CALIFORNIA STATE UNIVERSITY

FULLERTON

INTEGRATED BACHELOR AND MASTER OF SCIENCE IN COMPUTER ENGINEERING

Computer Engineering Program

College of Engineering & Computer Science

California State University, Fullerton

P. O. Box 6870

Fullerton, CA 92834-6870

E-mail: cpenprogram@fullerton.edu

Telephone: 657-278-5987

Fax: 657-278-5804

http://www.fullerton.edu/ecs/cpe

INTEGRATED BACHELOR AND MASTER OF SCIENCE

Computer Engineering Program

Program Coordinator:	Kiran George kgeorge@fullerton.edu
Program Advisor:	Kiran George kgeorge@fullerton.edu
Program Graduate Committee:	Kenneth John Faller II, Kiran George, and Pradeep Nair
Program Office:	E-100G
Email:	cpenprogram@fullerton.edu
Telephone:	657-278-5987
Fax:	657-278-5804
Website:	http://www.fullerton.edu/ecs/cpe
Faculty:	Yu Bai, Susamma Barua, Yoonsuk Choi, Jaya Dofe, John Faller, Kiran George, Ankita Mohapatra, Rakeshkumar Mahto, Pradeep Nair, Michael Turi, and Raman Unnikrishnan

COMPUTER ENGINEERING PROGRAM
INTEGRATED BACHELOR AND MASTER OF SCIENCE HANDBOOK
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INTRODUCTION

A Pathway to Success for High Caliber Students

The Integrated Computer Engineering Bachelor of Science-to-Master of Science (BS-MS) provides students with a strong understanding of the hardware design and practical applications of computer-based systems. 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. The program integrates pertinent science, mathematics and engineering courses in order to develop an engineer capable of designing and analyzing all aspects of modern computer and embedded systems. The BS-MS is a unique and attractive program that provides an accelerated route to completing both bachelors and master's degrees in four years, thereby saving both time and resources

Within this study plan are the 30 units required for the MS degree. Students must complete all requirements of the MS with an overall grade-point average of 3.0 or better on a 4.0 scale. All courses for the MS portion of the integrated program in the major must be passed with a "C" (2.0) or better.

In addition to the requirements for the major, students must meet all other university requirements for a bachelor's degree. Please consult the Graduation Requirements for the Bachelor's Degree section in this catalog for complete information.

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

PROGRAM MISSION STATEMENT

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

A. Technical Growth: Graduates will integrate into the local and global computer engineering workforce and contribute to the economy of California and the nation
B. Professional Skills: Graduates will demonstrate the professional skills necessary to be competent employees and assume/undertake leadership roles in their communities and/or profession. Qualified graduates will pursue advanced study if desired
C. Professional Attitude and Citizenship: Graduates will become productive citizens who make sound engineering or managerial decisions and have enthusiasm for the profession and professional growth

STUDENT OUTCOMES

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

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

ADVISEMENT

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

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

For information on how to schedule an appointment, see the Integrated 4-year BS-MS Advising website.

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

First-Time Freshmen

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

Credit by Examination

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

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

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

ADMISSION REQUIREMENTS

- Entering freshmen must be CSUF eligible
- Must have a minimum high school GPA (unweighted) of 3.0

Additional Information for International Students

International students must meet all the requirements listed above in the Admission Requirements. Verification of English proficiency and financial resources will be governed by the criteria established by the university.

All international students must submit their TOEFL score before they can be admitted to the program. Please consult the Office of Admission's International Graduate Eligibility Requirements website for current exam requirements.

Graduate Standing - Classified

Classified standing requires approval of a formal study plan by the computer engineering graduate adviser and Office of Graduate Studies. Students enrolled in the program must meet with an adviser prior to completing 13 units toward the MS degree to develop a study plan.

Placement Examination

Students with a working knowledge of a high-level programming language such as C++ are encouraged to take the Computer Science placement examination to qualify for a CPSC 120A and CPSC 120L waivers.

DEGREE REQUIREMENTS

The students in the program must complete all the requirements for the BS and the MS degree with a total of 150 semester units. The cohort degree program requires students to enroll during the summer sessions of the first and second year (total of 18 units).

The 150 units required for the 4-Year Integrated BS-MS Degree Program in Computer Engineering include 31 units of foundation courses in mathematics and science, 42 units of courses (24 unduplicated units) in General Education, 74 units of required core courses in the major, and 21 units of elective courses. Courses are designated as CPSC for computer science courses, EGCP for computer engineering courses, EGEE for electrical engineering courses, and EGGN for general engineering courses.

Minimum Academic Requirements

Degree program participants should maintain a minimum cumulative GPA of 3.0 every semester. Participants failing to do so will be placed on academic notice for two semesters. Failure to raise the cumulative GPA to 3.0 after the academic notice period will result in termination from the integrated BS-MS program. Students will be allowed to continue in the traditional 4-year BS program in Computer Engineering as long as they are eligible to continue in the program based on the criteria established for undergraduate programs at CSUF.

Required Core Courses: BS (56 units)

All courses must be passed with a "C-" (1.7) or better.

- CPSC 120A - Introduction to Programming (2)
- CPSC 120L - Introduction to Programming Laboratory (1)
- CPSC 121A - Object-Oriented Programming (2)
- CPSC 121L - Object-Oriented Programming Laboratory (1)
- CPSC 131 - Data Structures (3)
- EGCP 180 - Digital Logic and Computer Structures (3)
- EGCP 280 or EGEE 280 - Microcontrollers (3)
- EGCP 281 or EGEE 281 - Designing with VHDL (2)
- EGCP 371 - Modeling and Simulation of Signals and Systems (3)
- EGCP 381 - Computer Design and Organization (4)
- EGCE 401, EGCP 401, or EGEE 401 - Engineering Economics and Professionalism (3)
- EGCP 441 - Advanced Electronics for Computer Engineers (4)
- EGCP 446 - Advanced Digital Design using Verilog HDL (3)
- EGCP 450 - Embedded Processor Interfacing (4)
- EGCP 470 - Multidisciplinary Projects in Computer Engineering - I (2)
- EGCP 471 - Multidisciplinary Projects in Computer Engineering - II (2)
- EGEE 203 - Electric Circuits (3)
- EGEE 203L - Electric Circuits Laboratory (1)
- EGEE 303 - Electronics (3)
- EGEE 303L - Electronics Laboratory (1)
- EGEE 323 - Engineering Probability and Statistics (3)

Required Core Courses: MS (18 units)

Students must complete all requirements for the degree with an overall minimum GPA of 3.0.

Required (12 units)

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

Culminating Experience (6 units)

- EGCP 598 - Thesis (3) (must take 6 units in 3-unit intervals)

or

- EGCP 597 - Project (3)

or

- EGCP 543 - Advanced Cyber-Physical Systems Security (3) and
- EGCP 548 - Real-Time Audio and Language Processing (3) and
- Comprehensive Exam (0 units)

Electives for the BS (9 units) and MS (12 units)

For the Bachelor of Science, select 9 units of 300- and 400-level courses; 12 units if CPSC 120A and CPSC 120L are waived. Courses not on the list may count as electives only with adviser approval.

For the Master of Science, select from 400- and 500-level courses; a maximum 3 units of which may be 400-level. Courses not on the list may count as electives only with adviser approval.

- CPSC 332 - File Structures and Database Systems (3)
- CPSC 335 - Algorithm Engineering (3)
- CPSC 386 - Introduction to Game Design and Production (3)
- CPSC 431 - Database and Applications (3)
- CPSC 462 - Software Design (3)
- CPSC 463 - Software Testing (3)
- CPSC 464 - Software Architecture (3)
- CPSC 466 - Software Process (3)
- CPSC 471 - Computer Communications (3)
- CPSC 474 - Parallel and Distributed Computing (3)
- CPSC 481 - Artificial Intelligence (3)
- CPSC 483 - Introduction to Machine Learning (3)
- CPSC 484 - Principles of Computer Graphics (3)
- CPSC 486 - Game Programming (3)
- CPSC 489 - Game Development Project (3)
- CPSC 531 - Advanced Database Management (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 558 - Advanced Computer Networking (3)
- CPSC 566 - Advanced Computer Graphics (3)
- CPSC 583 - Expert Systems Design Theory (3)
- CPSC 585 - Artificial Neural Networks (3)
- EGCP 441 - Advanced Electronics for Computer Engineers (4)*
- EGCP 446 - Advanced Digital Design using Verilog HDL (3)*

* Not eligible as elective for BS degree

- EGCP 447 - Introduction to Cyber-Physical Systems Security (3)[†]
- EGCP 450 - Embedded Processor Interfacing (4)[*]
- EGCP 456 - Introduction to Logic Design in Nanotechnology (3)
- EGCP 461 or EGEE 461 - Low Power Digital IC Design (3)
- EGCP 463 - Current Topics in Computer Engineering (3)[†]
- EGCP 541 - Mixed-Signal IC Design (3)
- EGCP 542 - VLSI Testing and Design for Testability (3)
- EGCP 543 - Advanced Cyber-Physical Systems Security (3)[‡]
- EGCP 548 - Real-Time Audio and Language Processing (3)[‡]
- EGCP 556 - Advanced Nanoelectronics (3)
- EGEE 404 - Introduction to Microprocessors and Microcomputers (3)
- EGEE 410 - Electro-Optical Systems (3)
- EGEE 416 - Feedback Control Systems (3)
- EGEE 443 - Electronic Communication Systems (3)
- EGEE 455 - Microelectronics and Nano Devices (3)
- EGEE 460 - Introduction to Cellular Mobile Communications Systems (3)
- EGEE 465 - Introduction to VLSI Design (3)
- EGEE 480 - Optical Engineering and Communications (3)
- EGEE 483 - Introduction to Global Positioning Systems (GPS) (3)
- EGEE 483L - Global Positioning System Lab (2)
- EGEE 510 - Optics & Electromagnetics in Communications (3)
- EGEE 518 - Digital Signal Processing I (3)
- EGEE 522 - Spread Spectrum Communications (3)
- EGEE 523A - VLSI and Nano Technology and Devices (3)
- EGEE 523B - CMOS VLSI Design (3)
- EGEE 526 - Digital Control Systems (3)
- EGEE 529 - Principles of Neural Systems (3)
- EGEE 537 - Satellite Communications (3)
- EGEE 557 - Microprogramming and Embedded Microprocessors (3)
- EGEE 558B - Microprocessors and Systems Applications II (3)
- EGEE 559 - Introduction to Robotics (3)
- EGEE 580 - Analysis of Random Signals (3)
- EGGN 403 - Computer Methods in Numerical Analysis (3)

Requirements in Related Fields (31 units)

MATH 150A and MATH 170A must be passed with a "C" (2.0) or better. All other mathematics and science courses must be passed with a "C-" (1.7) or better to count as prerequisite courses for engineering courses, or as credit towards the degree.

[†] Not eligible as elective for MS degree

[‡] Not eligible as MS elective if taken for culminating experience

Mathematics Requirements (19 units)

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

Science Requirements (12 units)

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

General Education (GE) Requirements

All students at CSUF are expected to complete prescribed units of General Education that are made up of courses outside of their chosen disciplines. Students seeking a degree in Engineering have been provided exceptions from some of the General Education requirements. For this reason, it is important that students take the approved GE courses for Engineering majors that are found in their Titan Degree Audit (TDA). Additionally, they should confirm the GE courses that are required within their specific programs with their respective advisers.

Writing Requirement

Completing both of the following courses fulfills the upper-division English writing requirement as well as the Graduate writing requirement:

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

Additional Information

Written work for the two courses must meet professional standards. Both courses must be passed with a "C" (2.0) or better to satisfy the writing requirement.

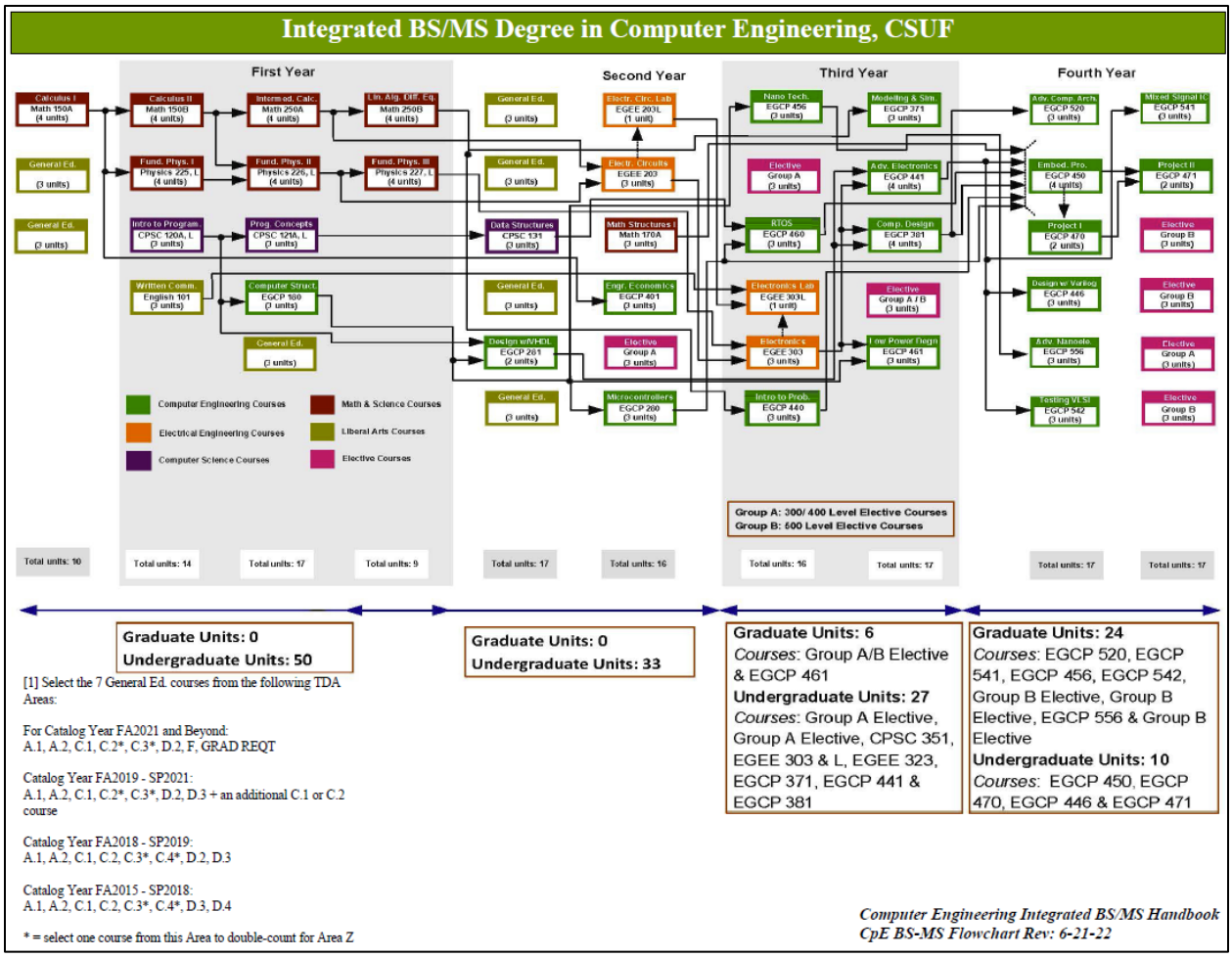
Graduation Requirement (3 units)

- HONR 201B - Honors Seminar: American Institutions and Values since 1900 (3)
- POSC 100 - American Government (3)

PROGRAM SCHEDULE PREPARATION

Recommended Schedule

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



OTHER INFORMATION

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

Course Prerequisites and Corequisites

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

Changing Technical Elective Courses

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

Internships and Cooperative Education

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

Benefits of the internship program in Computer Engineering include:

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

We encourage you to use the internship program once you reach junior or senior status. For more information, please see the ECS Academic Internship website.

Petition for Coursework Overload

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

GPA Calculation for Repeated Courses

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

Academic Notice and Disqualification

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

Student Clubs

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

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

COURSE DESCRIPTIONS

Computer Engineering (EGCP) Courses

EGCP 180 - Digital Logic and Computer Structures (3)

Binary number system and arithmetic, computer codes, Boolean algebra, logic gates, K-map minimization, sequential circuits, memory devices, state diagram and table, computer architecture, memory, Arithmetic Logic Unit and control unit. (2 hours lecture, 2 hours laboratory)

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

EGCP 280 - Microcontrollers (3)

Microcontrollers, microcontroller programming model and instruction set, assembler directives, writing and debugging microcontroller assembly language routines, microcontroller memory system, microcontroller communication systems. (1 hour lecture, 4 hours laboratory) (EGCP 280 and EGEE 280 are the same course.)

Prerequisite: EGCP 180 or EGEE 245

EGCP 281 - Designing with VHDL (2)

Introduction to various modeling methods, timings, events, propagation delays and concurrency, the language constructs, data representations and formats, and physical attributes. (1 hour lecture, 2 hours laboratory) (EGCP 281 and EGEE 281 are the same course.)

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

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

Modeling and simulation of physical systems, mathematical description of systems, transfer functions, poles and zeros, frequency response, continuous and discrete-time convolution, continuous and discrete Fourier transforms, Laplace and Z transforms, Fast Fourier Transforms, simulation using Matlab.

Prerequisite: MATH 250B

EGCP 381 - Computer Design and Organization (4)

Computer system, central processing unit (CPU) organization and design, instruction set and addressing modes, microprogrammed control unit design, cache memory, internal memory, virtual

memory, input/output interfacing, parallel processors, superscalar processors (2 hours lecture, 4 hours laboratory).

Prerequisites: EGCP 281, EGEE 303

EGCP 401 - Engineering Economics and Professionalism (3)

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

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

EGCP 441 - Advanced Electronics for Computer Engineers (4)

High-speed CMOS, biCMOS, CPLDs, FPGAs, A/D, D/A, transducers and optics; integration of these devices into complete systems. (2 hours lecture, 4 hours laboratory)

Prerequisites: EGCP 281, EGEE 303

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

Fundamentals of Verilog programming; behavioral modeling using Verilog; structural modeling using Verilog; RTL design using Verilog; Shannon's decomposition; FPGA architecture; Digital design, synthesis and implementation using FPGA.

Prerequisite: EGCP 441

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

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

Prerequisite: EGCP 281 or graduate standing

EGCP 450 - Embedded Processor Interfacing (4)

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

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

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

Promising novel Nanoelectronic technologies and logic primitives for such technologies, applicable basic logic design technique, design models for spatial dimensions, applicable word-level data structures, multilevel circuit design, testability and observability, tolerance and reliable computing.

Prerequisite: EGCP 180 or EGEE 245

EGCP 461 - Low Power Digital IC Design (3)

Importance of low power design; analysis of power dissipation in digital integrated circuits; circuit-level low-power techniques, logic-level low power techniques and system-level low power techniques. (EGCP 461 and EGEE 461 are the same course.)

Prerequisites: EGCP 180 or EGEE 245; EGEE 303

EGCP 463 - Current Topics in Computer Engineering (3)

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

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

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

The first course in the two-course senior design sequence. Student teams develop a hardware/software project, from conception through implementation and testing, under an instructor's supervision. Teams first explore technology issues related to the projects and then prepare complete design proposals.

Corequisite: EGCP 450

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

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

Prerequisites: EGCP 450, EGCP 470

EGCP 499 - Independent Study (1-3)

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

Prerequisite: senior standing

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

CPSC 120A - Introduction to Programming (2)

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

Corequisite: CPSC 120L, MATH 125 or MATH 116

CPSC 120L - Introduction to Programming Laboratory (1)

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

Corequisite: CPSC 120A, MATH 125 or MATH 116

CPSC 121A - Object-Oriented Programming (2)

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

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

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

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

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

CPSC 131 - Data Structures (3)

Classical data structures: vector, linked list, stack, queue, binary search tree, and graph representations. Worst-case analysis, amortized analysis, and big-O notation. Object-oriented and

recursive implementation of data structures. Self-resizing vectors and self-balancing trees. Empirical performance measurement.

Prerequisite: CPSC 121 or sufficient score on the Computer Science Placement Exam

CPSC 351 - Operating Systems Concepts (3)

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

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

CPSC 332 - File Structures and Database Systems (3)

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

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

CPSC 335 - Algorithm Engineering (3)

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

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

CPSC 349 - Web Front-End Engineering (3)

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

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

CPSC 362 - Foundations of Software Engineering (3)

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

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

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

Current and future technologies and market trends in game design and production. Game technologies, basic building tools for games and the process of game design, development and production.

Prerequisites: CPSC 121; completion of GE Category B.4; or Computer Science or Computer Engineering graduate standing

CPSC 431 - Database and Applications (3)

Database design and application development techniques for a real world system. System analysis, requirement specifications, conceptual modeling, logic design, physical design and web interface development. Develop projects using contemporary database management system and web-based application development platform.

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

CPSC 462 - Software Design (3)

Concepts of software modeling, software process and some tools. Object-oriented analysis and design and Unified process. Some computer-aided software engineering (CASE) tools will be recommended to use for doing homework assignments.

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

CPSC 463 - Software Testing (3)

Software testing techniques, reporting problems effectively and planning testing projects. Students apply what they learned throughout the course to a sample application that is either commercially available or under development.

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

CPSC 464 - Software Architecture (3)

Basic principles and practices of software design and architecture. High-level design, software architecture, documenting software architecture, software and architecture evaluation, software product lines and some considerations beyond software architecture.

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

CPSC 466 - Software Process (3)

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

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

CPSC 471 - Computer Communications (3)

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

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

CPSC 474 - Parallel and Distributed Computing (3)

Concepts of distributed computing; distributed memory and shared memory architectures; parallel programming techniques; inter-process communication and synchronization; programming for

parallel architectures such as multi-core and GPU platforms; project involving distributed application development.

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

CPSC 481 - Artificial Intelligence (3)

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

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

CPSC 483 - Introduction to Machine Learning (3)

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

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

CPSC 484 - Principles of Computer Graphics (3)

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

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

CPSC 486 - Game Programming (3)

Survey of data structures and algorithms used for real-time rendering and computer game programming. Build upon existing mathematics and programming knowledge to create interactive graphics programs.

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

CPSC 489 - Game Development Project (3)

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

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

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)

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

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

EGEE 280 - Microcontrollers (3)

Microcontrollers, microcontroller programming model and instruction set, assembler directives, writing and debugging microcontroller assembly language routines, microcontroller memory system, microcontroller communication systems. (1 hour lecture, 4 hours laboratory) (EGCP 280 and EGEE 280 are the same course.)

Prerequisite: EGCP 180 or EGEE 245

EGEE 281 - Designing with VHDL (2)

Introduction to various modeling methods, timings, events, propagation delays and concurrency, the language constructs, data representations and formats, and physical attributes. (1 hour lecture, 2 hours laboratory) (EGCP 281 and EGEE 281 are the same course.)

Prerequisites: CPSC 120A or CPSC 121A; EGCP 180 or EGEE 24

EGEE 203 - Electric Circuits (3)

Units; Ohm’s and Kirchhoff’s laws; mesh and nodal analysis, superposition; Thevenin and Norton theorems; RL and RC transients; phasors and steady state sinusoidal analysis; response as a function of frequency; current, voltage and power relationships; polyphase circuits.

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

EGEE 203L - Electric Circuits Laboratory (1)

Simple resistive RL and RC circuits, electrical measurement techniques, verification of basic circuit laws through hard-wired breadboarding and CAD circuit simulation. (3 hours laboratory)

Pre- or corequisite: EGEE 203

EGEE 303 - Electronics (3)

Characteristics and elementary applications of semiconductor diodes, field-effect transistors and bipolar-junction transistors and operational amplifiers; mid-frequency small-signal analysis and design of transistors.

Prerequisites: PHYS 227, EGEE 203

EGEE 303L - Electronics Laboratory (1)

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

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

EGEE 323 - Engineering Probability and Statistics (3)

Set theory: axiomatic foundation of probability; random variables; probability distribution and density functions; joint, conditional and marginal distributions; expected values; distribution of functions of random variables; central limit theorem; estimation.

Prerequisite: MATH 250A or MATH 170B

EGEE 401 - Engineering Economics and Professionalism (3)

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

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

EGEE 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 brand, 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)

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. SS systems performance in a jamming environment, with forward error correction.

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)

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.

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

General Engineering (EGGN) Course

EGGN 403 - Computer Methods in Numerical Analysis (3)

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

Prerequisites: MATH 250B, EGGN 205

EGGN 495 - Professional Practice (1-3)

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

Prerequisites: Engineering major; junior or senior standing

Related Courses for Computer Engineering Majors

MATH 150A - Calculus I (4)

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

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

MATH 150B - Calculus II (4)

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

Prerequisite: MATH 150A

MATH 250A - Calculus III (4)

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

Prerequisite: MATH 150B

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

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

Prerequisite: MATH 250A

MATH 170A - Mathematical Structures I (3)

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

PHYS 225 - Fundamental Physics: Mechanics (3)

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

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

PHYS 225L - Fundamental Physics: Laboratory (1)

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

Corequisite: PHYS 225

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

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

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

PHYS 226L - Fundamental Physics: Laboratory (1)

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

Corequisite: PHYS 226

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

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

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

PHYS 227L - Fundamental Physics: Laboratory (1)

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

Corequisite: PHYS 227

Disclaimer

This handbook is intended as a quick reference for BS-MS 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.