



CALIFORNIA STATE UNIVERSITY
FULLERTON

MASTER OF SCIENCE

IN

COMPUTER ENGINEERING

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COMPUTER ENGINEERING PROGRAM

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INTRODUCTION

Welcome to the Computer Engineering Program (CpE) in the College of Engineering and Computer Science (ECS) at California State University, Fullerton (CSUF). As a student pursuing an M.S. degree in Computer Engineering at CSUF, you are expected to make yourself familiar with the contents of this handbook and follow the steps and instructions included in it.

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 (smartphones, tablets, etc.) to high-performance computing, including warehouse-scale computing for e-commerce and supercomputing, which is a trend that 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 M.S. 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 M.S. 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 courses from the graduate program in Computer Science (CS) and key courses in Electrical Engineering (EE) 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 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 M.S. program, students must meet the CSUF minimum requirements for admission to a master's degree program. This information is available on the CSUF [Graduate Admissions](https://catalog.fullerton.edu/content.php?catoid=52&navoid=6280) webpage, which can be accessed online at <https://catalog.fullerton.edu/content.php?catoid=52&navoid=6280>.

In addition to meeting the minimum CSUF admission requirements, applicants must also meet the following departmental requirements to qualify for admission with conditionally classified standing:

- Minimum GPA of 2.5 for applicants that graduated from domestic (U.S.) institutions with undergraduate degrees in Engineering or Computer Science
- Minimum GPA of 2.5 for applicants that graduated from ABET-accredited international institutions with undergraduate degrees in Engineering or Computer Science

- Minimum GPA of 3.0 for applicants that graduated from domestic (U.S.) institutions with undergraduate degrees other than Engineering or Computer Science
- Minimum GPA of 3.0 for applicants with undergraduate degrees from non-ABET accredited international institutions

Additional Information for International Students:

In addition, for international students from countries where English is not the official language, a minimum TOEFL score of 550 on the paper-based version or 80 on the Internet-based version is required. A minimum International English Language Testing System (IELTS) score of 6.5 or a PTE (Pearson Test of English Academic) score of 58 is also acceptable.

Further 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>.

DEGREE REQUIREMENTS

In order to obtain an 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.

****IMPORTANT:** You are permitted to take only one approved 400-level elective as part of the Computer Engineering M.S. degree program, irrespective of your exit option.

Graduate Department Recommendation (GDR) Form and Prerequisites

Upon admission to the M.S. degree program in Computer Engineering at CSUF, a Graduate Department Recommendation (GDR) form is provided to each admitted student. This form indicates whether the admission was conditional or not. In the case of conditional admission, this form also lists the deficiencies or prerequisite requirements that must be met by the student. It is the responsibility of the student to be aware of these requirements. For timely graduation, it is very important for students to meet with the graduate advisor in-person early in their M.S. degree program to discuss plans for meeting such requirements.

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.

Class Attendance Expectation

All students are expected to attend all the classes for the courses in which they are enrolled.

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 the Office of Graduate Studies.
2. Satisfactory completion of no more than 13 units on the study plan

University Writing Requirement

The University Writing Requirement can be met by obtaining a passing score on the California State University (CSU) Examination in Writing Proficiency (EWP) exam. A score of 4.0 or more on the GRE Analytical Writing section is also acceptable for meeting the University writing requirement. The writing requirement can also be met by successfully completing the Computer Engineering Master's Thesis (EGCP 598) requirements.

Students who fail to pass the EWP test may complete ENGL 301 or ENGL 360 or TESL 301 with a "C" (2.0) or better as an alternative to the EWP requirement.

Study Plan

****IMPORTANT:** You are permitted to take only one approved 400-level elective as part of the Computer Engineering M.S. degree program, irrespective of your exit option.

Prior to the completion of 13 units towards the M.S degree requirements, the student must meet with the graduate advisor in person 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 CpE office.

It is the student's responsibility to follow-up on the status of the study plan, to make any recommended study plan changes, and to make sure that the study plan is approved prior to the completion of 13 units.

Failure to have an approved study plan prior to the completion of 13 units towards the M.S. degree may adversely affect the student's ability to register for the subsequent semesters in a timely manner.

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. Forms that may be used to file a request for a change in study plan are available in the Office of Graduate Studies or on the Office of Graduate Studies website.

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 members of the CpE graduate committee, ECS Dean's office, Admissions and Records (A&R), and International Programs (IP). The modes of communication may include emails, memos, letters, or phone calls. CpE graduate students are expected to follow instructions and follow up on such communication in a timely manner.

Summer Session and Graduate Advising

Summer is not a regular semester, and graduate advising may not be available in the summer. Students who are planning to either graduate in the summer or take summer courses must meet the graduate advisor no later than the end of April of the preceding spring semester to address any graduate advising needs.

Core Courses

Out of the 30-semester units required for the M.S degree, 18 units must be comprised of required core courses. These courses are listed below:

1. EGCP 456 – Introduction to Logic Design in Nanotechnology (3 units)
2. EGCP 461 – Low Power Digital IC Design (3 units)
3. EGCP 520 – Advanced Computer Architecture (3 units)
4. EGCP 541 – Mixed-Signal IC Design (3 units)
5. EGCP 542 – VLSI Testing and Design for Testability (3 units)
6. EGCP 556 – Advanced Nanoelectronics (3 units)

Culminating Experience

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

Option 1 (Comprehensive Examination):

This option requires 18 units of core courses, 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.

Option 2 (Project):

This option requires 18 units of core courses, 9 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 a 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 CpE. 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 proposal must be submitted to the CpE office no later than the last day of instruction of the regular semester (summer is not included) preceding the semester in which the student plans to enroll for the project. For example, if a student is planning to enroll in the project course (*EGCP 597*) in the fall semester, the proposal must be submitted to the CpE office no later than the last day of instruction of the spring semester. This form must be signed by the supervising full-time faculty member and by a graduate committee member.

The project option requires the presentation of project work and a question-and-answer session before the supervising faculty member and one or more members of the CpE graduate program committee.

Option 3 (Thesis):

This option requires 18 units of core courses, 6 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 Thesis (*EGCP 598*), a student must have classified graduate standing. The student must first choose a faculty advisor and then, in consultation with the faculty advisor, choose a thesis committee consisting of three 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 and a final thesis report. Thesis report submission must adhere to the deadlines set by the University and the Office of Graduate Studies. The thesis defense is announced in advance and open to the university community.

Before enrolling in the thesis, a proposal must be submitted to the CpE office no later than the last day of instruction of the regular semester (summer is not included) preceding the semester in which the student plans to enroll for the thesis. For example, if a student is planning to enroll in the thesis course (*EGCP 598*) in the fall semester, the thesis proposal must be submitted to the CpE office no later than the last day of instruction of

the spring semester. This form must be signed by the supervising full-time faculty member and by a graduate committee member.

Approved Technical Elective Courses

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

The number of electives to be taken depends upon the culminating experience option, as explained below:

Option 1 (Comprehensive Exam): students who wish to take the comprehensive exam option must take 12 units of advisor-approved elective courses. At least 9 of these 12 units must be at the 500-level.

Option 2 (Project): students who wish to take the project option must, in addition to the project (EGCP 597, 3 units), take 9 units of advisor-approved elective courses. At least 6 of these 9 units must be at the 500-level.

Option 3 (Thesis): students who wish to take the thesis option must, in addition to Thesis (EGCP 598, 6 units), take 6 units of advisor-approved elective courses. At least 3 of these 6 units must be at the 500-level.

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

****IMPORTANT:** Students are permitted to take only those electives that are listed in this handbook. If a student wishes to take any other course not listed in this document towards meeting the elective requirements, the student must get approval from the CpE graduate advisor or the program coordinator **before registering** in the course

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 the student has the background knowledge and preparation required to successfully complete the course.**

****IMPORTANT:** You are permitted to take **only one approved** 400-level elective as part of the Computer Engineering M.S. degree program, irrespective of your exit option.

The approved elective courses are listed below according to the subject area.

Course No.		Units
Algorithms and Computation		
EGGN 403	Computer Methods in Numerical Analysis	3
CPSC 439	Theory of Computation	3
CPSC 474	Parallel and Distributed Computing	3
CPSC 477	Introduction to Grid Computing	3
CPSC 479	Introduction to High-Performance Computing	3
CPSC 485	Computational Bioinformatics	3
CPSC 515	Mobile Computing	3

CPSC 533	Applied Algorithms	3
CPSC 535	Advanced Algorithms	3
Wireless Communication		
EGEE 443	Electronic Communication Systems	3
EGEE 460	Introduction to Cellular Mobile Communications Systems	3
EGEE 522	Spread Spectrum Communications	3
EGEE 537	Satellite Communications	3
Computer Communication and Networks		
CPSC 471	Computer Communications	
CPSC 558	Advanced Computer Networking	3
Circuits, Systems, Very Large Scale Integration (VLSI) and Optics		
EGCP 446	Advanced Digital Design using Verilog HDL	3
EGEE 410	Electro-Optical Systems	3
EGEE 442	Electronic Circuits	3
EGEE 455	Microelectronics and Nano Devices	3
EGEE 465	Introduction to VLSI Design	3
EGEE 480	Optical Engineering and Communications	3
EGCP 570	Introduction to Digital VLSI Logic Design and Computer Organization	3
EGEE 510	Optics & Electromagnetics in Communications	3
EGEE 523A	VLSI and Nano Technology and Devices	3
EGEE 523B	CMOS VLSI Design	3
EGEE 581	Theory of Linear Systems	3
EGEE 585	Optimization Techniques in Systems Engineering	3
Hardware Security		
EGCP 447	Introduction to Hardware Security and Trust	3
EGCP 543	Advanced Secure Hardware Design	3
Software Security		
CPSC 452	Cryptography	3
CPSC 454	Cloud Computing and Security	3
CPSC 456	Network Security Fundamentals	3
CPSC 552	Cyber Forensics	3
Microprocessors and Microcomputer Systems		
EGEE 404	Introduction to Microprocessors and Microcomputers	3
EGEE 406	Design Applications with Microcontroller and FPGA	3
EGEE 557	Microprogramming and Embedded Microprocessors	3
EGEE 558A	Microprocessors and System Applications I	3
EGEE 558B	Microprocessors and System Applications II	3
Control Systems, Signal Processing, and Systems Engineering		
EGEE 409	Introduction to Linear Systems	3
EGEE 416	Feedback Control Systems	3
EGEE 424	Computer Simulation of Continuous Systems	3
EGCP 548	Real-Time Audio Processing	3
EGEE 518	Digital Signal Processing I	3
EGEE 526	Digital Control Systems	3
EGEE 580	Analysis of Random Signals	3
EGEE 559	Introduction to Robotics	3
Global Positioning Systems (GPS)		
EGEE 483	Introduction to Global Positioning Systems	3
System Software		

CPSC 551	Operating Systems Design	3
Software Engineering		
CPSC 462	Software Design	3
CPSC 463	Software Testing	3
CPSC 464	Software Architecture	3
CPSC 466	Software Process	3
CPSC 541	Systems and Software Standards and Requirements	3
CPSC 542	Software Verification and Validation	3
CPSC 543	Software Maintenance	3
CPSC 544	Advanced Software Process	3
CPSC 545	Software Design and Architecture	3
CPSC 546	Modern Software Management	3
CPSC 547	Software Measurement	3
Database System Design		
CPSC 431	Database and Applications	3
CPSC 531	Advanced Database Management	3
Multimedia and Digital Game Development		
CPSC 484	Principles of Computer Graphics	3
CPSC 486	Game Programming	3
CPSC 489	Game Development Project	3
CPSC 566	Advanced Computer Graphics	3
Software Application Development		
CPSC 411	Mobile Device Application Programming	3
CPSC 449	Web Back-End Engineering	3
CPSC 549	Web Application Frameworks	3
Intelligent Systems		
CPSC 481	Artificial Intelligence	3
CPSC 483	Introduction to Machine Learning	3
CPSC 583	Expert Systems Design Theory	3
CPSC 585	Artificial Neural Networks	3
EGEE 529	Principles of Neural Systems	3
Others		
EGCP 463	Current Topics in Computer Engineering	3
EGCP 599	Independent Graduate Research	1 - 3
Graduate Project and Thesis		
EGCP 597	Graduate Project	3
EGCP 598	Graduate Thesis	6

Time Limit for Completion

All requirements for the graduate degree, including all coursework on the student's study plan, normally should be completed within five 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 ten (10) consecutive semesters. When individual circumstances warrant, this time limit may be extended for up to two (2) years (four additional consecutive semesters).

A student may request an extension of the five-year time limit by filing a petition with the Office of Graduate Studies. 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 Committee, and the Associate Vice President for Academic Programs (or designee). 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 Office of Graduate Studies website. Candidates for summer (August) graduation must also obtain departmental approval prior to the summer term by filing a Petition for Summer Completion. The form is available in the Office of Graduate Studies. The approved form must be returned to the Office of Graduate Studies during the spring semester.

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. Forms for changing the graduation date are available at the Office of Graduate Studies.

Graduation and Commencement

It is the responsibility of the student to ensure that all requirements for graduation, including any deficiencies/prerequisites listed on the **GDR form** provided at the time of admission, are met in a timely manner.

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.

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

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 (<http://fullerton.edu/commencement>) 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 (<i>4 points per unit x 3 units = 12 points for 3 units</i>)
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
IC	0 points (Incomplete Charged)
WU	0 points (Withdrawal Unauthorized)

The “+/-” grading system may not be used in some courses. In such courses, the possible letter grades are A, B, C, D, F, IC, WU, etc.

It is to be noted that the list of letter grades mentioned here is not exhaustive. For more information regarding the grading policies and the grading systems, refer to the latest University catalog.

An online GPA calculator from the CSUF Academic Advisement Center can be accessed at http://www.fullerton.edu/aac/resources/gpa_calculator.php

A GPA of at least 3.0 is required for graduation with a graduate degree. This GPA applies to (1) all 400-level, and 500-level courses attempted subsequent to admission to a degree program (*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” (2.0) or better.

A master’s degree student may request a change in the study plan in order to raise the study plan GPA 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 GPA 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 GPA.

REPEATED COURSES, PROBATION AND DISQUALIFICATION

Repeated Courses

For M.S. degree students, if a grade less than “C” (2.0) is received in a study plan course, the course must be repeated and passed with a grade of “C” (2.0) 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 CSUF GPA. 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.

Probation

A student enrolled in a graduate degree program will be placed on academic probation if either the graduate GPA or the study plan GPA falls below 3.0. A graduate student may also be placed on probation for reasons other than graduate and/or study plan GPA. This is known as administrative-academic probation. 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”).

M.S. degree students will be allowed two (2) semesters on academic probation before being subject to disqualification. Students will remain on administrative-academic probation contingent upon conditions required for their continuing in the program. The Office of Graduate Studies maintains a list of students on probation 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 probation if the student does not, or cannot, raise the study plan and graduate GPA to 3.0 by the completion of the second regular semester following the semester in which the GPA fell below the minimum 3.0 standard.

If a student’s GPA 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 GPA will be disqualified if:

1. the conditions for removal of administrative-academic probation are not met within the period specified;
2. the student becomes subject to academic probation while on administrative-academic probation; or

3. the student is removed from administrative-academic probation and subsequently becomes subject to administrative-academic probation for the same or similar reasons as originally placed on probation.

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;
 - b. be acceptable for credit toward a graduate degree at the institution where the coursework was taken;
 - c. have been completed with a grade of "B" (3.0) or better;
 - d. not have been used in meeting the requirements for another earned degree (either graduate or undergraduate) and;
 - e. 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

Students can enhance their technical knowledge by becoming a member of one or more of the following clubs and by attending their seminars, conferences or symposia, 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 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)
- IEEE-HKN Honor Society (IEEE-Eta Kappa Nu)
- Tau Beta Pi (TBP – National Engineering Honor Society)
- Upsilon Pi Epsilon (UPE - International Honors Society for the Computing and Information Disciplines)

COURSE DESCRIPTIONS

****IMPORTANT:** You are permitted to take only one approved 400-level elective as part of the Computer Engineering M.S. degree program, irrespective of your exit option.

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

Computer Engineering (EGCP) Courses

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 Hardware Security and Trust

Prerequisite: EGCP 281

Hardware Trojan detection and isolation, physical and invasive attacks, side-channel attacks, physically unclonable functions, watermarking of Intellectual Property (IP) blocks, passive and active metering for prevention of piracy, access control. (3 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 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

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 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 Secure Hardware Design

Prerequisites: EGCP 441 and 447

Secure hardware design and implementation at multiple levels of abstraction, cryptographic hardware primitives, cryptographic modules, trusted platforms, reverse engineering of cryptographic modules using passive attacks, active attacks, and cryptanalytic techniques, countermeasures against reverse engineering. (3 units)

EGCP 548 Real-Time Audio Processing

Prerequisites: EGCP/EGEE 280; EGCP 371 or EGEE 409

Introduction to designing, developing, and implementing audio 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, nano memory, DRAM, flash, M/F RAM, spin torque devices. (3 units)

EGCP 570 Introduction to Digital VLSI Logic Design and Computer Organization

Prerequisite: EGCP 180 or EGEE 245; or graduate standing in computer engineering or electrical engineering

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: Classified graduate status; consent of graduate program adviser and program coordinator. A project proposal must be approved prior to last day of class instruction of the preceding semester. (3 units)

EGCP 598 Thesis

Prerequisite: Classified graduate status; consent of graduate program adviser and program coordinator. A 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. (6 units)

EGCP 599 Independent Graduate Research

Prerequisite: Consent of graduate program adviser and program coordinator.

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. (1 - 3 units)

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Computer Science (CPSC) Courses - Approved Electives

CPSC 411 Mobile Device Application Programming

Prerequisite: CPSC 131 or graduate standing

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

Prerequisites: CPSC 332, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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 439 Theory of Computation

Prerequisites: CPSC 121 or MATH 320; MATH 270B or MATH 280.

Introduction to the theory of computation. Automata theory; finite state machines, context-free grammars, and Turing machines; hierarchy of formal language classes. Computability theory and undecidable problems. Time complexity; P and NP-complete problems. Applications to software design and security. (3 units)

CPSC 449 Web Back-End Engineering

Prerequisite: CPSC 332 or classified graduate standing in ECS

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: Examination in Programming Proficiency or CPSC 301 and MATH 270B, declared major/minor in CPSC, CPEN, or CPEI.

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. Programming projects involving implementation of cryptographic systems. (3 units)

CPSC 454 Cloud Computing and Security

Prerequisites: CPSC 351, CPSC 353, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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 456 Network Security Fundamentals

Prerequisite: CPSC 351, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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 462 Software Design

Prerequisite: CPSC 362, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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 or graduate standing

Practical guidance for improving the software development process. How to establish, maintain, and improve software processes. Exposure to agile processes, ISO 12207 and CMMI. (3 units)

CPSC 471 Computer Communications

Prerequisite: CPSC 351, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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 or graduate standing and declared major/minor in CPSC, CPEN, or CPEI.

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; a project involving distributed application development. (3 units)

CPSC 477 Introduction to Grid Computing

Prerequisite: CPSC 351, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

Introduction to grid computing concepts and technologies, and their applications to solving computationally intensive, real-world problems. Topics include designing grid operating systems, load balancing, distributed hash tables, locking, remote procedure calls, cycle-scavenging, fault tolerance, and security. (3 units)

CPSC 479 Introduction to High-Performance Computing

Prerequisite: CPSC 351 or graduate standing and declared major/minor in CPSC, CPEN, or CPEI.

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, MATH 338; declared major/minor in CPSC, CPEN, or CPEI. 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

Prerequisites: CPSC 335, MATH 338; declared major/minor in CPSC, CPEN or CPEI; or graduate standing.

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 301 or passing score on EPP; MATH 150B, MATH 270B; declared major/minor in CPSC, CPEN or CPEI; or graduate standing.

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. (3 units)

CPSC 485 Computational Bioinformatics

Prerequisites: CPSC 131; declared major/minor in CPSC, CPEN or CPEI

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, CPSC 484, junior or senior standing, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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, declared major/minor in CPSC, CPEN, or CPEI; or graduate student in CPSC, CPEN, or CPEI.

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

CPSC 515 Mobile Computing

Prerequisite: CPSC 471, or classified graduate standing.

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. (3 units)

CPSC 531 Advanced Database Management

Prerequisite: CPSC 431, declared major/minor in CPSC, CPEN, or CPEI.

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. (3 units)

CPSC 533: Applied Algorithms

Prerequisites: Computer Science M.S. student; or CPSC 121 and graduate standing.

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. (3 units)

CPSC 535: Advanced Algorithms

Prerequisites: classified graduate standing or CPSC 335.

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. (3 units)

CPSC 541 Systems and Software Standards and Requirements

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

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. (3 units)

CPSC 542 Software Verification and Validation

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

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.- (3 units)

CPSC 543 Software Maintenance

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI. 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. (3 units)

CPSC 544 Advanced Software Process

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

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. (3 units)

CPSC 545 Software Design and Architecture

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

Advanced software design and architecture principles focusing on 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. (3 units)

CPSC 546 Modern Software Management

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

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. (3 units)

CPSC 547 Software Measurement

Prerequisite: CPSC 362, declared major/minor in CPSC, CPEN, or CPEI.

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. (3 units)

CPSC 549 Web Application Frameworks

Prerequisite: CPSC 449 or graduate standing in Computer Science

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 551 Operating Systems Design

Prerequisite: CPSC 351, declared major/minor in CPSC, CPEN, or CPEI

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. (3 units)

CPSC 552 Cyber Forensics

Prerequisite: CPSC 456

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 558 Advanced Computer Networking

Prerequisite: CPSC 471, declared major/minor in CPSC, CPEN, or CPEI.

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

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CPSC 566 Advanced Computer Graphics

Prerequisite: CPSC 484, declared major/minor in CPSC, CPEN, or CPEI.

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

CPSC 583 Expert Systems Design Theory

Prerequisite: CPSC 481, declared major/minor in CPSC, CPEN, or CPEI.

Knowledge representation and search strategies for expert systems; logic programming; expert system tools; project. (3 units)

CPSC 585 Artificial Neural Networks

Prerequisite: CPSC 481, declared major/minor in CPSC, CPEN, or CPEI

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

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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 409 Introduction to Linear Systems

Prerequisite: EGEE 309 or graduate standing

Development of time and frequency domain models for physical systems. Linearization process and representation with block diagrams and signal flow graphs; discrete-time systems and digital signals including use of Z-transforms; stability theory of continuous and discrete-time systems. (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 424 Computer Simulation of Continuous Systems

Prerequisites: CPSC 120; EGEE 215 and 308

Using digital computer for simulation of physical systems modeled by ordinary differential equations; problem formulation, in-depth analysis of two integration methods, and the use of a general-purpose system simulation program such as CSSL. (3 units)

EGEE 442 Electronic Circuits

Prerequisites: EGEE 310.

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 EGEE 323

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

EGEE 455 Microelectronics and Nano Devices

Prerequisites: EGEE 303 and 311, or graduate standing.

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 nanostructure, nanodevices, and technology. (3 units)

EGEE 460 Introduction to Cellular Mobile Communications Systems

Prerequisite: EGEE 443 or graduate standing

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, or graduate standing

Optics review, lightwave fundamentals, integrated optic waveguides, the 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 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 I

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 EGEE 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 forwarding error correction. (3 units)

EGEE 523A VLSI and Nano Technology and Devices

Prerequisite: EGEE 455

Silicon crystal, PN junction physics, oxide and interface physics, wafer fabrication technology, oxidation, diffusion, ion-implantation, epitaxy, photolithography, thin film process. The layout design principle for integrated circuits. Nano-electronic devices and technology. (3 units)

EGEE 523B CMOS VLSI Design

Prerequisites: EGEE 465 and EGEE 448

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

Prerequisite: EGEE 310, and EGEE 409.

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

Microprocessors and microcomputers, 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

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 EGEE 409

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

EGEE 581 Theory of Linear Systems

Prerequisites: EGEE 416 and EGGN 403

State-space analysis, linear spaces, stability of systems, numerical methods of linear systems analysis, and design. (3 units)

EGEE 585 Optimization Techniques in Systems Engineering

Prerequisites: EGGN 403 or MATH 340 for computer science majors.

Calculus of variations, optimization of functions of several variables, Lagrange multipliers, gradient techniques, linear programming, and the simplex method, nonlinear and dynamic programming. (3 units)

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General Engineering (EGGN) Courses - Approved Electives**EGGN 403 Computer Methods in Numerical Analysis**

Prerequisites: MATH 250B and EGGN 205 or equivalent.

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

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Disclaimer

This handbook is intended as a quick reference for graduate students who are pursuing an M.S. degree in computer engineering. It does not apply to those who are pursuing an integrated BS-M.S. degree in 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 the relevant College and/or University documents (as applicable) shall take precedence over the contents of this handbook.