectrum (SS.) Systems. Performance analysis of coherent digital signaling schemes. Synchronization. Direct sequence, frequency hopping, time hopping and Hybrid Spread Spectrum Modulations. Binary shift register sequences. Code tracking loops. Performance of SS systems in a jamming environment, with forward error correction. (3 units)

EGEE 523A VLSI and Nano Technology and Devices

Prerequisite: EGEE 455 or equivalent

Silicon crystal, PN junction physics, oxide and interface physics, wafer fabrication technology; oxidation, diffusion, ion-implantation, epitaxy,

photolithography, thin films process. Layout design principle for integrated circuits. Nano-electronic devices and technology. (3 units)

EGEE 523B CMOS VLSI Design

Prerequisites: EGEE 465 and EGEE 448 or equivalent.

Surface physics of MOS system, MOS device physics. Short channel effect; hot carrier effect, subthreshold conduction. CMOS fabrication process. Layout design rules. Scaling design and analysis of CMOS circuits. Standard cell method. CAD design and SPICE simulation. (3 units)

EGEE 526 Digital Control Systems

Prerequisite: EGEE 416

Analysis, design and implementation of digital control systems; Z-transform methods; frequency domain and state-space approach for discrete-time systems. (3 units)

EGEE 529 - Principles of Neural Systems

Prerequisites: EGEE 310, EGEE 409 or graduate standing.

Principles of neural systems and their hardware implementation. Basic properties, discrete and continuous bidirectional associative memories. Temporal associative memories. Neural nets classifiers, perceptrons, supervised and unsupervised learning. Forward and backward propagation. Electrical models of neural networks using op-amp., analog VLSI. (3 units)

EGEE 537 Satellite Communications

Prerequisite: EGEE 443

Satellite systems, link analysis, propagation effects, SNR/CNR calculations, modulation schemes, TDMA, FDMA, CDMA techniques. (3 units)

EGEE 557 Microprogramming and Embedded Microprocessors

Prerequisites: EGEE 412 and EGEE 448

Introduction to microprogramming concepts and applications to the control unit of a computer, microprogrammable control, arithmetic-logic unit, implementation of an embedded process on FPGA and interfacing with external memories. (3 units)

EGEE 558A Microprocessors and System Applications I

Prerequisites: EGEE 404 and 404L

Microprocessors and micro-computers, their related software systems, system design with microprocessors, applications in peripheral controllers, communication devices and multiprocessing systems. (3 units)

EGEE 558B Microprocessors and Systems Applications II

Prerequisite: EGEE 558A

Advanced microprocessor architecture and their applications to microcomputer networking; RISC VS CISC architectures, communication protocol, distributed-operating system, and local area networks. (3 units)

EGEE 559 Introduction to Robotics

Prerequisite: EGEE 416 or consent of instructor

Science of robotics from an electrical engineering standpoint, including modeling, task planning, control, sensing, and robot intelligence. (3 units)

EGEE 580 Analysis of Random Signals

Prerequisites: EGEE 323 and 409 or equivalent

Random processes pertinent to communications, controls, and other physical applications, Markov sequences and processes, the orthogonality principle. (3 units)

EGEE 582 - Linear Estimation Theory

Prerequisites: EGEE 580, EGEE 581.

Mathematical models of continuous-time and discrete-time stochastic processes; the Kalman filter, smoothing and suboptimal filtering computational studies. (3 units)

Computer Science (CPSC) Courses - Approved Electives

CPSC 411 Mobile Device Application Programming

Prerequisite: CPSC 131

Introduction to developing applications for mobile devices, including but not limited to runtime environments, development tools and debugging tools used in creating applications for mobile devices. Use emulators in lab. Students must provide their own mobile devices. (3 units)

CPSC 431 Database and Applications

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. (3 units)

CPSC 449 - Web Back-End Engineering

Prerequisite: CPSC 332

Design and architecture of large-scale web applications. Techniques for scalability, session management and load balancing. Dependency injection, application tiers, message queues, web services and REST architecture. Caching and eventual consistency. Data models, partitioning and replication in relational and non-relational databases. (3 units)

CPSC 452 Cryptography

Prerequisites: MATH 170B and CPSC 131;

Introduction to cryptography and steganography. Encryption, cryptographic hashing, certificates, and signatures. Classical, symmetric-key, and public-key ciphers. Block modes of operation. Cryptanalysis including exhaustive search, man-in-the-middle, and birthday attacks. Programing projects involving implementation of cryptographic systems. (3 units)

CPSC 454 Cloud Computing and Security

Prerequisites: CPSC 351 and CPSC 253

Cloud computing and cloud security, distributed computing, computer clusters, grid computing, virtual machines and virtualization, cloud computing platforms and deployment models, cloud programming and software environments, vulnerabilities and risks of cloud computing, cloud infrastructure protection, data privacy and protection. (3 units)

CPSC 455 - Web Security

Prerequisites: CPSC 351 or CPSC 353

Concepts of web application security. Web security mechanisms, including authentication, access control and protecting sensitive data. Common vulnerabilities, including code and SQL attacks, cross-site scripting and cross-site request forgery. Implement hands-on web application security mechanisms and security testing. (3 units)

CPSC 456 Network Security Fundamentals

Prerequisite: CPSC 351

Learn about vulnerabilities of network protocols, attacks targeting confidentiality, integrity and availability of data transmitted across networks, and methods for diagnosing and closing security gaps through hands-on exercises. (3 units)

CPSC 458 - Malware Analysis

Prerequisite: CPSC 351

Introduction to principles and practices of malware analysis. Topics include static and dynamic code analysis, data decoding, analysis tools, debugging, shellcode analysis, reverse engineering of stealthy malware and written presentation of analysis results. (3 units)

CPSC 459 - Blockchain Technologies

Prerequisites: CPSC 351, CPSC 253 or CPSC 452

Digital assets as a medium of exchange to secure financial transactions; decentralized and distributed ledgers that record verifiable transactions; smart contracts and Ethereum; Bitcoin mechanics and mining; the cryptocurrency ecosystem; blockchain mechanics and applications. (3 units)

CPSC 462 Software Design

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. (3 units)

CPSC 463 Software Testing

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. (3 units)

CPSC 464: Software Architecture

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. (3 units)

CPSC 466 Software Process

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. (3 units)

CPSC 471 Computer Communications

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. (3 units)

CPSC 474 Parallel and Distributed Computing

Prerequisite: CPSC 351

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. (3 units)

CPSC 479 - Introduction to High Performance Computing

Prerequisites: CPSC 351

Introduction to the concepts of high-performance computing and the paradigms of parallel programming in a high level programming language, design and implementation of parallel algorithms on distributed memory, machine learning techniques on large data sets, implementation of parallel algorithms. (3 units)

CPSC 481 Artificial Intelligence

Prerequisite: CPSC 335 and MATH 338

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. (3 units)

CPSC 483 Introduction to Machine Learning

Prerequisite: CPSC 335 and MATH 338

Design, implement and analyze machine learning algorithms, including supervised learning and unsupervised learning algorithms. Methods to address uncertainty. Projects with real-world data. (3 units)

CPSC 484 Principles of Computer Graphics

Prerequisites: CPSC 131, MATH 150B, and MATH 170B

Examine and analyze of computer graphics; software structures, display processor organization, graphical input/output devices, display files. Algorithmic techniques for clipping, windowing, character generation and viewpoint transformation. (3 units)

CPSC 485 - Computational Bioinformatics

Prerequisites: CPSC 131

Algorithmic approaches to biological problems. Specific topics include motif finding, genome rearrangement, DNA sequence comparison, sequence alignment, DNA sequencing, repeat finding and gene expression analysis. (3 units)

CPSC 486 Game Programming

Prerequisite: CPSC 386 and CPSC 484

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. (3 units)

CPSC 489 Game Development Project

Prerequisite: CPSC 486

Individually or in teams, student design, plan and build a computer game. (3 units)

CPSC 515 - Mobile Computing

Wireless systems and communication fundamentals; IoT protocols for wireless software development; sensor network systems; techniques for native and cross-platform mobile application development; mobile connectivity; integration of mobile applications with cloud services. CPSC 471 recommended. (3 units)

CPSC 531 Advanced Database Management

Implementation techniques for query analysis, data allocation, concurrency control, data structures, and distributed databases. New database models and recent developments in database technology. Student projects directed to specific design problems. CPSC 431 recommended (3 units)

CPSC 533 - Applied Algorithms

Primer on data structures and algorithms applicable to software development and professional meetings. Lists, queues, search trees and hashing. Sorting and searching. Graph structures, traversal, paths and spanning. Design methods: asymptotic analysis, greedy methods, divide and conquer, and dynamic programming. CPSC 121 recommended. (3 units)

CPSC 535 - Advanced Algorithms

Design and analysis of sophisticated algorithms and data structures. Lower, tight and pseudo-polynomial bounds. Randomization, approximation and special-purpose data structures. Algorithmic frameworks, such as maximum flow and linear programming. CPSC 335 recommended. (3 units)

CPSC 541 Systems and Software Standards and Requirements

SESC framework and the IEEE Software Engineering Standards. -Establishing the following standards: Software Life Cycle Processes, Work Product Standards, Process Standards, Requirement Analysis and Management and System Integration. Introduces CMMI framework; discuss number of practical lessons. CPSC 362 recommended. (3 units)

CPSC 542 Software Verification and Validation

Theory and practice of software verification and validation (V&V), including software integrity levels, minimum V&V tasks, walkthroughs, inspections and clean room. Topics include: white-

box and black-box testing, boundary value analysis, equivalence class partitioning, unit testing, functional testing and test plans. CPSC 362 recommended. (3 units)

CPSC 543 Software Maintenance

Theory and practice of maintaining large-scale software. Maintenance framework, process, measures, and process management. Topics include fundamentals of software change and its implications, maintenance process models, reusability for maintenance, reverse engineering, maintenance testing, software configuration management and tools in maintenance. CPSC 362 recommended. (3 units)

CPSC 544 Advanced Software Process

Advanced guidance for defining and improving the software development process. Concepts of software maturity framework, principles of process improvement and software process assessment. Current topics such as CMMI and SCAMPI. CPSC 362 recommended. (3 units)

CPSC 545 Software Design and Architecture

Advanced software design and architecture principles focusing a software engineering approach to the development process. Topics include architecture business cycle, quality attributes, attribute-driven design method, architectural styles, design patterns, software product lines and component-based design. CPSC 362 recommended. (3 units)

CPSC 546 Modern Software Management

Modern project management methodologies and techniques. Software development process. Planning, estimating, organizing, directing, monitoring, controlling software projects and managing risks. Other related software management issues, such as infrastructure, quality software development, project and product metrics, and external factors. CPSC 362 recommended. (3 units)

CPSC 547 Software Measurement

Current software measurement practices. Topics include: establishing an effective software metrics program; measuring software product, project and process; applying Statistical Process Control and other statistical techniques. High maturity concepts defined in CMMI model will be discussed. Stresses a practitioner-based approach. CPSC 362 recommended. (3 units)

CPSC 549 - Web Application Frameworks

Examine and compare current patterns and models for modern web application development. Analyze front- and back-end web framework design and architecture. Emerging web technologies and current research. CPSC 449 recommended. (3 units)

CPSC 551 Operating Systems Design

Design and evaluation techniques for controlling automatic resource allocation, providing efficient programming environments and appropriate user access to the system, and sharing the problem-solving facilities. CPSC 351 recommended. (3 units)

CPSC 552 - Cyber Forensics

Introduction to principles and practices of cyber forensics. Topics include: developing an investigative capability; legal and IT requirements; forensic tools; incident response; live forensic

investigations; seizure of digital information; operating system boot processes; and investigation of network traffic. CPSC 456 recommended. (3 units)

CPSC 558 Advanced Computer Networking

System-oriented view of computer network design, protocol implementation, networking, high-speed networking, network management, computer network performance issues. CPSC 471 recommended. (3 units)

CPSC 559 - Advanced Blockchain Technologies

Prerequisites: CPSC 459 or CPSC 452

A holistic experience for different types of blockchain development. The ins and outs of blockchain and Ethereum from a developer perspective, along with smart contract security and best practices. (3 units)

CPSC 566 Advanced Computer Graphics

Three-dimensional: reflection models, shading techniques, rendering process, parametric representation, ray tracing, radiosity, texture, anti-aliasing, animation, color science. CPSC 484 recommended. (3 units)

CPSC 583 Expert Systems Design Theory

Knowledge representation and search strategies for expert systems; logic programming; expert system tools; Project. CPSC 481 recommended. (3 units)

CPSC 585 Artificial Neural Networks

Principles of neural networks; neural networks paradigms, software implementations, applications, comparison with statistical methods, use of fuzzy logic; Project. CPSC 481 recommended. (3 units)

General Engineering (EGGN) Courses - Approved Electives

EGGN 403 Computer Methods in Numerical Analysis

Prerequisites: MATH 250B and EGGN 205

Use of numerical methods and digital computers in the solution of algebraic, transcendental, simultaneous, ordinary and partial differential equations. (3 units)

****IMPORTANT**:

- Students are permitted to take **only one** ***approved*** 400-level elective as part of the Computer Engineering MS degree program, irrespective of your exit option.
- **Students must take only those approved elective courses that they intend to use to earn their degree.**