CALIFORNIA STATE UNIVERSITY
FULLERTON
MASTER OF SCIENCE
IN
COMPUTER ENGINEERING

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# COMPUTER ENGINEERING PROGRAM

## GRADUATE HANDBOOK

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INTRODUCTION

Welcome to the Computer Engineering Program (CpE) in the College of Engineering and Computer Science at California State University, Fullerton (CSUF).

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.

CpE 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 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 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 courses from the graduate program in Computer Science and key courses in Electrical Engineering 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

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

1. Have completed a four-year college course of study and hold an undergraduate degree in computer engineering or a related discipline from an ABET-accredited institution, or from an institution accredited by a regional accrediting association
2. Be in good academic standing at the last College or University attended and
3. Have attained a minimum grade point average of 2.5 in cumulative or the last 60 semester units (90 quarter units)

Additional Information for 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.
<table>
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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

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](http://www.fullerton.edu/ecs/future/graduate-admission.php)

DEGREE REQUIREMENTS

In order to obtain the MS 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.

Classified Graduate Standing

A student will obtain the status of Classified Graduate Standing upon the fulfillment of the following requirements:

1. Approval of a formal Study Plan by the Computer Engineering Graduate Advisor or the Program Coordinator and Office of Graduate Studies
2. Satisfactory completion of no more than 13 units on the Study Plan

University Writing Requirement

Competency in written communication in English must be demonstrated through one of the following ways:

- Successfully completing the Computer Engineering Master’s Thesis (EGCP 598) requirements
- Passing ENGL 301, ENGL 360 or TESL 301 with a “C” (2.0) or better
- Or a score of 4.0 or more on the GRE Analytical Writing section
For more information, see the catalog for the University Writing Requirement. The University writing requirement must be satisfied before the student can be classified.

**Study Plan**

Prior to the completion of 13 units towards the MS degree requirements, the student must meet with the graduate advisor and develop a formal Study Plan. The latest version of the CpE Study Plan template can be obtained from the Computer Engineering website or from the office of the CpE Program office.

The Study Plan must be approved by the Computer Engineering graduate advisor or the program coordinator and the Office of Graduate Studies. Courses taken towards meeting the undergraduate degree requirements cannot be used towards the Graduate Study Plan.

**Changes in Study Plan**

If a classified 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. 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. The form which may be used to file a request for a change in the Study Plan is available on the Graduate Studies Website: Forms and Documents - Graduate Studies | CSUF.

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

**Communication of Policies, Procedures, and Deadlines**

CpE 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 CpE office, graduate advisor, program coordinator, Office of Graduate Studies (OGS), members of the CpE graduate committee, ECS Dean’s office, Admissions and Records (A&R), and International Program and Global Engagement (IPGE). The modes of communication may include emails, text messages, memos, letters, or phone calls. CpE graduate students are expected to follow instructions and follow up on such communication in a timely manner.

**Core Courses**

Out of the 30-semester units required for the MS degree, 12 units must be comprised of required core courses. 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.

To enroll in the Thesis (EGCP 598), a student must have Classified Graduate Standing. The 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 open to the university community.

Before enrolling in the Thesis, a Thesis Proposal must be submitted to the CpE office no later than the last day of instruction of the semester preceding the semester in which the student plans to enroll for the Thesis. This form must be signed by a supervising full-time faculty member and by a 2nd faculty reviewer.

**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 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.

To enroll in the Project, a student must have Classified Graduate Standing. Before enrolling in the Project, a Project Proposal must be submitted to the CpE office no later than the last day of instruction of the semester preceding the semester in which the student plans to enroll for the Project. This form must be signed by a supervising full-time faculty member and by a 2nd faculty reviewer.

The Project option requires the presentation of project work, a demo (if applicable), and a question-and-answer session before the supervising faculty member and one or more members of the CpE program 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.

**Approved Technical Elective Courses**

The technical electives shall constitute a coherent body of study consistent with the student’s professional and educational objectives. All CpE 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.

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

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

**Prerequisites for Electives:** Prior to enrolling in any approved elective course, CpE 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.

- CPSC 431 - Database and Applications (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 481 - Artificial Intelligence (3 units)
- CPSC 483 - Introduction to Machine Learning (3 units)
- CPSC 484 - Principles of Computer Graphics (3 units)
- CPSC 486 - Game Programming (3 units)
- CPSC 489 - Game Development Project (3 units)
- CPSC 531 - Advanced Database Management (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 558 - Advanced Computer Networking (3 units)
- CPSC 566 - Advanced Computer Graphics (3 units)
- CPSC 583 - Expert Systems Design Theory (3 units)
- CPSC 585 - Artificial Neural Networks (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 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)
- EGCP 548 - Real-Time Audio and Language Processing (3 units)
- EGCP 556 - Advanced Nanoelectronics (3 units)
- EGEE 404 - Introduction to Microprocessors and Microcomputers (3 units)
- EGEE 410 - Electro-Optical Systems (3 units)
- EGEE 416 - Feedback Control Systems (3 units)
- EGEE 443 - Electronic Communication Systems (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)
- EGGN 403 - Computer Methods in Numerical Analysis (3 units)

**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 filing a petition with the Graduate Studies Office. The petition must contain a full explanation of the circumstances that prevented completion of the degree requirements within the normal five-year limit. The petition must be approved (signed) by the Graduate Program Advisor, the Chair of the appropriate Graduate Program, and the Graduate Studies Office.

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1 If not taken for culminating experience
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.

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 form for changing the graduation date is available 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 graduate 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 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). Each course on the Master’s 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, Graduate Programs and Research (or designee), in consultation with the student’s Graduate Program Advisor, will disqualify a master’s student who is on academic notice 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 academic notice 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 notice while on administrative-academic notice or
3. the student is removed from administrative-academic notice 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 towards unit requirements for a graduate degree. The use of transfer coursework on a student’s Study Plan is subject to the following provisions.

1. 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. And have been completed within the student’s five-year time period, which 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.

**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 core and elective courses included in the graduate curriculum are given below:

**Computer Engineering (EGCP) Courses**

**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 270A
**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 520 - Advanced Computer Architecture (3)**

Performance analysis and evaluation; limitations of scalar pipelines; super-pipelined, 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.

Prerequisite: EGCP 381

**EGCP 540 - Computer Arithmetic Structures (3)**

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.

Prerequisite: EGCP 381 or EGEE 407; or Computer Engineering graduate standing

**EGCP 541 - Mixed-Signal IC Design (3)**

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.

Prerequisite: EGCP 441

**EGCP 542 - VLSI Testing and Design for Testability (3)**

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).

Prerequisite: EGCP 441
**EGCP 543 - Advanced Cyber-Physical Systems Security (3)**

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.

Prerequisite: EGCP 447

**EGCP 548 - Real-Time Audio and Language Processing (3)**

Introduction to designing, developing and implementing audio and language processing algorithms, in real time, on dedicated processors.

Prerequisite: CPSC 121

**EGCP 556 - Advanced Nanoelectronics (3)**

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.

Prerequisite: EGCP 456

**EGCP 570 - Introduction to Digital VLSI Logic Design and Computer Organization (3)**

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

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

**EGCP 597 - Project (3)**

Project proposal must be approved prior to last day of class instruction of the preceding semester. Requires classified graduate status, consent of graduate program adviser and program coordinator. Department consent required.

**EGCP 598 - Thesis (3)**

Thesis proposal must be approved prior to the last day of class instruction of the preceding semester. May be repeated for a maximum of 6 units. Requires classified graduate status, and consent of graduate program adviser and program coordinator. Department consent required.

**EGCP 599 - Independent Graduate Research (1-3)**

Open to graduate students only. Independent study or research under the direction of a full-time faculty member. May be repeated for a maximum of 3 total units of credit. Requires consent of graduate program adviser and program coordinator. Department consent required.

**Computer Science (CPSC) Courses - Approved Electives**

**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)**

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 270B, 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

**CPSC 531 - Advanced Database Management (3)**
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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 541 - Systems and Software Standards and Requirements (3)**
Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 542 - Software Verification and Validation (3)**

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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 543 - Software Maintenance (3)**

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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 544 - Advanced Software Process (3)**

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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 545 - Software Design and Architecture (3)**

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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 546 - Modern Software Management (3)**

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.

Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 558 - Advanced Computer Networking (3)**

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

Prerequisite: Computer Science or Computer Engineering graduate standing
**CPSC 566 - Advanced Computer Graphics (3)**
Three-dimensional: reflection models, shading techniques, rendering process, parametric representation, ray tracing, radiosity, texture, anti-aliasing, animation, color science. CPSC 484 recommended.
Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 583 - Expert Systems Design Theory (3)**
Knowledge representation and search strategies for expert systems; logic programming; expert system tools. Project. CPSC 481 recommended.
Prerequisite: Computer Science or Computer Engineering graduate standing

**CPSC 585 - Artificial Neural Networks (3)**
Principles of neural networks; neural networks paradigms, software implementations, applications, comparison with statistical methods, use of fuzzy logic; project. CPSC 481 recommended.
Prerequisite: Computer Science or Computer Engineering graduate standing

**Electrical Engineering (EGEE) Courses - Approved Electives**

**EGEE 404 - Introduction to Microprocessors and Microcomputers (3)**
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.
Prerequisite: EGEE 245L, EGEE 280; or graduate 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.
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 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

EGEE 510 - Optics & Electromagnetics in Communications (3)
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.
Prerequisite: EGEE 480

**EGEE 518 - Digital Signal Processing I (3)**

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.

Prerequisite: EGEE 420

**EGEE 522 - Spread Spectrum Communications (3)**


Prerequisites: EGEE 443, EGEE 580

**EGEE 523A - VLSI and Nano Technology and Devices (3)**

Silicon crystal, PN junction physics, oxide and interface physics and wafer fabrication technology; oxidation, diffusion, ion-implantation, epitaxy, photolithography and thin films process. Layout design principle for integrated circuits. Nano-electronic devices and technology.

Prerequisite: EGEE 455

**EGEE 523B - CMOS VLSI Design (3)**

Surface physics of MOS system and 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.

Prerequisites: EGEE 465, EGEE 448

**EGEE 526 - Digital Control Systems (3)**

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

Prerequisite: EGEE 416

**EGEE 529 - Principles of Neural Systems (3)**


Prerequisites: EGEE 310, EGEE 409

**EGEE 537 - Satellite Communications (3)**

Satellite systems, link analysis, propagation effects, SNR/CNR calculations, modulation schemes, TDMA, FDMA, and CDMA techniques.

Prerequisite: EGEE 443
**EGEE 557 - Microprogramming and Embedded Microprocessors (3)**

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.

Prerequisite: EGEE 448

**EGEE 558B - Microprocessors and Systems Applications II (3)**

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

Prerequisite: EGEE 558A

**EGEE 559 - Introduction to Robotics (3)**

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

Prerequisite: EGEE 416

**EGEE 580 - Analysis of Random Signals (3)**

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

Prerequisite: EGEE 323, EGEE 409

**Disclaimer**

This handbook is intended as a quick reference for graduate 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.