Optimization of plant design, investment and operations.

193. Internship in Industry
(1-4) STAFF

196.Undergraduate Research
(2-4) STAFF
Prerequisite: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; consent of the instructor.

Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated for up to 12 units. Not more than 3 units may be applied to departmental electives.

Research opportunities for undergraduate students. Students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

198. Independent Studies in Chemical Engineering
(1-5) STAFF
Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in chemical engineering.

Must have a minimum 3.0 grade-point-average for the preceding three quarters. May be repeated up to twelve units. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.

Directed individual studies.

GRADUATE COURSES

Graduate courses for this major can be found in the UCSB General Catalog.

Computer Engineering

Computer Engineering Major,
Trailer 380, Room 101;
Telephone (805) 893-5615
E-mail: info@ce.ucsb.edu
Web site: www.ce.ucsb.edu

Director: Li-C. Wang

Faculty

Kaustav Banerjee, Ph.D., UC Berkeley, Professor (high performance VLSI and mixed signal system-on-chip designs and their design automation methods; single electron transistors; 3D and optoelectronic integration)

Forrest D. Brewer, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer system design automation, theory of design and design representations, symbolic techniques in high level synthesis)

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (specification and automated analysis of concurrent systems, computer-aided verification, model checking)

Ben Hardekopf, Ph.D., University of Texas at Austin, Associate Professor (programming languages: desgin, analysis, and implementation)

Yogananda Isukapalli, Ph.D., UC San Diego (Low power hardware design, Multi-antenna wireless communications, Transmit beam forming, Vector quantization, Performance analysis of communication systems)

Chandra Krintz, Ph.D., University of California, San Diego, Professor (dynamic and adaptive compilation systems, high-performance internet (mobile) computing, runtime and compiler optimizations for Java/CIL, efficient mobile program transfer formats)

Behrooz Parhami, Ph.D., UC Los Angeles, Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)

Tim Sherwood, Ph.D., UC San Diego, Professor (computer architecture, dynamic optimization, network and security processors, embedded systems, program analysis and characterization, and hardware support of software systems)

Dmitri B. Strukov, Ph.D., Stony Brook University, Assistant Professor (hybrid circuits, nanoelectronics, resistance switching devices, memristors, digital memories, programmable circuits, bio-inspired computing)

Luke Theogarajan, Ph.D., Massachusetts Institute of Technology, Associate Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block co-polymer synthesis, self-assembly, and microfabrication)

Li-C. Wang, Ph.D., University of Texas at Austin, Professor (design verification, testing, computer-aided design of microprocessors)

Richard Wolski, Ph.D., UC Davis/Livermore, Professor (high-performance distributed computing, computational grids, computational economies for resource allocation and scheduling)

Yuan Xie, Ph.D., Princeton University, Professor (EDA, VLSI design, computer architecture, embedded systems, high-performance computing)

Zheng Zhang, Ph.D., Massachusetts Institute of Technology, Assistant Professor (Design Automation Algorithms for VLSI/MEMS/Photonics; Uncertainty Quantification and Data Analysis; Modeling and Control for Robotic and Autonomous Systems; Computation for Biomedical Imaging)

The Computer Engineering major's objective is to educate broadly based engineers with an understanding of digital electronics, computer architecture, system software and integrated circuit design. These topics bridge traditional electrical engineering and computer science curricula. The Computer Engineering degree program is conducted jointly with faculty from the Department of Computer Science and the Department of Electrical and Computer Engineering. Computer engineers emerging from this program will be able to design and build integrated digital hardware and software systems in a wide range of applications areas. Computer engineers will seldom work alone and thus teamwork and project management skills are also emphasized. The undergraduate major in Computer Engineering prepares students for a wide range of positions in business, government and private industrial research, development and manufacturing organizations.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Faculty advisors are also available to help with academic program planning. Students who hope to change to this major should consult the department advisor.

The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Mission Statement

To prepare our students to reach their full potential in computer engineering research and industrial practice through a curriculum emphasizing the mathematical tools, scientific basics, fundamental knowledge, engineering principles, and practical experience in the field.

Educational Objectives

The Computer Engineering Program seeks to produce graduates who:
1) Make positive contributions to society by applying their broad knowledge of computer engineering theories, techniques, and tools.
2) Create processes and products, involving both hardware and software components, that solve societal and organizational problems effectively, reliably, and economically.
3) Are committed to the advancement of science, technical innovation, lifelong learning, professionalism, and mentoring of future generations of engineers.
4) Understand the ethical, social, business, technical, and human contexts of the world in which their engineering contributions will be utilized.

Program Outcomes

Upon completion of this program, students will have:
1) Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized professional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.
2) Experienced in-depth training in state-of-the-art specialty areas in computer engineering.
3) Benefited from hands-on, practical laboratory experiences where appropriate throughout the program. The laboratory experiences will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students will have completed both hardware-oriented and software-oriented assignments.
4) Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired during their course of study. These challenges may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and test a system, analyze experimental results, and draw logical conclusions from them.
5) Learned to function well in multidisciplinary teams and collaborative environments. To this end, students must

develop communication skills, both written and oral, through teamwork and classroom participation. Teamwork and individual originality will be evidenced through written reports, webpage preparation, and public presentations.

6) Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This outcome provides for the ability to understand the impact of engineering solutions in a global and societal context. A required course in engineering ethics will have prepared students for making professional contributions while maintaining institutional and individual integrity.

Undergraduate Program

Bachelor of Science—Computer Engineering

A minimum of 191 units is required for graduation. A complete list of requirements for the major can be found on page 48. Schedules should be planned to meet both General Education and major requirements.

The curriculum contains a core required of all computer engineers, a choice of at least 48 units of senior year elective courses including completion of two out of ten elective sequences and a senior year capstone design project.

Because the Computer Engineering degree program is conducted jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering, several of the upper-division courses have equivalent versions offered by ECE or CMPSC. These courses are considered interchangeable, but only one such course of a given equivalent ECE/CMPSC pair may be taken for credit.

Courses required for the major, whether inside or outside of the Departments of Electrical and Computer Engineering or Computer Science, must be taken for letter grades. They cannot be taken for the passed/not passed grading option.
The upper-division requirements consist of a set of required courses and a minimum of 48 units (12 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group. The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B-C). Upper-division courses required for the major are: Computer Science 130A; ECE 152A,154A; either ECE 139 or PSTAT 120A; Engineering 101.

The required departmental electives are taken primarily in the senior year; they permit students to develop depth in specialty areas of their choice. A student's elective course program and senior project must be approved by a departmental faculty advisor. A variety of elective programs will be considered acceptable. Sample programs include those with emphasis in: computer-aided design (CAD); computer systems design; computer networks; distributed systems; programming languages; real-time computing and control; multimedia; and very large-scale integrated (VLSI) circuit design.

The defined sequences from which upper-division departmental electives may be chosen are:
• Computer Systems Design: ECE/CMPSC 153A, ECE 153B
• Computer Networks: ECE 155A/CMPSC 176A, ECE 155B/CMPSC 176B
• Distributed Systems: ECE 151/CMPSC 171 and one or both of the Computer Networks courses
• Programming Languages: CMPSC 160, 162
• Real-Time Computing & Control: ECE 147A-B, 157
• Multimedia: ECE 178, ECE/CMPSC 181B, ECE 160/CMPSC 182
• VLSI: ECE 122A, ECE 122B/ECE 124A, 124D
• Signal Processing: ECE 130A-B
• Robotics: ECE 179D & ECE 179P
•Design & Test Automation: ECE 156A, ECE 156B
•Machine Learning: CMPSC 165A, CMPSC 165B
•System Software Architecture: CMPSC 170, CMPSC 171/ECE 151

Satisfactory Progress and Prerequisites

A majority of Computer Science and Electrical and Computer Engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite classes requires a grade of C or better in Mathematics 3A-B and 4A, and a grade of C- or better in ECE classes. Students will not be permitted to take any ECE or CMPSC course if they received a grade of F in one or more of its prerequisites. Students who fail to maintain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major.

Computer Engineering Courses

See listings for Computer Science starting on page 25 and Electrical and Computer Engineering starting on page 30.

Computer Science

Department of Computer Science, Harold Frank Hall, Room 2104; Telephone (805) 893-4321 Web site: www.cs.ucsb.edu

Chair: Tevfik Bultan

Vice Chair: Elizabeth Belding
John Gilbert

Faculty

Divyakant Agrawal, Ph.D., State University of New York at Stony Brook, Distinguished Professor (distributed systems and databases)

Kevin Almeroth, Ph.D., Georgia Institute of Technology, Professor (computer networks and protocols, large-scale multimedia systems, performance evaluation and distributed systems)

Elizabeth Belding, Ph.D., University of California, Santa Barbara, Professor (mobile wireless networking, network performance evaluation, advanced service support, solutions for developing and under-developed regions)

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (software verification, program analysis, software engineering, computer security)

Phillip Conrad, Ph.D., University of Delaware, Lecturer SOE (computer science education, web technologies, computer networks and communication, transport protocols, multimedia computing)[1]

Wim van Dam, Ph.D., University of Oxford and University of Amsterdam, Associate Professor (quantum computation, quantum algorithms, quantum communication, quantum information theory)[5]

Yufei Ding, Ph.D., North Carolina State University, Assistant Professor (high-level large-scale program optimizations, high-performance domain-specific languages, heterogeneous massively parallel computing, high-performance machine learning, and quantum computing)

Ömer Egecioglu, Ph.D., University of California, San Diego, Professor (bijective and enumerative combinatorics, parallel algorithms, approximation algorithms, combinatorial algorithms)

Amr El Abbadi, Ph.D., Cornell University, Distinguished Professor (Information and data management; distributed systems, cloud computing)

Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (High resolution multiscale simulation, scientific computing, tools and software for computational science and engineering, engineering applications)[2]

John R. Gilbert, Ph.D., Stanford University, Professor (combinatorial scientific computing, high-performance graph algorithms, tools and software for computational science and engineering, numerical linear algebra)

Trinabh Gupta, Ph.D., University of Texas at Austin, Assistant Professor (computer systems with a focus on privacy)

Ben Hardekopf, Ph.D., University of Texas at Austin, Associate Professor (programming languages: design, analysis and implementation)

Tobias Höllerer, Ph.D., Columbia University, Professor (human computer interaction; augmented reality; virtual reality; visualization; computer graphics; 3D displays and interaction; wearable and ubiquitous