
Computer Science

[2009-10 update to the *General Catalog*, changes highlighted]

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Program Description

Computer science is the study of the theoretical and practical aspects of computer technology and computer usage. The Computer Science Department offers courses on a wide range of topics, many of which include a mathematical component, and offers undergraduate bachelor of arts and bachelor of science degrees in computer science, a bachelor of science in computer science: computer game design, as well as the master of science and doctor of philosophy degrees. Besides offering instructional courses, the department engages in a substantial research program in which both advanced undergraduates and graduate students participate.

The bachelor of arts program at UCSC is designed to give students a solid grounding in both theoretical and practical topics in computer science, computer engineering, and mathematics while leaving flexibility for a broad program of study, including many courses outside of science and engineering, or even for a double major in another discipline. The bachelor of science program is appropriate for students desiring a somewhat stronger concentration in the sciences, with more courses in computer science and computer engineering, as well as courses in physics or chemistry; this program also allows for electives outside of science and engineering.

The bachelor of science in computer game design builds on a rigorous core program of study in computer science, adding interdisciplinary study on the artistic, dramatic, and narrative elements of computer game design; a year-long game design project acts as a capstone learning experience. Because many courses in all three programs have prerequisites, students leaning toward any of these programs will enjoy greater scheduling flexibility if they begin some preparatory courses in their first year. The specific course requirements for each undergraduate degree are given below.

Applications of computer science are found in many other areas of study, from art and music to business and science. Thus, interdisciplinary activities are encouraged. For those students whose primary interest is in another area, a minor in computer science is offered.

Courses for Nonmajors

The Computer Science Department offers a wide range of courses intended for nonmajors as well as majors. These include course 2, *Computer Literacy*; course 10, *Introduction to Computer Science*; course 80B, *Systems and Simulation*; course 80C, *Computer Arts and Graphics*; course 80J, *Technology Targeted at Social Issues*; course 80S, *From Software Innovation to Social Entrepreneurship*; and course 80K, *Foundations of Interactive Game Design*. Course 10, *Introduction to Computer Science*, may be beneficial to students who are considering the major but have a limited background in computer science. There are also introductory programming classes intended for nonmajors: courses 5C, 5J, 5P, *Beginning Programming*.

Computer Science Policies

Admissions Policy

Admission to the computer science majors is selective. First-year applicants may receive direct admission at the time they apply to UCSC based on their high school record and test scores. Admission to the major after a student has entered UCSC is based on performance in all School of Engineering and Physical and Biological Sciences courses attempted at UCSC. Please refer to the School of Engineering section of the catalog for the full admissions policy.

Foundation Courses

The foundation courses for each computer science major are as follows:

Computer Science BS and BA: Computer Science 12A and 12B (or 13H); Computer Engineering 16; and Mathematics 19A-B, or 20A-B

Computer Game Design: Computer Science 12A and 12B, Computer Engineering 16; and Mathematics 19A-B, or 20A-B.

UCSC students that have completed three or more quarters at UCSC must complete the foundation courses before they can declare a computer science major.

Disqualification and Satisfactory Progress in the Major

Students who do not make adequate progress in the computer science major may be disqualified from the major. Adequate progress normally means passing a minimum of three courses required for the major over every three consecutive quarters. (For part-time students, 15 credits attempted equals one full term.) Students who do not expect to meet this requirement should consult their faculty adviser and/or the undergraduate director for their major beforehand.

Students who receive a total of three grades of D, F, or No Pass in the key courses, Computer Science 12A, 12B, 13H, 101; and Computer Engineering 12 and 16, may, at the discretion of the department, be disqualified from the major.

The department may, at its sole discretion, disqualify from the major any student making two unsuccessful attempts in any one of the following principal courses commonly used to satisfy degree requirements:

Computer Science 12A, 12B, 13H, 101, 102, 104A, 104B, 105, 111, 112, 115, 116, 130, 132, 140, 160, 161, 180, 181, and 183;

Computer Engineering 12, 16, 100, 107, and 110;

Applied Mathematics and Statistics 10, 131, and 147;

Physics 5A, 5B, 5C, 6A, 6B, and 6C;

Chemistry 1B and 1C;

Mathematics 19A-B or Mathematics 20A-B, and 23A.

Each grade of D, F, or No Pass counts as one unsuccessful attempt; each grade of W counts as one-half of an unsuccessful attempt.

The School of Engineering section contains additional disqualification policies, such as maintaining a 2.0 School of Engineering GPA and the ethics requirement, that apply to computer science majors.

Students at risk of disqualification must meet with an undergraduate adviser to discuss their options for continuing in the major.

Letter Grade Policy

The Computer Science Department requires letter grades for all courses applied toward the B.A., B.S., Computer Game Design, and minor in computer science with the exception of two lower-division courses which students may elect to take Pass/No Pass. This policy includes courses required for the computer science majors but sponsored by other departments.

Transfer Students

Most courses in the computer science program at UCSC have a strong theoretical component to prepare the student for designing, as opposed to simply using, computer systems. Often, courses taken at other institutions which emphasize applications of current languages and computers do not count toward the computer science major at UCSC.

At UCSC, students are first introduced to programming using the programming language Java. The core programming sequence, courses 12A/L and 12B/M (or 13H/L, which covers both 12A/L and 12B/M), exposes students to both Java and C. Many upper-division courses that involve programming use the C and C++ programming languages. Transfer students who are not familiar with both Java and C may need to take a remedial course. Students familiar with C++ and Unix should find the transition to Java and C relatively simple.

Please refer to the School of Engineering section of the catalog for the policy regarding transfer students.

School of Engineering Policies

Please refer to the School of Engineering section of the catalog for additional policies that apply to all School of Engineering programs. These policies include admission to the major, limits on the number of times courses can be attempted, and the need for computer science students to obtain preapproval before taking courses elsewhere.

Preparation for the Major

It is recommended that high school students intending to apply to the computer science major have completed four years of mathematics (through advanced algebra and trigonometry) and three years of science in high school. Comparable college mathematics and science courses completed at other institutions also serve to properly prepare a student for the computer science major.

B.A. Major Requirements

The aim of this program is to expose students to a rigorous curriculum in computer science while maintaining sufficient flexibility so that students can take courses outside computer science, pursue a minor in another discipline, or complete a double major. Every student must complete a minimum of 17 courses, eight lower-division and nine upper-division. Out of these, the eight lower-division courses and the first upper-division course are required preparatory courses for every student. Once these preparatory courses are completed, students tailor their own program by choosing eight additional upper-division elective courses. To provide an adequate balance in subject matter, these additional courses must be divided between those that emphasize the theoretical aspects of the field and those that have a more practical focus. To provide a depth of study in one aspect of computer science, students must complete one of the approved depth sequences.

Lower-Division Requirements

Each student must successfully complete the following nine required preparatory courses:

Computer Science

12A/L, *Introduction to Programming*(*Accelerated*)/~~Computer Programming Laboratory~~ (or 5J *Introduction to Programming in Java* and 11 *Intermediate Programming*);

12B/M, *Introduction to Data Structures/Laboratory*;

Computer Engineering

12/L, *Computer Systems and Assembly Language/ Laboratory*

16 (or 16H), *Applied Discrete Mathematics* (or *Honors Applied Discrete Mathematics*)

Mathematics

19A-B, *Calculus for Science, Engineering, and Mathematics* (credit for one or both may be granted with adequate performance on the CEEB calculus AB or BC Advanced Placement exam); or Mathematics

20A-B, *Honors Calculus*

23A, *Multivariable Calculus*

Applied Mathematics and Statistics

10, *Mathematical Methods for Engineers I* or Mathematics 21, *Linear Algebra*

Upper-Division Requirements

101, *Algorithms and Abstract Data Types*

In addition to the above nine required courses, students must complete eight upper division electives, by completing the requirements for one depth sequence. At least 50 percent of these upper-division courses must be completed at UCSC.

Depth Sequence Requirements

For the following depth sequences, students must take at least seven courses from the theory and practice course lists, as follows:

a minimum of three courses from the theory course list and a minimum of three courses from the practice course list;

the seven courses from the theory and practice course lists must include all of the courses of one of the depth sequences;

the eighth upper-division elective must be selected from any upper-division (5-credit) School of Engineering course.

The depth sequence courses are:

Compilers and language theory: Computer Science 104A, 112, and 104B or 130;

Operating systems and hardware: Computer Engineering 100/L, Computer Science 111, and Computer Engineering 110 or 121/L;

Theory: Computer Science 102, 130, and 132;

Software methodology: Computer Science 115 and two of the following: Computer Science 104A, 112, and 116;

Graphics: Computer Science 160/L, 161/L, and Applied Mathematics and Statistics 147;

Databases: Computer Science 180, 181, and 183

For the interactive game design depth sequence only, students must satisfy the following requirements:

Core courses: students must take Computer Science 130, 105, 140, 160/L, and 115.

Game design electives: students must take two courses from the game design electives list.

Free elective: any course from the theory and practice course lists.

Theory Course List

Computer Science

102 *Introduction to Analysis of Algorithms*

130 *Computational Models*

132 *Computability and Computational Complexity*

142 *Machine Learning and Data Mining*

166A *Game Theory and Applications I*

Computer Engineering

107 *Mathematical Methods of Systems Analysis: Stochastic*

108 *Data Compression*

154 *Data Communications*

177 *Applied Graph Theory and Algorithms*

Electrical Engineering

103 *Signals and Systems*

153 *Digital Signal Processing* (formerly Computer Engineering 153)

Applied Mathematics and Statistics

131 *Introduction to Probability Theory*

146 *Introduction to Dynamical Systems*

147 *Computational Methods and Applications*

162 *Design and Analysis of Computer Simulation Experiments*

Mathematics

115 *Graph Theory*

117 *Advanced Linear Algebra*

126 *Mathematical Control Theory*

148 *Numerical Analysis*

Practice Course List

Computer Science

104A *Fundamentals of Compiler Design I*

104B *Fundamentals of Compiler Design II*

105 *Systems Programming*

- 109 *Advanced Programming*
- 111 *Introduction to Operating Systems*
- 112 *Comparative Programming Languages*
- 115 *Software Methodology*
- 116 *Software Design Project*
- 122 *Computer Security*
- 128 *Distributed Systems: File Sharing, Online Gaming, and More*
- 129 *Data Storage Systems*
- 140 *Artificial Intelligence*
- 146 *Game Artificial Intelligence*
- 148 *Interactive Storytelling*
- 160/L *Introduction to Computer Graphics/Laboratory*
- 161/L *Visualization and Computer Animation/Laboratory*
- 164/L *Game Engines/Laboratory*
- 180 *Database Systems I*
- 181 *Database Systems II*
- 183 *Hypermedia and the Web*
- 190X *Methods of Cryptography*
- 204 *Compiler Design*

Computer Engineering

- 100/L *Logic Design/Laboratory*
- 110 *Computer Architecture*
- 112 *Computer and Game Console Architecture*
- 113 *Parallel and Concurrent Programming*
- 117/L *Embedded Software/Laboratory*
- 118/L *Introduction to Mechatronics/Laboratory*
- 121/L *Microprocessor System Design/Laboratory*
- 123A *Computer Engineering Design Project I*
- 123B *Computer Engineering Design Project II*
- 125/L *Logic Design with Verilog/Laboratory*
- 126/L *Advanced Logic Design/Laboratory*
- 150/L *Introduction to Computer Networks/Laboratory*
- ~~152 *Analysis and Design of Communication Protocols*~~
- 155/L *Computer Networks Project/Laboratory*
- 167/L *Sensing and Sensor Technologies/Laboratory*

Electrical Engineering

- 130/L *Introduction to Optoelectronics and Photonics/Laboratory*

Game Design Electives

Computer Science

- 102 *Introduction to Analysis of Algorithms*
- 116 *Software Design Project*
- 128 *Distributed Systems: File Sharing, Online Gaming, and More*
- 146 *Game Artificial Intelligence*
- 148 *Interactive Storytelling*
- 161/L *Visualization and Computer Animation/Laboratory*
- 164/L *Game Engines/Laboratory*
- 180 *Database Systems I*

Computer Engineering

- 112 *Computer and Game Console Architecture*
- 150 *Introduction to Computer Networks*
- 167/L *Sensing and Sensor Technologies/Laboratory*

Film and Digital Media

- 170A *Introduction to Digital Media Production*
- 171D *Social Information Spaces*
- 177 *Digital Media Workshop: Computer as Medium*

Disciplinary Communication (DC) Requirement

Students of every major must satisfy that major's upper-division Disciplinary Communication (DC) requirement. The DC requirement will normally be met within one to three courses already required for the major. For detailed information on this major's DC requirement, consult your major adviser or see the 2010-11 general catalog.

B.S. Major Requirements

This program is designed for students who wish to maximize exposure to computer science concepts and methods by taking a larger selection of upper-division computer science courses, as well as additional courses in the sciences and mathematics. A minimum of 22 courses must be completed for the B.S. in computer science, whereas a minimum of 17 courses must be completed for the B.A. in computer science. Out of the 22 courses, 10 are lower-division courses (including two science courses), and 12 are upper-division courses. The B.S. is more structured than the B.A.; 18 specific courses are required, and the remaining four are elective upper-division computer science or computer engineering courses.

Lower- and Upper-Division Requirements

Students are required to take the following 18 courses:

Computer Science

- 12A/L *Introduction to Programming(Accelerated)/Laboratory* (or 5J *Introduction to Programming in Java and 11 Intermediate Programming*)
12B/M *Introduction to Data Structures/Laboratory*
101 *Algorithms and Abstract Data Types*
102 *Introduction to Analysis of Algorithms*
104A *Fundamentals of Compiler Design I*
111 *Introduction to Operating Systems*
112 *Comparative Programming Languages*
130 *Computational Models*

Computer Engineering

- 12/L *Computer Systems and Assembly Language/Laboratory*
16 *Applied Discrete Mathematics*
107 *Mathematical Methods of Systems Analysis: Stochastic*, or AMS 131, *Introduction to Probability Theory*
110, *Computer Architecture*, or 112, *Computer and Game Console Architecture*

Mathematics

- 19A-B *Calculus for Science, Engineering, and Mathematics*, or Mathematics 20A-B, *Honors Calculus*
23A *Multivariable Calculus*

Applied Mathematics and Statistics

- 10 *Mathematical Methods for Engineers I*; or Mathematics 21, *Linear Algebra*
131 *Introduction to Probability Theory*; or Computer Engineering 107, *Mathematical Methods of Systems Analysis: Stochastic*

Physics or Chemistry

Either two physics or two chemistry courses, with their associated laboratories, from the following:

- Physics 5A/L, *Introduction to Physics I/Laboratory* (or 6A/L);
and either Physics 5B/M, *Introduction to Physics II/Laboratory* (or 6B/M);
or Physics 5C/N, *Introduction to Physics III/Laboratory* (or 6C/N)
Chemistry 1B/M, *General Chemistry/Laboratory*
Chemistry 1C/N, *General Chemistry/Laboratory*

The remaining four courses must be upper-division computer science or computer engineering electives selected from the theory and practice course lists (see B.A. Major Requirements reference above). One of these courses may be replaced by an upper-division mathematics course from the theory course list.

Disciplinary Communication (DC) Requirement

Students of every major must satisfy that major's upper-division Disciplinary Communication (DC) requirement. The DC requirement will normally be met within one to three courses already required for the major. For detailed information on this major's DC requirement, consult your major adviser or see the 2010-11 general catalog.

Comprehensive Requirement

In addition to the above B.A. or B.S. requirements, students in the computer science majors must satisfy one of the following three exit requirements: pass one of the capstone courses (see Capstone Courses below); obtain a scaled score of 600 or above on the graduate record examination (GRE) advanced computer science subject test; or successfully complete a senior thesis.

Capstone Courses

Students may choose from one of the following capstone courses to satisfy their exit requirement:

- 104B *Fundamentals of Compiler Design II*
116 *Software Design Project*
140 *Artificial Intelligence*
161/L *Visualization and Computer Animation/Laboratory*
181 *Database Systems II*
183 *Hypermedia and the Web*

Students taking one of the capstone courses will enroll normally. Students need to pass the capstone course to pass the exit requirement. No course may be attempted more than twice without prior approval from the chair of the department offering the course. W's count as an attempted class for this purpose. If a student fails to receive a passing score during these two attempts, he or she may still take the GRE Advanced Computer Science Subject Test and achieve a scaled score of 600 or above to satisfy the exit requirement.

The senior thesis consists of a self-contained project within the broad scope of computer science, but one that is not available in the regular course offerings. A student wishing to complete a senior thesis must successfully complete a minimum of 5 credits in course 195, Senior Thesis Research; submit a written thesis proposal; and have it accepted by a faculty supervisor. The supervision of a senior thesis student is always at the discretion of the faculty member. A written report and an oral presentation to a faculty examining committee are required.

Students who elect to use the GRE advanced computer science subject test as their senior exit requirement must arrange to take the GRE test and have scores submitted to the department before graduation deadlines. Contact the UCSC Career Center for GRE information and application forms.

Honors in the Major

Students must obtain a GPA of 3.8 or higher in the courses in the major to be considered for the distinction of "Highest Honors in the Major." Students must obtain a GPA of 3.5 or higher in the courses in the major to be considered for the distinction of "Honors in the Major." The School of Engineering reserves the right to withhold honors based on other criteria, such as an incident of academic dishonesty.

Computer Science Major Planners

The following are four sample academic plans for first-year students as preparation for the computer science major. Plans One A and Two A are suggested guidelines for students who have some prior experience with programming. Plans One B and Two B are for students who are considering the major and have no prior programming experience. Students who plan carefully can still have several openings free to take other breadth courses they find interesting.

Plan One A, B.A. Degree			
Year	Fall	Winter	Spring
1st (frsh)	Cmps-CMPS 10 Math-MATH 19A	Cmps-CMPS 12A/L Math-MATH 19B	Cmps-CMPS 12B/M Math-MATH 23A
2nd (soph)	Cmpe-CMPE 16	Cmpe-CMPE 12/L	Cmps-CMPS 101 AMS 10

Plan One B, B.A. Degree			
Year	Fall	Winter	Spring
1st (frsh)	AMS 3 Cmps-CMPS 10	Math-MATH 19A Cmps-CMPS 5J	Math-MATH 19B Cmps-CMPS 11
2nd (soph)	Math-MATH 23A	Cmpe-CMPE 16 or 16H/L Cmps-CMPS 12B/M	Cmps-CMPS 101 AMS 10

Plan Two A, B.S. Degree			
Year	Fall	Winter	Spring
1st (frsh)	Cmps-CMPS 12A/L Math-MATH 19A	Cmps-CMPS 12B/M Math-MATH 19B	Cmpe-CMPE 12/L Math-MATH 23A
2nd (soph)	Cmpe-CMPE 16 AMS 10	Cmpe-CMPE 100/L Phys-PHYS 6A/L	Cmps-CMPS 101 Phys-PHYS 6C/N

Plan Two B, B.S. Degree			
Year	Fall	Winter	Spring
1st (frsh)	Cmps-CMPS10	Math-MATH 19A Cmps-CMPS 5J	Cmps-CMPS 11 Math-MATH 19B
2nd (soph)	Math-MATH 23A	Cmps-CMPS 12B/M Cmpe-CMPE 16	Cmps-11 Math-19B Cmpe-CMPE 12/L Cmps-CMPS 101 or AMS 10

B.S. Computer Science: Computer Game Design Major Requirements

The goal of this degree is to provide students a deep understanding of the technical aspects of computer game engineering, and a broad background in the artistic, narrative, and dramatic elements of game design. The core of the degree program is a strong grounding in computer science and computer

engineering, preceded by a foundation in math and physics. Classes in ethics, as well as courses in art, film, music, theater arts, and economics provide breadth in topics of special relevance to computer game design. In their upper division courses, students gain depth by taking upper division electives in computer science and computer engineering. Two advanced courses in digital media give students the ability to view computer software from an artistic framework. A year-long capstone game design studio class allows students to develop substantial computer games, and integrate materials from the rest of the program.

The curriculum has 124-141 credits in 24-25 courses (depending on whether a student enters as a transfer student). 12 of the courses are upper division. Students interested in the major should pay special attention to the overlap between general education requirements and major requirements, as the major covers up to six general education requirements.

Lower- and Upper-Division Requirements

Course requirements are divided into six conceptual areas:

Mathematics and Physics

Complete all of the following courses:

Mathematics 19A-B, *Calculus for Science, Engineering, and Mathematics* (students can alternately take, Mathematics 20A-B, *Honors Calculus*. Credit for one or both Mathematics 19A-B may be granted with adequate performance on the CEEB calculus AB or BC advanced placement exams).

Mathematics 21, *Linear Algebra*, or Applied Mathematics and Statistics 10, *Mathematical Methods for Engineers I*

Computer Engineering 16, *Applied Discrete Mathematics* (or 16H, *Honors Applied Discrete Mathematics*)

Physics 5A/L, *Introduction to Physics I/Laboratory* (or 6A/L)

Computational Foundations

Complete all of the following courses:

Computer Science 12A/L, *Introduction to Programming(Accelerated)/Laboratory* (or 5J *Introduction to Programming in Java*, and 11 *Intermediate Programming*)

Computer Science 12B/M, *Introduction to Data Structures/Laboratory*

Computer Engineering 12/L, *Computer Systems and Assembly Language/Laboratory*

Computer Science 109, *Advanced Programming*

Computer Science 101, *Algorithms and Abstract Data Types*

Game Design

Complete all of the following courses.

~~Course 20, *Game Design Experience* is waived for transfer students.~~

Computer Science 20, *Game Design Experience*

Computer Science 170, *Game Design Studio I*

Computer Science 171, *Game Design Studio II*

Computer Science 172, *Game Design Studio III*

Computer Game Engineering

Complete five courses from the following list:

Computer Science 160/L, *Introduction to Computer Graphics/Laboratory*

Computer Science 161/L, *Visualization and Computer Animation/Laboratory*

Computer Science 164/L, *Game Engines/Laboratory*

Computer Science 140, *Artificial Intelligence*

Computer Science 146, *Game Artificial Intelligence*

Computer Science 148, *Interactive Storytelling*

Computer Science 166A, *Game Theory and Applications I*

Computer Engineering 110, *Computer Architecture*

Computer Science 128, *Distributed Systems, File Sharing, Online Gaming, and More*

Computer Science 105, *Systems Programming*

Computer Science 111, *Introduction to Operating Systems*

Computer Engineering 112, *Computer and Game Console Architecture*

Computer Engineering 150/L, *Introduction to Computer Networks/Laboratory*

~~Computer Engineering 152, *Analysis and Design of Communication Protocols*~~

Computer Engineering 113, *Parallel and Concurrent Programming*

Computer Engineering 118/L, *Introduction to Mechatronics/Laboratory*

Computer Science 180, *Database Systems I*

Computer Science 181, *Database Systems II*

Computer Science 183, *Hypermedia and the Web*

Computer Science 102, *Introduction to Analysis of Algorithms*

Computer Science 130, *Computational Models*

Computer Engineering 117/L, *Embedded Software/Laboratory*

Applied Mathematics and Statistics 131, *Introduction to Probability Theory*

Applied Mathematics and Statistics 147, *Computational Methods and Applications*

Applied Mathematics and Statistics 162, *Design and Analysis of Computer Simulation Experiments*

Digital Media

Complete two courses from the following list,

Film and Digital Media 170A, *Introduction to Digital Media Production*

Film and Digital Media 177, *Digital Media Workshop, Computer as Medium*

Film and Digital Media 171D, *Social Information Spaces*

Any 5-unit course offered in the digital arts new media (DANM) curriculum (requires approval of professor)

Art 118, *Computer Art: Theories, Methods, and Practices* (may require approval of instructor)

Theater Arts 157, *Playwriting*

Art and Social Foundations

Complete the ethics requirement and three of the following electives.

Ethics Requirement

One of:

Computer Engineering 80E, *Engineering Ethics*

Philosophy 22, *Introduction to Ethical Theory*

Philosophy 24, *Introduction to Ethics, Contemporary Moral Issues*

Philosophy 28, *Environmental Ethics*

Biomolecular Engineering 80G, *Bioethics in the 21st Century: Science, Business, and Society* (crosslisted as Philosophy 80G)

Art Elective

One of:

Art 10G, *2D Foundation*

Art 10H, *3D Foundation*

Art 80A, *Introduction to Drawing*

Art 80F, *Introduction to Issues in Digital Media*

Film Elective

One of:

Film and Digital Media 20A, *The Film Experience*

Film and Digital Media 20C, *Introduction to Digital Media*

Film and Digital Media 20P, *Introduction to Production Technique*

Theater Elective

One of:

Theater Arts 10, *Introduction to Theater Design and Technology*

Theater Arts 18, *Drafting for Theatrical Production*

Theater Arts 19, *Design Studio, Lighting Studio*

Theater Arts 20, *Introductory Studies in Acting*

Theater Arts 30, *Introduction to Modern Dance Theory and Technique*

Theater Arts 40, *Introduction to Directing*

Theater Arts 80E, *Stand-Up Comedy*

Theater Arts 80L, *Muppet Magic: Jim Henson's Art*

Music Elective

One of:

Music 11A, *Introduction to Western Art Music*

Music 11B, *Introduction to Jazz*

Music 11C, *Introduction to American Popular Music*

Music 11D, *Introduction to World Music*

Music 80C, *History, Literature, and Technology of Electronic Music*

Music 80L, *Artificial Intelligence and Music*

Music 80M, *Film Music*

Music 80R-, *Music and the World Wide Web*

Economics Elective

One of:

Economics 1, *Introductory Microeconomics, Resource Allocation and Market Structure*

Economics 2, *Introductory Macroeconomics, Aggregate Economic Activity*

Economics 80H, *Wall Street and the Money Game*

Comprehensive Requirement

Students satisfy the senior comprehensive requirement by either receiving a passing grade in all three courses of the game design studio sequence or performing a senior thesis.

Computer Science: Computer Game Design Major Planners

The following are three sample academic plans that students can use to plan their sequence of courses in the major. Plans one and two are suggested guidelines for students who begin their studies in their freshman year. Such students, if they plan carefully will have several openings free to take other breadth courses they find interesting. Plan one is for a student entering UCSC in their freshman year who is prepared to go directly into Mathematics 19A/20A and Computer Science 12A. Plan two is for a student entering UCSC their freshman year who needs to take preparatory courses prior to Mathematics 19A or Computer Science 12A to ensure a successful outcome in those courses. Plan three is for students that transfer to campus at the beginning of their junior year.

Plan One—Enter UCSC Freshman Year			
Year	Fall	Winter	Spring
1st (frsh)	Core Math-MATH 19A or 20A Cmps-CMPS 12A/L	Cmps-CMPS 20 (Game Design Experience) Math-MATH 19B or 20B Cmps-CMPS 12B/M	Art/Social Elective I Cmps-CMPE 12/L Composition (C, or gen ed)
2nd (soph)	Phys-PHYS 5A/L or 6A/L gen ed Math-MATH 21 or AMS 10	Art/Social Elective II Cmps-CMPS 109 Cmps-CMPE 16	Art/Social Elective III Ethics Requirement Cmps-CMPS 101
3rd (jr)	gen ed Game Engineering Elective I Game Engineering Elective II	gen ed Game Engineering Elective III Game Engineering Elective IV	gen ed Game Engineering Elective V
4th (sr)	gen ed Cmps-CMPS 170 (Game Design Studio I) Digital Media Elective I	gen ed gen edd Cmps-CMPS171 (Game Design Studio III)	gen ed Cmps-CMPS 172 (Game Design Studio III) Digital Media Elective II

Plan Two –Enter UCSC Freshman Year, Need Math and Computer Science Preparation Classes (Mathematics 3, Computer Science 10)			
Year	Fall	Winter	Spring
1st (frsh)	Core Math-MATH 3 Cmps-CMPS 10	Writing (C, or gen ed) Math-MATH 19A Cmps-CMPS 12A/L	Math-MATH 19B Cmps-CMPS 12B/M Art/Social Elective I
2nd (soph)	Art/Social Elective II	Cmps-CMPS 20 (Game Design Experience)	Math-MATH 21 or AMS 10 Ethics Requirement

Plan Two –Enter UCSC Freshman Year, Need Math and Computer Science Preparation Classes (Mathematics 3, Computer Science 10)			
	Cmpe -CMPS 12/L Phys -PHYS 6A/L	Cmpe -CMPE 16 Cmpe -CMPS 109	Art/Social Elective III
3rd (jr)	Cmpe -CMPS 101 Digital Media Elective I gen ed	Game Engineering Elective I Game Engineering Elective II gen ed	gen ed Game Engineering Elective III Digital Media Elective II
4th (sr)	gen ed Cmpe -CMPS 170 (Game Design Studio I) Game Engineering Elective IV	gen ed Cmpe -CMPS 171 (Game Design Studio II) Game Engineering Elective V	gen ed gen ed Cmpe -CMPS 172 (Game Design Studio III)

Plan Three – Transfer Student			
Year	Fall	Winter	Spring
1st (frsh)	Cmpe -CMPS 101 Cmpe -CMPE 12/L Art/Social Elective I	Cmpe -CMPS 109 Game Engineer- ing Elective I Digital Media Elective I	Ethics Requirement Game Engineering Elective II Digital Media Elective II
2nd (soph)	Art/Social Elective II Cmpe -CMPS 170 (Game Design Studio I) Game Engineering Elective III	Art/Social Elective III Cmpe -CMPS 171 (Game Design Studio II) Game Engineering Elective IV	gen ed Cmpe -CMPS 172 (Game Design Studio III) Game Engineering Elective V

Minor Requirements

Courses required for the computer science minor are Mathematics 19A-B or 20A-B, and 23A; Applied Mathematics and Statistics 10;- Computer Science courses 12A/L and 12B/M (or 13H/L can be taken to cover both 12A/L and 12B/M) and course 101; Computer Engineering 12/L and 16; and four additional upper-division computer science courses from a list of approved electives (see the department's checklist for the computer science minor at www.soe.ucsc.edu/programs/cs/undergraduate/). In selecting the four upper-division courses, students may elect to focus on one subdiscipline of computer science by completing the courses in a BA depth sequence. Upper-division computer engineering and mathematics courses that generally apply toward the computer science major may not be applied toward the computer science minor. In addition, some upper-division computer science courses may not be applied toward the computer science minor. There is no comprehensive examination or senior thesis requirement for the minor.

Graduate Programs

Program Description

The Computer Science Department at UCSC offers both a master's program and a doctoral program. The goal of these programs is to help students develop into independent scholars who are prepared for productive careers in research, teaching, and industry. The master's degree may be used as a terminal degree or as the first step toward the Ph.D. degree. The student-faculty ratio is five to one, making it possible for students to receive individual attention and to pursue programs that fit their individual needs. The intellectual atmosphere is enriched by regular colloquia and seminars presented by eminent contributors to the field, many of whom are associated with other major universities and industrial research centers in the San Francisco Bay Area.

The Computer Science Department enjoys a close relationship with the Computer Engineering and Electrical Engineering Departments, the Bioinformatics Department, and the new Applied Mathematics and Statistics Department.

Most computer science graduate students are hired as teaching assistants helping with undergraduate courses, hired as research assistants working for computer science and other School of Engineering faculty, or awarded fellowships to pursue their research.

Additional information on the computer science graduate programs can be found on the department's web pages at www.soe.ucsc.edu.

Requirements for the Master's Degree: Project Track

Course Requirements

Each student is required to take 50 credits as follows:

Computer Science

200, *Research and Teaching in Computer Science and Engineering*, 3 credits;

201, *Analysis of Algorithms*, 5 credits;

203, *Programming Languages*, 5 credits;

296, *Master's Project*, 2 credits;

a base requirement in computer architecture must be met by taking Computer Engineering 110 or Computer Engineering 202 or equivalent elsewhere (approval required);

one course each from three different breadth categories for a total of three courses (15 credits) — see www.soecs.ucsc.edu/programs/cs/graduate/graduates/breadth/;

all remaining credits units must be regular, 5-credit graduate elective courses from: computer science CS, within the list of approved graduate School of Engineering OE (with adviser's approval); or outside the SOE School of Engineering (with adviser's and Grad D director's approval); — courses — see www.soe.ucsc.edu/programs/cs/graduate/; that do not count include all courses numbered 200, 280, 296, 297, and 299;

at least 30 units must be in CS computer science;

two upper-division undergraduate computer science courses (other than course 101) or a graduate course (not seminar) in related disciplines outside the list of approved graduate courses may be substituted for one graduate course, when necessary to strengthen a student's preparation for graduate studies, with prior approval from the adviser and the graduate director.

Project

Completion of a master's project is required for the master's degree. In consultation with the adviser, the student forms a master's project reading committee of at least two faculty members, each of whom is provided a copy of the project report. The final project must be accepted by the review committee before the award of the master of science degree.

Requirements for the Master's Degree: Thesis Track

Course Requirements

Each student is required to take 48 credits as follows:

Computer Science

200, *Research and Teaching in Computer Science and Engineering*, 3 credits;

201, *Analysis of Algorithms*, 5 credits;

203, *Programming Languages*, 5 credits;

a base requirement in computer architecture must be met by taking Computer Engineering 110 or Computer Engineering 202 or equivalent elsewhere (approval required);

one course each from three different breadth categories for a total of three courses (15 credits) — see www.soecs.ucsc.edu/programs/cs/graduate/graduates/breadth/;

up to 10 credits of course 297, *Independent Study or Research*; or course 299, *Thesis Research*;

all remaining credits units must be regular, 5-credit graduate elective courses from: CS computer science, within the list of approved graduate School of Engineering OE (with adviser's approval); or outside the SOE School of Engineering OE (with adviser's and Grad D director's approval); — courses — see www.soe.ucsc.edu/programs/cs/graduate/; that do not count include all courses numbered 200, 280, 296, 297, and 299;

at least 28 units must be in CS computer science;

two upper-division undergraduate computer science courses (other than course 101) or a graduate course (not seminar) in related disciplines outside the list of approved graduate courses may be substituted for one graduate course, when necessary to strengthen a student's preparation for graduate studies, with prior approval from the adviser and the graduate director.

Thesis

Completion of a master's thesis is required for the master's degree. To fulfill this requirement, the student submits a written proposal to a faculty member, usually by the third academic quarter. By accepting the proposal, the faculty member becomes the thesis adviser. In consultation with the adviser, the student forms a master's thesis reading committee with at least two additional faculty members, each of whom is provided a copy of the proposal. The student presents an expository talk on the thesis research, and the final thesis must be accepted by the review committee before the award of the master of science degree.

Requirements for the Ph.D. Degree

Course Requirements

Each student is required to take 58 credits as follows:

Computer Science

200, *Research and Teaching in Computer Science and Engineering*, 3 credits;

201, *Analysis of Algorithms*, 5 credits;

203, *Programming Languages*, 5 credits;

a base requirement in computer architecture must be met by taking Computer Engineering 110 or Computer Engineering 202 or equivalent elsewhere (approval required);

one course each from three different breadth categories for a total of three courses (15 credits) — see www.soecs.ucsc.edu/programs/cs/graduate/graduates/breadth/;

up to 10 credits of course 297, *Independent Study or Research*; or course 299, *Thesis Research*;

all remaining units must be regular, 5-credit graduate courses from: CS computer science, within the School of Engineering OE (with adviser's approval); or outside the School of Engineering OE (with adviser's and Grad D director's approval); — courses that do not count include all courses numbered 200, 280, 296, 297, and 299;

at least 33 units must be in computer science;

all remaining credits must be graduate elective courses from the list of approved graduate courses—see www.soe.ucsc.edu/programs/es/graduate/;

graduate courses (not seminars) in related disciplines outside the list of approved graduate courses may be substituted, when necessary to strengthen a student's preparation for graduate studies, with prior approval from the adviser and the graduate director. Course selection should form a coherent plan of study and requires adviser approval. Undergraduate courses may not be used to satisfy Ph.D. course requirements;

each student is required to complete at least one quarter of teaching assistantship. This requirement can be met after advancement to candidacy. Certain exceptions may be permitted for those with extensive prior teaching experience or those who are not allowed to be employed due to visa regulations.

Ph.D. students who have satisfied the requirements for the master's degree are eligible to receive a master's degree.

Dissertation

Each student writes a Ph.D. dissertation. The dissertation must show the results of in-depth research, be an original contribution of significant knowledge, and include material worthy of publication. Where appropriate, research internships with companies, government labs, or elsewhere are recognized (and may be required) as an integral part of the research leading to the dissertation. As the first step, a student submits a written dissertation proposal to a School of Engineering faculty member. By accepting the proposal, the faculty member becomes the dissertation supervisor. The dissertation proposal is publicly and formally presented in an oral qualifying examination given by a qualifying exam committee, approved by the graduate committee and the Graduate Council. The student must submit his or her written dissertation proposal to all members of the committee and the graduate assistant one month in advance of the examination.

Students are advanced to candidacy after they have completed the course requirements, passed the qualifying examination, cleared all Incompletes from their records, have an appointed dissertation reading committee, and paid the filing fee. Students who have not advanced to candidacy by the end of their fourth year will be placed on academic probation.

Each Ph.D. candidate submits the completed dissertation to a reading committee at least one month prior to the dissertation defense. The appointment of the dissertation reading committee is made immediately after the qualifying exam and is necessary for advancing to candidacy. The candidate presents his or her research results in a public seminar sponsored by the dissertation supervisor. The seminar is followed by a defense of the dissertation to the reading committee and attending faculty, who will then decide whether the dissertation is acceptable or requires revision. Successful completion of the dissertation fulfills the final academic requirement for the Ph.D. degree.

Transfer Credit

Up to three School of Engineering courses fulfilling the degree requirements of either the M.S. or Ph.D. degrees may be taken before beginning the graduate program through the concurrent enrollment program.

Ph.D. students who have previously earned a master's degree in a related field at another institution may substitute courses from their previous university with approval of the adviser and the graduate committee.

Courses from other institutions may not be applied to the M.S. degree course requirements.

Petitions should be submitted along with the transcript from the other institution or UCSC extension. For courses taken at other institutions, copies of the syllabi, exams, and other course work should accompany the petition. Such petitions are not considered until the completion of at least one quarter at UCSC.

At most, a total of three courses may be transferred from concurrent enrollment and other institutions.

Review of Progress

Each year, the faculty reviews the progress of every student. Students not making adequate progress toward completion of degree requirements (see Graduate Handbook for policy on satisfactory academic progress) are subject to dismissal from the program. Students with academic deficiencies may be required to take additional courses. Full-time students with no academic deficiencies are normally expected to complete the degree requirements at the rate of at least two courses per quarter. Full-time students must complete course 201, Computer Engineering 202, and course 203 within two years and normally must complete all course requirements within two years for the M.S. and three years for the Ph.D.

Students receiving two or more grades of below B or U (fail) in the School of Engineering (SoE) courses are not making adequate progress and will be placed on academic probation for the following three quarters of registered enrollment. Withdrawing or taking a leave of absence does not count as enrollment. Part-time enrollment is counted as a half quarter of enrollment.

Should any computer science graduate student fail a SoE course while on probation, the Computer Science Department may request the graduate dean to dismiss that student from the graduate program. If after being removed from probation, the student again fails a SoE course, he or she will return immediately to academic probation.

Graduate students experiencing circumstances or difficulties that impact their academic performance should contact their adviser and the graduate director immediately. Students may appeal their dismissal.

See www.soe.ucsc.edu/programs/es/graduate/CSCurrentReq.html#progress for more information on this policy.