



# COMPUTER SCIENCE

BACHELOR OF SCIENCE  
MINOR  
MASTER OF SCIENCE

## PROGRAM DESCRIPTION

The BS degree in Computer Science is accredited by the Computer Science Accreditation Commission (CSAC) of the Computer Science Accreditation Board.

The BS program provides majors with a sound educational base. Beyond the core curriculum students select one or two of seven areas of further study: Computing Theory and Symbolic Computation, Computer Architecture and Operating Systems, Database, Data Communication and Networking, Graphics, Software Engineering, and System Software.

The MS degree offers, in addition to a core curriculum, advanced studies in one of five areas: Artificial Intelligence, Computer Architecture, Computer Engineering, Software Engineering, and Systems Software.

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 units: with the Mathematics Department, a BA double major in Mathematics and Computer Science (refer to the Mathematics section of this catalog); with the Electrical and Electronics Engineering Department, a major in Computer Engineering (refer to the Computer Engineering section of this catalog).

**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) requirements are required to complete and submit a Change of Major form to the Computer Science Department office along with transcript copies: CSC 15, 20, 35, and MATH 30 and 31.

## FACULTY

Anne-Louise Radimsky, *Department Chair*

Frederick Blackwell; Robert Buckley; Senad Busovaca; John Clevenger; Nikrouz Faroughi; Dwight Freund; Isaac Ghansah; John Gwynn, Jr.; James Kho; Kwai-Ting Lan; Floyd LeCureux; Mary Jane Lee; Meiliu Lu; Carole McNamee; John Miles; William Mitchell; Richard Smith; Donald Steward; Richard Thayer; Chung-E Wang; Don Warner; Du Zhang

Virginia Duran, *Department Secretary*  
*Department Office, ECS-3018, 278-6834*

## FEATURES

The department consists of 24 full-time faculty members. The faculty's research interests span a broad spectrum of Computer Science including 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.

A large heterogeneous network of Sun, DEC, and Hewlett-Packard RISC servers and workstations combined with PC's, Macintoshes, and NEXT workstations supports the instructional programs. PC and Macintosh 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. All students have access to the Internet and the World Wide Web. Majors are urged 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.

## CAREER POSSIBILITIES

Computer Scientist • Management Information Specialist • Computer Systems Analyst • Technical Representative • Teleprocessing Coordinator • Scientific Application Programmer • Data Processing Application Programmer • Computer Operations Manager • Computer Services Coordinator • Data Base Administrator • Data Communications Manager • Data Processing Manager • Information Specialist • Programmer Analyst • Software Engineer • Systems Manager • Systems Programmer • Technical Control Specialist • Computer Graphics Specialist • Knowledge Engineer • Systems Engineer

## MAJOR REQUIREMENTS • BS

Total units required for BS: 130

Total units required for Major: 87-88 units

**Courses in parentheses are prerequisites.**

**Note:** Grade "C-" or better required in all courses applied to a Computer Science major.

### A. Required Lower Division Courses (12 units)

- (3) CSC 15 Programming Concepts & Methodology I (CSC 1 or programming experience)
- (3) CSC 20 Programming Concepts & Methodology II (CSC 15)
- (3) CSC 35 Assembly Language Programming (CSC 15)
- (3) CSC 60 C Programming in UNIX Environment (CSC 20)

### B. Required Mathematics Courses (18 units)

- (4) MATH 30 Calculus I (MATH 29)
- (4) MATH 31 Calculus II (MATH 30)
- (3) MATH 101 Discrete Mathematics (MATH 31)
- (4) STAT 50 Introduction to Probability & Statistics (MATH 30)
- (3) Select one of the following:
  - MATH 35 Introduction to Linear Algebra (MATH 30)
  - MATH 45 Differential Equations for Science & Engineering (MATH 31)
  - MATH 100 Applied Linear Algebra (MATH 31)
  - MATH 150 Introduction to Numerical Analysis (MATH 32 or 45)

### C. Required Science Courses (11-13 units)

- (4) PHYS 11A General Physics: Mechanics (MATH 30, 31)
- (4) PHYS 11C General Physics: Electricity & 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 & 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 & 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 (34 units)

- (3) CSC 130 Data Structures & Algorithm Analysis (CSC 20)
- (3) CSC 131 Computer Software Engineering (CSC 130; may be taken concurrently)
- (3) CSC 132 Computing Theory (MATH 101, CSC 130; may be taken concurrently)
- (3) CSC 134 File Organization for Data Management (CSC 130)
- (3) CSC 135 Systems Programming (CSC 35, 60, 130; 60 and 130 may be taken concurrently)
- (3) CSC 136 Programming Languages (CSC 132)
- (4) CSC 137 Computer Organization (CSC 35, 130, MATH 101)
- (3) CSC 139 Operating System Principles (CSC 60, 137; or equivalents)
- (2) CSC 190\* Senior Project: Part I (CSC 131, CSC senior standing, Writing Proficiency Exam)
- (2) CSC 191 Senior Project: Part II (CSC 190)
- (3) PHIL 103 Business & Computer Ethics
- (2) Select two units from the following:
  - CSC 192 Career Planning (1 unit maximum)
  - CSC 194 Computer Science Seminar
  - CSC 195 Fieldwork in Computer Science
  - CSC 198 Co-curricular Activities in Computer Science
  - CSC 199 Special Problems

\* Senior standing is defined as successful completion of at least five required upper division computer science courses beyond CSC 130 and excluding 19X courses

### E. Area Requirements (12 units)

Each student is required to meet with his/her advisor to plan a program of elective study. Students select a total of two courses designed to provide in-depth study in one or more areas of the computing sciences. If the pairs overlap and result in the selection of only three courses, the fourth course will be selected from any Computer Science course numbered 140 to 189. This list will be updated to include experimental (196X) and new courses that the Department develops. Students with a GPA of 3.0 or better may, with prior approval of the course instructor, their advisor and the Department Chair, substitute graduate courses for the courses listed below.

#### Computing Theory and Symbolic Computation

- CSC 151 Compiler Construction (CSC 135, 136)
  - CSC 160 Symbolic Computation (CSC 136)
- Select the following pair: (151 and 160)

#### Computer Architecture, Operating Systems

- CSC 142 Advanced Computer Organization (CSC 137)
- CSC 159 Operating System Pragmatics (CSC 139)
- CSC 162 Ada Environment (CSC 130)
- CSC 175 Data Communication Systems (CSC 137, 139)

Select one of the following pairs: (142 and 159), (159 and 175), (159 and 162).

### Database

- CSC 170 Structured Systems Analysis & Design (CSC 131)
- CSC 174 Data Base Management Systems (CSC 131, 134)
- CSC 176 Adv. Data Base Management Systems (CSC 174)

Select one of the following pairs: (174 and 170), (174 and 176).

### Data Communication and Networking

- CSC 142 Adv. Computer Organization (CSC 137)
- CSC 148 Simulation (MATH 31, STAT 50, programming proficiency)
- CSC 175 Data Communication Systems (CSC 137, 139)

Select one of the following pairs: (175 and 142), (175 and 148).

### Graphics

- CSC 154 Principles of Computer Graphics (CSC 130)
- CSC 155 Intermediate Computer Graphics (CSC 154)
- CSC 161 Object Oriented Concept and Programming (CSC 130, 60)

Select one of the following pairs: (154 and 155), (154 and 161)

### Software Engineering

- CSC 170 Structured Systems Analysis & Design (CSC 131)
- CSC 171 Software Engineering Project Management (CSC 131)
- CSC 179 Software Testing & Quality Assurance (CSC 131)

Choose one of the following pairs: (170 and 171), (170 and 179), (171 and 179)

### System Software

- CSC 151 Compiler Construction (CSC 132)
- CSC 159 Operating Systems Pragmatics (CSC 139)
- CSC 175 Data Communication Systems (CSC 137, 139)

Select one of the following pairs: (151 and 175), (151 and 159)

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## ADDITIONAL INFORMATION

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### 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,

or 195D) 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, LSN-2008, 278-7234.

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## MINOR REQUIREMENTS

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Total units required for Minor: 18

### A. Required Courses (9 units)

- (3) CSC 15 Programming Concepts & Methodology I (CSC 1, programming experience)
- (3) CSC 20 Programming Concepts & Methodology II (CSC 15)
- (3) CSC 130 Data Structures and Algorithm Analysis (CSC 20)

### B. Electives (9 units)

- (9) Select nine additional units with faculty approval; at least 6 units must be upper division courses, and CSC 1, 1A, and 124 may not be applied to this requirement.

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## GRADUATE PROGRAM

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The primary goal of the Computer Science graduate program is to prepare students to serve as effective professional computer specialists in a society which increasingly depends on computer usage and technology. A secondary goal is to prepare some students for research, teaching, or further study toward the Ph.D. in Computer Science. The program also enables individuals with background in other areas to obtain the skills and knowledge necessary to enter and advance in employment in computer-related industries. Graduate students must focus their studies in one of the following six areas:

- **Artificial Intelligence** — This area covers the programming of computers to carry out tasks normally associated with human intelligence. Specific areas include expert systems, pattern recognition, computer vision, machine learning, and logic programming.
- **Computer Architecture** — This area covers the design of a broad range of modern computers from basic architecture to more specialized systems including parallel machines, fault tolerant computers, data flow machines, and special purpose processors. It includes design consideration of computer networks, and VLSI design methodology.
- **Computer Engineering** — This is a broad area that covers advanced topics in the application of engineering design principles, including the use of hardware description languages such as Verilog and VHDL, to the design, modelling and synthesis of high and micro-processors and micro-computer systems, computer architecture, data communication systems, and digital signal processing.
- **Software Engineering** — This area covers the whole software application development process from problem definition through requirements, design, implementation, testing, operation and maintenance.
- **Systems Software** — This area is concerned with developing the programs designed to facilitate the efficient use of the computer resources and to aid in the development and execution of application programs. This includes operating systems, compilers, data communication and computer networking software, and data base management systems.

The department has a small number of graduate assistantships for qualified graduate students. Graduate assistants assist in instruction of undergraduate courses, supervision of laboratory work, and aid faculty members in research projects. Interested persons should apply at the Graduate Center.

Due to the large number of graduate students in computer science who are employed, most graduate level courses are offered in the late afternoon or evening.

### Admission Requirements

Admission as a classified graduate student requires:

- a baccalaureate degree **and**
- a minimum 3.0 GPA in the last 60 units attempted **and**
- advanced proficiency in Pascal, C, or Ada, including an introduction to data structures **and**
- proficiency in an assembly language **and**
- two semesters of calculus and one semester of probability and statistics **and**
- a minimum 3.25 GPA in CSUS courses: CSC 130, 131, 137, 139, and MATH 101.

Applicants with deficiencies in the admission requirements are advised to remove any such deficiencies before applying. The department will only grant conditional admission to students who are likely to complete all admission requirements by the semester they enter the graduate program.

### Admission Procedures

Applications are accepted during the initial filing period of the semester (February for Fall semesters or August for Spring semesters). All prospective graduate students, including CSUS graduates, must file the following with the CSUS Graduate Center:

- an application for admission and a supplemental application for graduate admission (Forms A and B in the CSU application booklet)
- two sets of official transcripts from all colleges and universities attended, *other than CSUS*

Approximately six weeks after receipt of all items listed above, a decision regarding admission will be mailed to the applicant.

### Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the classified graduate student has:

- removed any deficiencies in Admission Requirements **and**
- completed at least 9 units of graduate level (200 series) computer science courses with a minimum 3.0 GPA

Students must have been advanced to candidacy before they can register for Master's thesis or project. Advancement to Candidacy forms are available in the Graduate Center. The student fills out the form after planning a degree program in consultation with a Computer Science graduate advisor. The completed form must be signed by the Graduate Coordinator or the Department Chair and is then returned to the Graduate Center for approval.

## Degree Requirements

The Master of Science in Computer Science requires completion of 30 units of coursework, including at least 21 units of 200-level and 500-level courses, with a minimum 3.0 GPA. Only those courses completed within seven years prior to date of graduation will satisfy course requirements. An outline of degree requirements follows:

### A. Required Courses (13 units)

- |     |          |   |
|-----|----------|---|
| (3) | CSC 201* | Programming Language Principles (graduate standing)   |
| (3) | CSC 204* | Data Models for Data Management Systems (graduate standing)   |
| (3) | CSC 205* | Computer Systems Structure (CSC 137, 139)   |
| (3) | CSC 206  | Algorithms and Paradigms (graduate standing)  |
| (1) | CSC 209  | Graduate Seminar (fully classified graduate standing, Writing Proficiency Exam, 9 units of 200-level courses) |

\*Students whose undergraduate preparation has covered a significant amount of the material in CSC 201, 204, or 205 may be given a waiver by the Department from taking one or more of these courses. In this case, for each course waived with Department approval, the student must take three additional units of Restricted Electives, **Section C** below.

### B. Area Requirements (9 units)

- (9) Select three courses from **one** of the following five areas:

#### 1. Artificial Intelligence

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|---------|---|
| CSC 214 | Knowledge-Based Systems (graduate standing) |
| CSC 215 | Artificial Intelligence (graduate standing) |
| CSC 216 | Pattern Recognition (CSC 201)               |
| CSC 217 | Logic Programming (MATH 101, CSC 201)       |
| CSC 219 | Machine Learning (graduate standing)        |

#### 2. Computer Architecture

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|---------|--|
| CSC 237 | Microprocessor Systems Architecture (CSC 205)                    |
| CSC 242 | Computer-Aided Design Methodology for Computer Systems (CSC 205) |
| CSC 273 | Hierarchical Digital Design Methodology (CPE 64 or equivalent)   |
| CSC 275 | Advanced Data Communication Systems (CSC 175, 205, or CPE 175)   |
| CSC 280 | Advanced Computer Architecture (CSC 205)                         |

#### 3. Computer Engineering

- |         |  |
|---------|--|
| CSC 237 | Microprocessor Systems Architecture (CSC 205)                    |
| CSC 242 | Computer-Aided Design Methodology for Computer Systems (CSC 205) |
| CSC 273 | Hierarchical Digital Design Methodology (CPE 64 or equivalent)   |
| CSC 275 | Advanced Data Communication Systems (CSC 175, 205, or CPE 175)   |
| CSC 280 | Advanced Computer Architecture (CSC 205)                         |



#### 4. Software Engineering

CSC 230	Software System Engineering (CSC 131)
CSC 231	Software Engineering Economics (CSC 230)
CSC 232	Software Requirements Engineering (CSC 230)
CSC 233	Advanced Software Engineering Project Management (CSC 131, 230 or equivalent industrial experience)
CSC 234	Software Verification & Validation (CSC 131, 230 or equivalent industrial experience)

#### 5. Systems Software

CSC 239	Advanced Operating System Principles and Design (CSC 205)
CSC 244	Data Base Design (CSC 174)
CSC 245	Performance Modeling and Evaluation (graduate standing)
CSC 246	Principles of Concurrent Programming (MATH 101, CSC 139; or graduate standing)
CSC 250	Computer Security and Privacy (graduate standing)
CSC 251	Principles of Compiler Design (CSC 151 or 201)
CSC 255	Computer Networks (CSC 175 or CPE 175)
CSC 258	Distributed Systems (CSC 175 or CPE 175; graduate standing)

**Note:** A course from the Computer Architecture area may be substituted for one of the above courses.

#### C. Restricted Electives (3-6 units)

Students in the Computer Engineering area must choose their electives as follows: EEE 285 or 286, and CSC 142.

Students in other areas should choose their electives to complement the courses in their area requirements according to the following guidelines:

1. Select upper division courses 140 to 189, and which have not been used for a bachelor's degree. These must be chosen with advisor and department approval since certain courses may be disallowed depending on the student's selected area.
2. Any 200-level CSC courses not used to satisfy the **Area Requirements**, with the exception of CSC 295 and 299. Students not required to take CSC 201, 204, or 205 must, for each course waived, take an additional three units in this category or category one above.
3. Related 200-level courses from outside the Computer Science Department, with prior department approval, which have not been used in another program.

Students must, prior to taking the courses, obtain approval from their graduate advisor and either the graduate coordinator or the department chair.

#### D. Culminating Requirement (2-5 units)

- (2-5) CSC 500 Master's Thesis **OR**  
(2) CSC 502 Master's Project

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## LOWER DIVISION COURSES

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**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, 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 — Data Base Management.

A microcomputer-based introductory level course in data base 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.

**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 1, 1A, or programming experience. 3 units.

**16. FORTRAN Programming.** Design and development of structured FORTRAN programs to solve numerical problems in mathematics, science and engineering. Topics include input/output, variables, loops and nested loops, decision structures, functions, subroutines, and arrays. Lecture one hour, laboratory three hours. 2 units. (CAN CSCI 4)

**17. Introduction to Computer Aided Engineering.** Introduction to the use of computers for engineering, science and mathematical computations. Provides basic computer operation skills, and includes the use of modern interactive symbolic and numerical computation packages as well as an introduction to programming methods for solving problems. The use of graphical visualization tools for output will be emphasized. Sample applications will be drawn from a variety of science and engineering areas. Lecture one hour, laboratory three hours. **Prerequisites:** MATH 30, PHYS 11A, ENGR 30; PHYS 11A, ENGR 30 may be taken concurrently. 2 units.

**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.

**22. BASIC Programming.** 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.

**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. C Programming in UNIX Environment.** An introduction to the C programming language and the UNIX operating system. C topics include: declarations, functions, pointers, arrays, structures, I/O, string manipulation, and system calls. UNIX topics include: files, utilities, the shell, and shell programming. Assignments emphasize the use of software tools in C program development and the interface between C and UNIX. **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. 3 units.

**96. 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.

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## UPPER DIVISION COURSES

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**125. Applied Computer Graphics.** Introduction to computer graphics devices, methods, current technologies, and applications. Comprehensive survey of graphics devices, with specific examples and exercises in bit-mapped, raster graphics; characteristics and features of 2D and 3D CAD modeling systems; linear transformations for manipulating 2D and 3D wire frame objects; planar and perspective projections, viewing operations and parameters; animation and audio/visual integration techniques. Numerous assignments using a variety of different graphics hardware/software systems. Course may not be taken as an elective in the CSC major. **Prerequisite:** CSC 15 or 16. 3 units.

**130. Data Structures and Algorithm Analysis.** Programming with abstract data types. 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 sorting. **Prerequisite:** CSC 20. 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:** MATH 101, CSC 130; CSC 130 may be taken concurrently. 3 units.

**134. File Organization for Data Management.** Introduction to database systems: concepts, design, implementation, file system support. Survey of current mass storage systems and discussion of trends. Extensive study of file organizations: sequential, indexed, direct and hybrids; access methods in data management environments. Discussion of distributed file systems. **Prerequisite:** CSC 130. 3 units.

**135. Systems Programming.** A study of the elements of system software. Assemblers, 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. **Prerequisites:** CSC 35, 60, 130; CSC 60 and 130 may be taken concurrently. 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 35, 130, MATH 101. 4 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.

**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. Queueing 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. **Prerequisites:** CSC 135 and 136. 3 units.

**154. Computer Graphics Systems Design.** Introduction to computer graphics system and applications software design and implementation. Topics include: graphics output devices, graphics libraries, two and three dimensional transformation, scan conversion algorithms, windowing and clipping, interactive input methods, modeling methods and an introduction to curve representation. **Prerequisite:** CSC 130; may be taken concurrently. 3 units.

**155. Intermediate Computer Graphics.** Investigation of the principles and techniques underlying computer graphics systems, and of more advanced topics in three-dimensional graphics. Topics include modeling systems, data structures and graphics command software; graphics languages; transformations, clipping, and windowing; three dimensional projections; hidden line/surface problems; advanced techniques for realism such as shading, shadows, highlights, and texture. **Prerequisite:** CSC 154 or permission of instructor. 3 units.

**159. Operating System Pragmatics.** The application of operating system principles to the design and implementation of a multitasking 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.

**160. Symbolic Computation.** Symbolic computing languages and their importance in contemporary computing; study of one or more languages in depth; algorithms and heuristics; representation techniques typical of symbolic computing; knowledge representation techniques. **Prerequisite:** CSC 136. 3 units.

**161. Object Oriented Concept and Programming.** An introduction to object oriented programming principles and concepts using C++. The objective is to develop sufficient expertise in C++ to be able to design and use object libraries employing the object oriented extension in C++. Major topics include the class mechanism, inheritance and encapsulation, scope and member access of classes, access privileges of members of derived classes, constructors and destructors, virtual functions and polymorphism, abstract classes, operator overloading, friend functions and classes, container classes, designing, implementing, extending and using object libraries. **Prerequisites:** CSC 130 and CSC 60 or equivalent experience. 3 units.

**162. Ada Environment.** Fundamentals of Ada programming language; object-oriented design, data abstraction and modularity, packages, generic program units, overloading, tasking and the rendezvous, exception handling, and Ada programming support environment. **Prerequisite:** CSC 130. 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 lifecycle. 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. Data Base Management Systems.** Design of applications using data base 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; query facilities; database administration; introduction to transaction processing, and backup and recovery. **Prerequisites:** CSC 131, 134. 3 units.

**175. Data Communication Systems.** Fundamentals of data communications. Topics include: classification of data communication systems, layered architectures, protocol suites, hardware and software elements, communication media and the interfaces, roles and inter-relationships of the system elements, users, analysts and designers. Cross-listed as CPE 175, and may only be taken once for credit. **Prerequisites:** CSC 137 or permission of instructor; and 139; CSC 139 may be taken concurrently. 3 units.

**176. Advanced Data Base Management Systems.** Advanced topics in data base analysis and design, and applications: query processing and optimization, concurrency control mechanisms, transaction performance and recovery algorithms, integrity constraints, catalog systems, security mechanisms, functional dependencies and design algorithms. Application generator technologies. Programming experience using database facilities. Database administration: system utilities, selection and acquisition of data base software. Topics in distributed data base systems. **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.** A group project for the design, development and delivery of a computer product. The product may be a software product or a product containing both hardware and software components. The product's customer must be a representative from industry, government, or some other approved area. The course emphasizes the software development process and documentation using a software engineering lifecycle approach. Oral and written reports are required. In Part I (CSC 190), student teams define the project requirements and plan the complete project. In Part II (CSC 191), the teams design, implement, test, and deliver the product. Lecture one hour, laboratory three hours. **Prerequisites:** CSC 131, senior standing in CSC, passing Writing Proficiency Exam. 2 units.

**191. Senior Project: Part II.** Continuation of the individual or group project begun in CSC 190. In Part II, the student teams complete the project, including design, implementation, testing, and delivery. End of project reports are required. 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 and 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. Graded Credit/No Credit. 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 School 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.

**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.

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## GRADUATE COURSES

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**201. Programming Language Principles.** Evolution of programming languages. Formal description of programming languages: regular, context-free, attribute grammars. Features of programming language design: variables, binding, scope, extent, data type, abstract data types, control structures, procedures, parameters, recursion. Selection of an appropriate programming language for a specific application. Formal analysis techniques: bottom-up, top-down, recursive descent, LALR parser generators. Translation of programming languages: activation records, error recovery. Code optimization. **Note:** not intended for students who have taken CSC 132. **Prerequisite:** fully classified graduate standing in Computer Science. 3 units.

**204. Data Models for Data Base Management Systems.** Study of: file systems; file design techniques such as normalization; file utilities; file organizations (heap, sequential, indexed, direct, multi-ring); distributed file systems; data models (entity relationship, various database management systems [DBMS] models); DBMS file internals; transaction processing; backup and recovery. **Note:** not intended for students who have completed CSC 134 and 174. **Prerequisite:** fully classified graduate standing in Computer Science. 3 units.

**205. Computer Systems Structure.** Overview of computer systems structure, covering hierarchical structure from software and hardware points of view. Concepts of relocation, linking, and loading; hardware-software interfaces from both application program and operating system points of view. Various CPU structures, including RISC and CISC machines, survey of tightly and loosely-coupled architecture, introduction to pipelined, distributed, and parallel systems, computer system communication principles including local and wide-area networks concepts, and various CAD tools and methodologies are introduced. **Prerequisites:** CSC 137, 139. 3 units.



- 206. Algorithms and Paradigms.** Design and analysis of computer algorithms and examples of their use in a wide variety of problem domains. Contemporary paradigms of computing, including parallel and heuristic approaches. Theoretical limits of the algorithmic method. **Note:** may not be taken for credit by students who have received credit for CSC 220. **Prerequisite:** fully classified graduate standing in Computer Science or permission of instructor. 3 units.
- 209. Graduate Seminar.** Presentations on various topics in the computing sciences; requirements and resources for completion of the master's project/thesis; presentation of papers/literature surveys by students. **Prerequisites:** fully classified graduate standing, Writing Proficiency Exam, completion of at least 9 units of 200-level courses in Computer Science. Graded Credit/No Credit. 1 unit.
- 214. Knowledge-Based Systems.** Historical perspective of knowledge-based systems and their relationship to artificial intelligence. Concepts of knowledge representation and automated reasoning. Survey of expert systems in a variety of applications in engineering and other fields. Implementation of expert systems and expert system shells. **Prerequisite:** graduate standing in Computer Science or Engineering. 3 units.
- 215. Artificial Intelligence.** Nature of intelligence and possibility of its realization on digital computers via algorithmic and heuristic programming methods. Knowledge representation. Search procedures. Problem-solving paradigms and simulation of cognitive processes. Machine learning. Natural language understanding, expert systems, and knowledge engineering. Image understanding. Future of artificial intelligence and limits of machine intelligence. **Prerequisite:** graduate standing. 3 units.
- 216. Pattern Recognition.** Symbolic and mathematical representation of patterns and structures. Sensing, preprocessing, feature extraction, and classification using both syntactic and mathematical methods. Comparison and integration of structural and mathematical approaches to recognition. Relationship to artificial intelligence; neural networks for recognition. Selected applications. **Prerequisite:** CSC 201. 3 units.
- 217. Logic Programming.** Introduction to the representation and problem-solving techniques of logic programming. Topics covered include: first order predicate logic, unification algorithm, resolution principle, resolution refutation, Horn clauses and Horn clause logic programs, interpretations and control strategies of Horn clause programs, semantics and parallel execution of logic programs, applications, existing research problems and future directions of logic programming. **Prerequisite:** MATH 101 and CSC 201 or permission of instructor. 3 units.
- 219. Machine Learning.** Introduction to major paradigms and methods of machine learning. Inductive learning, explanation-based learning, classifier systems and genetic algorithms, analogical reasoning, case-based learning, connectionist learning, data driven approaches to empirical discovery, and basis of learning theory. Focus is on representative systems that have been built. **Prerequisite:** graduate standing. 3 units.
- 230. Software System Engineering.** Overall integration of managerial and technical activities controlling the cost, schedule, and technical achievement of developing software systems; and application of system engineering principles, activities, tasks, and procedures to development of software systems are covered. **Prerequisites:** fully classified graduate standing in Computer Science; CSC 131 or equivalent experience. 3 units.
- 231. Software Engineering Economics.** A project management course with emphasis on software costs, budgeting and scheduling. Also covered are topics on software costs models, cost-benefit analysis, software productivity, macro and micro level cost estimation, maintenance cost estimating, and model calibration. **Prerequisite:** CSC 230 or equivalent experience. 3 units.
- 232. Software Requirements Engineering.** Examines state-of-the-art techniques of system analysis, software requirements analysis, and software requirements specifications. Emphasis is placed on developing software requirements from system requirements; using modern techniques and tools to analyze software requirements; and using document-driven, process-driven, structured, and formal methods for representing requirements. Class projects will provide experience in analyzing and specifying a software system. **Note:** cannot be taken by students who have received credit for CSC 210. **Prerequisite:** CSC 230 or equivalent experience. 3 units.
- 233. Advanced Software Engineering Project Management.** Advanced methods and procedures for managing a software development project. Providing a cost effective process necessary to lead a software project to a successful conclusion. Topics include project planning, scheduling and cost estimation, project organizational types, staffing and training considerations, leading and motivating computer personnel, and methods for measuring and controlling a project. Also included are topics on the major issues of management and the "The Keys to Project Success." **Prerequisite:** CSC 131 or 230, or equivalent industrial experience. 3 units.
- 234. Software Verification and Validation.** The identification and use of verification and validation (V&V) techniques used to identify and resolve software problems and high-risk issues early in the software lifecycle. Application of V&V to all phases of the lifecycle process to include planning and reporting on the V&V effort. Topics also include software quality assurance and software testing. **Prerequisite:** CSC 131 or 230, or equivalent industrial experience. 3 units.
- 237. Microprocessor Systems Architecture.** Microprocessor/microcomputer architecture and hardware/software interfacing design. RISC v. CISC architecture in depth, case studies of several popular commercial advanced 32-bit microprocessors. Microcomputer firmware architecture is discussed and illustrated with detail examples. Term project in which students specify, design and build the hardware and firmware of a computer system. **Prerequisite:** CSC 205. 3 units.
- 239. Advanced Operating Systems Principles and Design.** Advanced concepts of concurrent processes, concurrent programming and operating systems. Virtual memory management systems, deadlock, file systems, operating system performance measurement and evaluation. **Prerequisite:** CSC 205. 3 units.
- 242. Computer-Aided Design Methodology for Computer Systems.** Computer-aided design methodology; CAD tools for computer design; alternatives for IC Chip design; the use of tools for schematic capture, circuit routing, PC board layout, CMOS VLSI design; principles of operation of CMOS VLSI circuits; VLSI design project. **Prerequisite:** CSC 205. 3 units.
- 244. Data Base Design.** This course discusses the various components of general data base systems. Implementation methods of the major data models — hierarchical, network and relational — of data base systems will be discussed. Other topics include query language design, methods to gain reliability, protection schemes, integrity, methods of coding data, performance considerations and other special topics. Some actual data base systems will be used for illustrative purposes. **Prerequisite:** CSC 174 or 204. 3 units.

**245. Performance Modeling and Evaluation.** Performance and cost measures; software and hardware performance monitors; data reduction and evaluation; analytic and simulation models of hardware and program behavior; performance-cost trade-offs and resource allocation. **Prerequisite:** fully classified graduate standing. 3 units.

**246. Principles of Concurrent Programming.** Fundamental concepts of sequential program verification; fundamental concepts and applications of concurrent program; issues of liveness, fairness, and safety; concurrent program verification and derivation; language constructs for parallel computation; distributed programming techniques. **Prerequisites:** MATH 101, CSC 139; or fully classified graduate standing. 3 units.

**250. Computer Security and Privacy.** Data processing controls. Errors and fraud. Software and hardware protection. Cryptographic techniques. Disaster and catastrophe prevention. Privacy. **Prerequisite:** graduate or professional status in computer science. 3 units.

**251. Principles of Compiler Design.** Syntactic description of programming languages. Topics covered include syntax-directed parsing, bottom up vs. top down parsing, operator precedence, LR, LALR parsing, syntax directed translation. Error detection and recovery. Code optimization using flow analysis, and code generation. **Prerequisite:** CSC 151 or 201. 3 units.

**255. Computer Networks.** Computer networking fundamentals with emphasis on higher level protocols and functions. Network design considerations, software design and layering concepts, interface design, routing and congestion control algorithms, internetworking, transport protocol design, and end-to-end communication, session and application protocols. Specific examples of commercial and international standards. **Prerequisite:** CSC 175, CPE 175, or permission of instructor. 3 units.

**258. Distributed Systems.** Coordination of decentralized autonomous computer systems connected by a communication subnet to achieve a common goal. Topics include architectures, message-passing, remote procedure calls, deadlock detection, concurrency control, replication and error recovery, synchronization, resource management, distributed database systems, languages, distributed algorithms, and case studies. **Prerequisites:** CSC 175 or CPE 175, fully classified graduate standing. 3 units.

**273. Hierarchical Digital Design Methodology.** This is a hierarchical digital design course that covers the following topics: state machine design, use of programmable logic devices, digital simulation techniques, digital interface, design with ASIC (Application Specific Integrated Circuits), and design with programmable gate arrays. The course will also cover designing with GaAs high speed logic devices. The problems with EMI, RFI, and EMC will be presented along with design guidelines. Lecture three hours. Cross-listed as EEE 273, and can only be counted once for credit. **Prerequisite:** CPE 64 or equivalent. 3 units.

**275. Advanced Data Communication Systems.** Topics include: concepts, principles and issues of data communication systems; ISO/OSI reference model as a vehicle for discussion; emphasis on lower layers of the model; motivation and objectives, layered architectures, physical layer principles and protocols, data link and multiple-access control principles and protocols, circuit and packet switching, local area network design principles and performance comparisons, introduction to wide area network architectures; typical examples and standards for point-to-point, satellite, packet radio and local area networks. **Prerequisite:** CSC 175, 205, or CPE 175. 3 units.

**280. Advanced Computer Architecture.** Course introduces computer classification schemes, structures of uni- and multi-processor systems, parallelism in uniprocessor systems, design and performance analysis of pipelined and array processors; survey and analysis of interconnection networks and parallel memory organizations; programming issues of multiprocessor systems; and fault tolerant computing and design for testability. Cross-listed as EEE 280, only one of these courses may be counted for credit. **Prerequisite:** CSC 205. 3 units.

**295. Fieldwork.** 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. 1-3 units.

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

**299. Special Problems.** Any properly qualified student who wishes to pursue a problem of his own choice may do so if the proposed subject is acceptable to the member of the staff with whom he works and to his advisor. May be repeated for credit. Graded Credit/No Credit. 1-3 units.

**500. Master's Thesis.** Credit given upon successful completion of a thesis approved for the master's degree. **Note:** open only to the graduate student who has been advanced to candidacy for the master's degree and who secures the permission of the chair of the student's thesis committee and the Graduate Curriculum Committee. Course may be repeated for credit. **Prerequisite:** CSC 209. Graded Credit/No Credit. 1-5 units.

**502. Master's Project.** Credit given upon successful completion of a project approved for the master's degree. **Note:** open only to graduate students advanced to candidacy for the master's degree, and who elect Plan B. Student must secure the permission of a faculty sponsor. **Prerequisite:** CSC 209. Graded Credit/No Credit. 1-2 units.