California State University, Sacramento
College of Engineering and Computer Science

DEPARTMENT OF COMPUTER SCIENCE
BACHELOR OF SCIENCE AND MINOR
2002-2004

California State University, Sacramento offers a Bachelor of Science degree in Computer Science. On this Web page you will find information about our faculty, admission requirements, degree requirements and course offerings. For admissions procedures, including procedures for international students, please see the main Admissions Web page at: http://webapps1.csus.edu/admr/home/adm&rechome.asp

COMPUTER SCIENCE DEPARTMENT FACULTY

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Bill Mitchell, Associate Chair

Behnam Arad    Kwai-Ting Lan
Robert Buckley Meiliu Lu
Senad Busovaca Martin Meyers
Weide Chang    Jinsong Ouyang
John Clevenger Anne-Louise Ramdimsky
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Isaac Ghansah   Richard Smith
Scott Gordon    Cui Zhang
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COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

Founded in 1955, Engineering and Computer Science is recognized as a leader in the state and nation for its excellent programs and facilities. The College emphasizes quality instruction in all of its programs.
One of seven colleges within the university, Engineering and Computer Science has an enrollment of approximately 2,000 undergraduate and 500 graduate students. Our seventy-eight full-time faculty members earned their degrees at some of the nation’s best universities, and are dedicated to personally educating and training students for both professional practice and advanced study in their chosen discipline. The undergraduate programs in Civil Engineering, Computer Engineering, Electrical and Electronic Engineering, Mechanical Engineering, and Mechanical Engineering Technology are accredited by the Accreditation Board for Engineering and Technology. The undergraduate program in Computer Science is accredited by the Computer Science Accreditation Commission of the Computer Science Accreditation Board. There are Master of Science degree programs in Biomedical Engineering, Civil Engineering, Computer Science, Electrical and Electronic Engineering, and Mechanical Engineering. A modern, 55,000 square-foot, five-story building houses these programs. The College awards, on average, 350 Bachelor of Science degrees and 70 Master of Science degrees each year. Among the major employers of recent computer science graduates are Hewlett-Packard, Apple, AT&T, Bank of America, Bechtel, Bell Northern Research, Cabledata, Control Data Corporation, DISC, IBM, Grass Valley Group, Intel, Lawrence Livermore Laboratories, NASA, NEC, Pacific Bell, Price Waterhouse, SMUD, State of California, Sutter Health, UNISYS, PG&E, Silicon Graphics, and Heuristics.

The College is noted for the use of its educational equity program, reflected in its diverse student body. African Americans, Latinos and American Indians, all groups which are historically underrepresented in engineering, comprise 21.4% of Engineering and Computer Science undergraduates. Over 400 students participate in the Minority Engineering Program, an increase of 400% accomplished in the past six years. About 17% of Engineering and Computer Science students are female; of these, 36% are Minority Engineering students. About 28% of Computer Science majors are women. The College reaches out to over 5,000 pre-college students in grades 1-12. MESA (Mathematics, Engineering, Science Achievement) and BEST (Business, Education, Science Team) are programs instrumental in recruiting Sacramento area students.

PROGRAM DESCRIPTION

The Bachelor of Science degree in Computer Science is accredited by the Computer Science Accreditation Commission (CSAC) of the Computer Science Accreditation Board. The B.S. program provides majors with a sound educational base. Beyond the core curriculum students select three elective courses with the help of faculty advisors.

The minor in Computer Science is available for students majoring in disciplines other than Computer Engineering.

The Department offers two programs in conjunction with other disciplines:

1. Bachelor of Arts, Mathematics and Computer Science (Mathematics Department)
2. Bachelor of Science, Computer Engineering (Electrical and Electronic Engineering Department)

NOTE: All students are admitted as Pre-Computer Science majors. To change to the Computer Science major, students who have completed the following lower division (pre-major) courses are required to complete and submit a Change of Major form to the Computer Science Department office along with transcript copies of CSC 15, 20, 35, 60, and MATH 30 and 31 or their articulated equivalents.
CAREER POSSIBILITIES


FEATURES

The Department consists of 23 full-time faculty members. Research interests of the faculty span a broad spectrum of Computer Science. Machine learning, pattern recognition, knowledge representation, logic programming, database systems, fault tolerant computing, VLSI design, system integration, computer interfacing, computer networks, distributed systems, computer architecture, parallel processing, concurrent programming, object-oriented programming, analysis of complex systems, project management, verification and validation, computer graphics, user interfaces, performance modeling and evaluation, modeling and simulation, formal methods and theory of computing are among the areas currently being studied.

A large heterogeneous network of Sun, DEC, and Hewlett-Packard RISC servers and workstations combined with PC workstations supports the instructional programs. PC laboratories support lower and some upper division instruction. An X-terminal laboratory provides access to RISC servers and workstations. Specialized laboratories support systems, communications and networking, and computer architecture instruction. A graduate laboratory is designed to provide graduate students with access to a variety of advanced workstations.

Majors are encouraged to join the student chapter of the Association for Computing Machinery or the IEEE Computer Society. Students with high scholastic achievement may be invited to join Upsilon Pi Epsilon, the National Honor Society in Computer Science.

FACULTY AREAS OF INTEREST

The Computer Science Department faculty are involved in various areas of interest. Projects are conducted individually and with students. Projects are also conducted in conjunction with members of industry.

Current faculty members, with their areas of interest, are:

Behnam Arad  computer engineering, computer architecture, parallel processing, neural networks

Robert Buckley  software engineering, structured programming, computer simulation, structural systems analysis and design, management science, project
management, object-oriented programming, object-oriented analysis and design

**Senad Busovaca** robotics, nonlinear optimization, operating systems

**Weide Chang** speech and image recognition, embedded systems, intelligent interfaces and devices

**John Clevenger** operating systems, computer graphics, machine organization, VLSI design, programming contests

**Nikrouz Faroughi** computer architecture, computer-aided design testability, design validation

**Dwight Freund** computer-aided geometric design, computing theory, computer-aided mapping

**Isaac Ghansah** computer networking, computer architecture, distributed systems, simulation modeling

**Scott Gordon** artificial intelligence, genetic algorithms, neural networks, programming languages, database design, game tree search, software engineering

**Roxalie Jones** computers in education

**Ted Krovetz** cryptography, network security, algorithms, computing theory, computer architecture

**Kwai-Ting Lan** operating systems, computer architecture

**Meiliu Lu** data mining, machine learning, bioinformatics technology

**Martin Meyers** software engineering, introductory programming instruction, programming contests

**William Mitchell** database management systems, software engineering, simulation
Jinsong Ouyang  Manageability, security, and reliability of networking and distributed systems; embedded system design; network engineering; Web and Internet systems architecture, middleware, and application

Anne-Louise Radinsky  artificial intelligence, knowledge-based systems, compilers, programming languages, education tools

Ahmed Salem  software engineering, software testing, software process improvement, computer security

Richard Smith  computer networking, computer engineering, operating systems, computer security

Chung-E Wang  computer networks, data compression, Chinese OCR, design and analysis of algorithms

Don Warner  database design, system analysis, user interfaces, client/server software engineering

Cui Zhang  software engineering, programming languages, formal methods, computer aided specification and verification

Du Zhang  machine learning, knowledge-based systems, data mining, internet/web agents, bioinformatics

MAJOR REQUIREMENTS – BACHELOR OF SCIENCE

Total units required for the Bachelor of Science degree: 130
Total units required for the Computer Science Major: 87-89 units

NOTE: A minimum grade of C- is required in all courses applied to the Computer Science degree. Courses in parentheses are prerequisites.

A. Required Lower Division Courses (15 units)
   (3) CSC 15  Programming Concepts & Methodology I (CSC 10 or programming experience)
   (3) CSC 20  Programming Concepts & Methodology II (CSC 15)
   (3) CSC 28  Discrete Structures for Computer Science (MATH 29, CSC 20; CSC 20 may be taken concurrently)
   (3) CSC 35  Assembly Language Programming (CSC 15)
   (3) CSC 60  Introduction to Systems Programming (CSC 20)
B. Required Mathematics Courses (15 units)
(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30)
(3) MATH 101 Discrete Mathematics (CSc 28)
(4) STAT 50 Introduction to Probability and Statistics (MATH 30)

C. Required Science Courses (11-13 units)
(4) PHYS 11A General Physics: Mechanics (MATH 30, 31)
(4) PHYS 11C General Physics: Electricity and Magnetism, Modern Physics (MATH 31, PHYS 11A)
(3-5) Select one of the following:*
   BIO 11 Animal Biology (BIO 10)
   BIO 12 Plant Biology (BIO 10)
   BIO 22 Introductory Human Anatomy (BIO 10)
   BIO 102 The Natural History of Plants (a college biology course)
   BIO 103 Plants and Civilization (BIO 10)
   BIO 104 Physiology of Human Reproduction (BIO 10 or 20)
   BIO 115 Introduction to Neuroscience (PSYC 1, 101), cross-listed with PSYC 155
   BIO 120 Biology of Aging (BIO 10 or 20)
   CHEM 1A General Chemistry
   CSC 148 Systems Simulation (MATH 31, STAT 50, proficiency in a programming language)
   ECON 141 Introduction to Econometrics (ECON 1A, 1B, STAT 1)
   ENGR 17 Introductory Circuit Analysis (PHYS 11C, MATH 45)
   ENGR 45 Engineering Materials (PHYS 11A, CHEM 1A)
   PHYS 11B General Physics: Heat, Light, Sound (PHYS 11A)
   PHYS 115A Introduction to Electric and Electronics Measurements (PHYS 11C)

*The course chosen cannot be used to satisfy the General Education B2 requirement.

Note: CSAB, the Computer Science accreditation agency, requires that students take a two semester sequence in a laboratory science (Physics 11A and 11C satisfies this requirement) and two additional one-semester courses in a scientific discipline or in a quantitative science. The courses in a scientific discipline must be those typically taken by the majors in that discipline. Students ordinarily complete one of the two courses required by choosing an appropriate course in General Education Category B2. BIO 10, Basic Biological Concepts, is recommended for meeting this requirement. The second course is expected to be chosen from the list above. Hence, students must have taken a total of four courses in this category.

D. Required Upper Division Courses (37 units)
(3) CSC 130 Data Structures and Algorithm Analysis (CSC 20, 28; CSC 28 may be taken concurrently)
(3) CSC 131 Computer Software Engineering (CSC 130; may be taken concurrently)
(3) CSC 132 Computing Theory (CSC 28, CSC 130; may be taken concurrently)
(3) CSC 133 Object-Oriented Computer Graphics Programming (CSC 60, 130)
(3) CSC 134 Database Management and File Organization (CSC 130)
(3) CSC 136 Programming Languages (CSC 132)
(4) CSC 137 Computer Organization (CSC 28, 35, 130)
(3) CSC 138 Computer Networks and Internets (CSC 35, 60, 130)
(3) CSC 139  Operating System Principles (CSC 60, 137; or equivalents)
(2) CSC 190  Senior Project: Part I (CSC Senior standing, passed the WPE, completed
CSC 130 and 131 and four additional 3-unit courses that fulfill the major
requirement (excluding CSC 192-199)
(2) CSC 191  Senior Project: Part II (CSC 190)
(3) PHIL 103  Business and Computer Ethics
(2) Select 2 units from the following:
   CSC 192  Career Planning (1 unit maximum)
   CSC 194  Computer Science Seminar
   CSC 195  Field Work in Computer Science
   CSC 195A-D  Professional Practice
   CSC 197A-D  Campus-Based Professional Practice
   CSC 198  Co-curricular Activities in Computer Science
   CSC 199  Special Problems

E.  Electives (9 units)

In addition to the required lower-division and upper-division Computer Science courses (CSC 15, 20, 28,
35, 60, 130, 131, 132, 133, 134, 136, 137, 138, 139, 190, 191, and 2 units chosen from 192, 194, 195,
195A-D, 197A-D, 198 or 199), majors must take three additional elective courses, totaling at least nine
units, chosen from undergraduate Computer Science courses numbered CSC 140 or above (excluding
CSC 192, 194, 195, 195A-D, 197A-D, 198, 199). Any combination of courses is acceptable, but it is
highly recommended that these elective courses be chosen with advisor consultation and approval. With
advance written approval from their advisor, qualified students may take graduate courses as electives.
In any case, students must meet the prerequisite stated in the catalog prior to taking any elective course.

ADDITIONAL INFORMATION

Work Experience

Students may receive a limited amount of academic credit for relevant work experience in computer
science. There are many opportunities for students to work part-time in state government and in
positions in federal and local governments. The number of private employers is also increasing as new
high-technology industry moves to the Sacramento area. Work experience often leads to a permanent
position upon graduation.
Cooperative Education Program

The Computer Science Department encourages students to participate in the Cooperative Education Program which provides alternate periods of university study and major-related, paid, off-campus work experience in private industry or government. The experience will enhance the student's employment prospects upon graduation. Most participants in this program will complete the equivalent of two six-month work periods, one in their junior year and one in their senior year. Students must enroll in the appropriate Professional Practice course (CSC 195A, 195B, 195C, 195D or CSC 197A, 197B, 197C, 197D) and are awarded a certificate upon satisfactory completion of the two work periods. However, the credits for this course do not replace the curricular requirements of the BS Computer Science degree. Students interested in this program should apply in the Cooperative Education Program Office, Public Services Building Room 201, 278-7234.

MINOR REQUIREMENTS

Admission requirement: Completion of Math 29 with a grade of C- or better, or passing the ELM at a level qualifying for Math 30.

Total units required for Minor: 21

A. Required Courses (12 units)

(3) CSC 15 Programming Concepts & Methodology I (CSC 10 or programming experience)
(3) CSC 20 Programming Concepts & Methodology II (CSC 15)
(3) CSC 28 Discrete Structures for Computer Science (MATH 029 and CSC 020; CSC 020 may be taken concurrently)
(3) CSC 130 Data Structures and Algorithm Analysis (CSC 20, 28; CSC 28 may be taken concurrently)

B. Electives (9 units)

(9) Select nine additional units with faculty approval; at least 6 units must be upper division courses, and only Computer Science courses which are part of the major may be applied to this 9-unit requirement.

LOWER DIVISION COURSES

1. Introduction to Computer Science. Fundamental concepts of computers, computation and programming; history and principles of computing; problem solving; input, output; data representation, storage, and file organization; computer hardware, networking and data communication; social, economic and ethical implications; computer security and privacy. Students will solve problems using the BASIC programming language. Lecture, two hours; technical activity and laboratory, two hours. Prerequisite: intermediate algebra. 3 units.
1A. *Introduction to Computer Science for Advanced Students.* Same material as covered in CSC 1 but intended for students who already have significant knowledge of the fundamental concepts of computers and/or computer programming. Student must attend the orientation session during the first class meeting. Two placement tests, one on programming and one on concepts will be scheduled and used to determine student's prior preparation. This course may be taken by those wishing to obtain credit by examination. Please refer to examination credit guidelines in the University catalog. Note: not open to students who have received credit for CSC 1 or MIS 5. Graded Credit/No Credit. 3 units.

4A. *Introduction to the PC Environment.* Introduction to computer hardware and software. This course is based on the Intel chipset (286, 386 and 489 Pentium machines). Topics include: components of computer hardware including boards found inside a typical computer, basic DOS command, application software, simple software installation, program management, file/directory organization, and buying your own computer. This course does not require any prior knowledge of computers. 1 unit.

4B. *Introduction to Windows.* Introduction to Microsoft Windows. Topics include: using the Program Manager, running Windows and DOS programs, organizing the desktop, customizing Windows and installing Windows software. Prerequisite: CSC 4A. 1 unit.

4C. *Configuring your PC.* This course is designed to provide the student with enough understanding of the hardware and software PC system operating in a Windows environment to be able to upgrade their computer, ask the right questions from vendors, understand the possible sources of hardware and software conflicts, install new hardware and do advanced installation of new software. Prerequisite: CSC 4B. 1 unit.

5. *Personal Computing.* An introduction to the role and use of personal (micro) computers. Explanation and hands-on experience with the personal computer, emphasizing the use and relevancy of common software for word processing, filing, spreadsheet analysis, graphics, and communications. Examination of the personal computing milieu and the applications environment. Lecture two hours, technical activity and laboratory, two hours. 3 units.

6A. *Microcomputer Applications-Word Processing.* A microcomputer-based introductory level course in word processing on microcomputers. 1 unit.

6B. *Microcomputer Applications-Spreadsheets.* A microcomputer-based introductory level course in spreadsheet concepts and applications. Note: not open to students receiving credit for MIS 1B. 1 unit.

6C. *Microcomputer Applications-Database Management.* A microcomputer-based introductory level course in database management concepts and applications. 1 unit.

8. *Exploring the Internet.* A user’s view of local, state, national and international computer networks. Software tools to access and retrieve information from around the world. Lecture one hour, technical activity and laboratory, two hours. 2 units.

8S. *Self-Paced Exploring the Internet.* This course covers the same material as CSC 8, Exploring the Internet. Course lectures are however, provided by electronic means, in addition to meetings for orientation, laboratory demonstrations and tests. The course provides a user’s view of local, state, national and international computer networks. Software tools to access and retrieve information from around the world include World Wide Web software tools, and much more. Included also are basic
elements of communication protocols, trends and future of the information superhighway, and an overview of how the CSUS computer network fits in the larger picture. Graded Credit/No Credit. 2 units.

10. **Introduction to Programming.** An introduction to computer science with an emphasis on programming concepts and methodology. Intended to prepare students with little or no programming experience for CSc 15. Computer hardware and software, data representation, data storage, programming concepts and methodology including problem solving and algorithm development, sequential programming, flow of control, modular and/or object based programming. Lecture two hour, technical activity and laboratory two hours. Prerequisite: Passing grade on the ELM. 3 units.

15. **Programming Concepts and Methodology I.** Programming concepts using a high-level, block structured language. Introduction to methodologies for program design, development, testing, and documentation. Topics include algorithm and program design, control structures, arrays, functions, procedures, text files, and records. Lecture two hours, technical activity and laboratory, two hours. Prerequisites: CSC 10 or programming experience. 3 units.

15W. **Programming Methodology I Workshop.** Course is designed to assist students in developing a more thorough understanding of programming methodology and problem solving techniques. Activity two hours. Corequisite: CSC 15. Graded Credit/No Credit. 1 unit.

20. **Programming Concepts and Methodology II.** Case study approach applying techniques for systematic problem analysis, and program specification, design, coding, testing, debugging, and documentation of large programs. Advanced language features: strings, sets, text and non-text files, pointers. Abstract data types: simple lists, stacks, queues. Recursion. Selected sorting and searching algorithms and their analysis. Lecture two hours, technical activity and laboratory two hours. Prerequisite: CSC 15. 3 units.

20W. **Programming Methodology II Workshop.** Course is designed to assist students in developing a more thorough understanding of programming methodology, data structures, and problem solving techniques. Activity two hours. Corequisite: CSC 20. Graded Credit/No Credit. 1 unit.

22. **Visual Programming in BASIC.** Beginning and advanced features of BASIC language available on personal computers. Topics include: program loops, arrays, tables, user and system functions, subroutines, strings, files. Applications in areas such as business, graphics, music, and games. Lecture one hour, technical activity and laboratory two hours. 2 units. (CAN CSCI 6)

25. **Introduction to C Programming.** An introduction to C programming. Topics include: types, operators, control structures, input/output, arithmetic operations, the C library and preprocessor, functions and parameters, arrays, strings, pointers, and structures. Program design and style will be emphasized. Students will use a microcomputer C compiler. Students with significant programming experience should take CSC 60 rather than CSC 25. Lecture two hours, technical activity and laboratory two hours. 3 units.

28. **Discrete Structures for Computer Science.** An introduction to the essential discrete structures used in Computer Science, with emphasis on their applications. Topics to be covered include: elementary formal logic and set theory, elementary combinatorics, recursive programming and algorithm analysis, digital logic and switching and combinatorial circuits, and computer arithmetic. Prerequisites: Math 29 and CSC 20 (CSC 20 may be taken concurrently). 3 units.
35. **Assembly Language Programming.** Fundamentals of assembly language programming. Topics include: internal representation of numeric and non-numeric data, assembly level machine architecture, addressing modes, register management, polled input/output, interrupts, macros and pseudo operations. Lecture two hours, technical activity and laboratory two hours. Prerequisite: CSC 15. 3 units.

60. **Introduction to Systems Programming.** An introduction to systems programming concepts using the C language. The course covers features of the C language commonly used in systems programming, and the application of those features to systems programming in a Unix environment. Topics include C preprocessor macros, I/O and bit-manipulation facilities; basic timesharing system concepts; file permissions; shells and shell script programming; makefiles and source code control systems; basic system calls including fork and exec; and relocation and linking concepts including assembler handling of symbol tables. Prior knowledge of C++ is presumed. Prerequisite: CSc 20. 3 units.

80. **Information Exchange on the Web.** The course will cover the basic elements needed to communicate on the World Wide Web. The primary emphasis will be use of the HTML language to create home pages. Other topics include Internet protocols, use of different browsers, setting up a Web server, and new Web software tools. Prerequisite: CSC 8. 3 units.

85. **Programming with Java.** Introduction to the programming language Java and the Java language environment. In addition, students will learn how to do Internet programming and how to run a program by "program renting". Topics include: creating an applet, Java/HTML interface, Java enabled browsers, Java stand alone application, client server, graphical user interface, Java development tools, Java scripting, custom networking and security. Prerequisite: CSC 60. 3 units.

**UPPER DIVISION COURSES**

120. **Setting Up and Maintaining a Web Server.** Set-up and maintenance procedures for a web server. Topics include: Communication on the web, HTTP protocol, choosing server software, basic installation, configuring the server, CGI scripts, managing the server, web security, working with JAVA, use of server scripts and procedures for doing business on the web. Prerequisite: CSC 80, instructor approval. 3 units.

121. **Using Scripts on the Web.** This course will provide the student experience in developing interactive web pages. Scripting tools are most useful to both internet providers and intranet developers. They provide the quickest, easiest way to create windows and documents with dynamic features and to develop forms with user interface elements to capture user input and management of information on the web. Students will work with Navigator, MIME types, plug-in objects, web security, and cookies. Prerequisite: CSC 80 or instructor approval. 3 units.

122. **Web Database Systems.** This course introduces students to database management systems, their structure and usage, with lecture and lab components throughout the course. Particular emphasis on database access via web interfaces. Topics will include connectivity between web pages and databases. The course will also cover an introduction to SQL, the standard relational DBMS query language, as well as selected topics on web search engines. Prerequisite: CSC 120 and permission of instructor. 3 units.
123. **Server Side Web Programming.** An introduction to developing dynamic web pages using Active Server Pages. Tools such as Visual Interdev will be used to develop scalable, client/server, database-driven applications that are browser-neutral. Prerequisite: CSC 22 or equivalent experience with Visual Basic or Visual Basic for Applications (VBA); CSC 80 or equivalent HTML skills; CSC 120 recommended. 3 units.

130. **Data Structures and Algorithm Analysis.** Specification, implementation, and manipulation of complex data structures: multi-lists, trees, sets, and graphs. Design and analysis of algorithms. Recursion and stack-based memory management. Advanced searching and sorting. NP-completeness. Prerequisite: CSC 20, 28; CSC 28 may be taken concurrently. 3 units.

131. **Computer Software Engineering.** Principles of Software Engineering covering the system project life cycle, software requirements analysis and design, planning and managing a project; also test design and testing, and project reporting. Topics include software development methods, data flow and tree diagramming, prototyping, top-down and bottom-up implementation and testing. Also included are program management plans, cost and schedule estimating, and user's manuals. Prerequisite: CSC 130; may be taken concurrently. 3 units.

132. **Computing Theory.** Introduction to computing theory with examples and applications. Automata and formal languages; language recognition and generation; language hierarchy; finite state machines: deterministic and non-deterministic automata; regular grammars and expressions; pushdown automata and context-free grammars; turing machines; computable and noncomputable functions; undecidable problems. Prerequisites: CSC 28, CSC 130; CSC 130 may be taken concurrently. 3 units.

133. **Object-Oriented Computer Graphics Programming.** An introduction to computer graphics and to advanced topics in object-oriented (OO) programming. It uses an OO paradigm throughout, utilizing computer graphics as the vehicle for solidifying basic OO concepts, studying the implementation of event-driven systems, and for developing a thorough understanding of advanced OO concepts such as inheritance and polymorphism. Topics covered include fundamental concepts of object-oriented programming, software design patterns, graphics devices, line and surface drawing, simple 2D and 3D representation, and use of User Interface components. Prerequisite: CSC 60, 130. 3 units.

134. **Database Management and File Organization.** Design of applications using database technology; elements of commercial data base management systems: concepts of database, storage structure, data modeling, with emphasis on the Entity-Relationship model; concepts of data normalization; relational, network and hierarchical models; basic physical design; file access methods, index definition; query facilities; introduction to database administration; introduction to transaction processing and backup and recovery; Introduction to SQL. Prerequisite: CSC 130. 3 units.

136. **Programming Languages.** Characteristics of programming languages. Compiled vs. interpreted languages; subprograms, recursion, parameter passing, scope of variables, binding time; structured programming and general control structures; run-time storage management; formal descriptions of languages; list processing, string manipulation, and data description languages; survey of advanced languages, including a detailed study of one or more; trends in programming languages. Prerequisite: CSC 132. 3 units.

137. **Computer Organization.** An introduction to digital logic, computer organization and computer architecture. Topics include: combinational and sequential circuits, memory, bus structures, input/output and interrupt structures, CPU organization, control unit design and organization, and an
introduction to modern architectural features. Lecture three hours, laboratory three hours. Prerequisites: CSC 28, 35, 130. 4 units.

138. Computer Networks and Internets. An overview of the fundamentals of computer networks and connections between networks, from the physical layer up through peer-to-peer communications at the application level. Lower layer characteristics including serial vs. parallel, capacity issues, high-speed connections, LAN framing and error handling. LAN vs. WAN characteristics, network architecture and the ISO network model. Internetworking components including LANs, repeaters, routers, bridges, and gateways. Internet addresses, TCP/IP, and the Domain Name System. Common Internet client/server application protocols including SMTP and FTP. Client/Server programming involving sockets. World Wide Web characteristics including CGI and HTTP protocol, Web pages, Web browsers, Web servers, and Applets. Introduction to advanced Web issues such as Web security, search engine operations, and Web database operations. Prerequisites: CSC 35, 60, 130. Cross-listed as CpE 138; only one may be counted for credit. 3 units.

139. Operating System Principles. Contemporary operating system organization and structure. Topics include: process representation, concurrency, scheduling, interprocess communication and synchronization, deadlock, real and virtual memory management, device management, file systems, network and distributed operating systems, and protection. Prerequisites: CSC 60, 137 or equivalents. 3 units.

142. Advanced Computer Organization. Design and performance issues of computers: CPU, I/O interface, and memory. Design alternatives for arithmetic functions, CPU internal architecture, instruction set, instruction cycle, I/O, interrupt, direct memory access, and bus and memory hierarchy. CAD tools for schematic capture and simulations. Students will design and simulate a microcomputer. Cross-listed as CPE 142, and can only be taken once for credit. Prerequisite: CSC 137 or equivalent. 3 units.

145. Advanced Systems Programming. A study of the elements of system software. Asemblers, both two-pass and one-and-a-half pass, including the processing of macros. Relocatable code and loaders. Linkage editors. The difference between interpreters and compilers. Simulation of one computer by another. The student will be required to write one or more large systems programs. Prerequisite: CSC 35, 60, 130; CSC 60 and 130 may be taken concurrently. 3 units.

148. Modeling and Experimental Design. Modeling and simulation techniques in system representation. Problem analysis, model formulation, data collection and analysis, experimental design, testing, verification and validation, and simulation experiments. Monte Carlo methods. Queuing theory. Term projects. Prerequisites: MATH 31, STAT 50, and proficiency in at least one programming language. 3 units.

151. Compiler Construction. A practical approach to compiler design and implementation. Organization of a compiler, algorithms for lexical and syntactic analysis, recursive descent, and/or LALR parsing, organization of symbol tables, error detection and recovery, object code generation. Structured design will be emphasized. Prerequisite: CSC 136. 3 units.

155. Advanced Computer Graphics. Modeling, viewing, and rendering techniques in 3D computer graphics systems. Topics include modeling systems and data structures; polygonal and parametric surface representation; transformations, windowing, clipping and projections in 3D; hidden surface removal algorithms; techniques for realism such as shading, shadows, highlights, and texture; fractals and
procedural models; introduction to animation; hardware support for computer graphics; and the application of graphics principles to virtual reality systems and 3D games. Prerequisite: CSC 133. 3 units.

159. **Operating System Pragmatics.** The application of operating system principles to the design and implementation of a multi-tasking operating system. Students will write an operating system for a computer system. Topics include: scheduling of processes, control and allocation of computer resources, and user interfacing. Cross-listed as CPE 159, and can only be taken once for credit. Prerequisite: CSC 139. 3 units.

170. **Software Requirements and Specification.** Analysis and specification of functional and non-functional requirements for real-time and non-real-time software systems in the context of a software development lifecycle. Determining customer and user software requirements and ensuring that specifications are correct, complete, and testable. Includes modeling techniques, methods for representing real-time requirements, and the use of Computer-Aided Software Engineering (CASE) tools to illustrate analysis concepts. Prerequisite: CSC 131. 3 units.

171. **Software Engineering Project Management.** Fundamental issues in the management and economics of a software engineering project in the context of the software development life cycle. Topics include: techniques for project planning (budgeting and scheduling), controlling (including quality assurance and configuration management), organizing, staffing, and directing a software project (leadership and motivation); and contemporary issues in management. Prerequisite: CSC 131. 3 units.

174. **Database Management Systems.** Additional topics in data base analysis and design, and applications, Extended Entity-Relational and UML modeling; query processing and optimization, concurrency control mechanisms, transaction performance and recovery algorithms, integrity constraints, triggers, functional dependencies and database design and normalization algorithms; data storage schemes Application generator technologies. Programming experience using database facilities. Introduction to XML. Database administration: system utilities, selection and acquisition of data base software. Prerequisites: CSC 131, 134. 3 units.

176. **Advanced Database Management Systems.** Advanced object-relational systems, advanced catalog systems, security mechanisms, distributed database processing, advanced schema design-partitioning, introduction to data warehousing and data mining, materialized views, internet technologies, parallel query processing, system utilities, database tuning, DBA tools and techniques. Prerequisite: CSC 174. 3 units.

179. **Software Testing and Quality Assurance.** Testing, verification, validation, and control of real-time and non-real-time software systems in the context of a software development lifecycle. Topics include: unit, integration and system testing; verification and validation (V&V), quality assurance, metrics, and configuration management. Prerequisite: CSC 131. 3 units.

190. **Senior Project: Part I.** The first of a two-course sequence in which student teams undertake a project to develop and deliver a software project. Approved project sponsors must be from industry, government, a non-profit organization, or other area. Teams apply software engineering principles in the preparation of a software proposal, a project management plan and a software requirements specification. All technical work is published using guidelines modeled after IEEE documentation standards. Oral and written reports are required. Lecture one hour, laboratory three hours. Prerequisite: Senior standing.
passed the WPE, completed CSC 130, CSC 131, and four additional 3-unit courses that fulfill the major requirements (excluding CSC 192 through CSC 199). 2 units.

191. **Senior Project: Part II.** Continuation of the group project begun in CSC 190. Teams apply software engineering principles to the design, implementation and testing of their software product. All technical work is published using guidelines modeled after IEEE documentation standards along with an appropriate user manual. Oral and written reports are required. Senior project is completed with the successful delivery, installation and demonstration of the software along with all approved documentation. Lecture one hour, laboratory three hours. Prerequisite: CSC 190. 2 units.

192. **Career Planning.** Designed to help students learn more about the labor market and opportunities in the Computer Science field. Students will examine their interests, consider their goals, and learn how to conduct an effective proactive job search. Strategies for long term career growth will be identified. Prerequisite: CSC 190; may be taken concurrently. 1 unit.

194. **Computer Science Seminar.** A series of weekly seminars on Computer Science topics. These topics would cover subjects not normally taught in the course of a school year and they range from the very theoretical in Computer Science through applications to presentations by industry on working conditions, real world environment and job opportunities. May be repeated for credit. Prerequisite: upper division or graduate standing in CSC. 1 unit.

195. **Fieldwork in Computer Science.** Directed observations and work experience in computer science with firms in the industry or public agencies. Supervision is provided by the instructional staff and the cooperating agencies. Note: faculty approval required. May be repeated for credit. Graded Credit/No Credit. 1-4 units.

195A-D. **Professional Practice.** Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. Prerequisite: Permission of instructor. Graded Credit/No Credit. 1-12 units.

196. **Experimental Offerings in Computer Science.** When a sufficient number of qualified students apply, one of the staff will conduct a seminar in some topic of computer science. May be repeated for credit. 1-4 units.

197A-D. **Campus-Based Professional Practice.** Industry-sponsored on-campus professional practice administered through the Co-op Program of the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. Graded Credit/No Credit. 1-12 units.

198. **Co-curricular Activities in Computer Science.** Tutoring of students taking computer science courses through the Computer Science Department Tutoring Center; peer advising of less advanced students in the major; or other activities related to the subject matter and concerns of the department. Graded Credit/No Credit. 1-3 units.

199. **Special Problems.** Individual projects or directed reading in specified topics in computer science. Note: open only to students who appear competent to carry on individual work; approval of faculty supervisor and advisor required. May be repeated for credit. Graded Credit/No Credit. 1-3 units.
GRADUATE COURSES

Graduate courses may be taken as electives by undergraduate students with a GPA of 3.0 or better. Consult the department for a list of appropriate courses.

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The information presented here is believed to be correct. For official descriptions and requirements, please consult the general catalog of the University; however, there may be some changes in progress which are reflected here and not in the catalog.