BACHELOR OF SCIENCE IN COMPUTER SCIENCE

Students intending to enter this program at the freshman level should have completed two years of algebra and one semester of trigonometry in high school. One year each of high school geometry and physics, as well as basic knowledge of computer organization and programming, are very desirable.

All lower division courses (course numbers below 300) included among the degree requirements are available at many community colleges in California; students intending to enter the program upon transferring to San Francisco State University from a community college should take as many of those courses there as possible.

Students should plan their program of study in the major with the help of a departmental advisor as soon as possible so that the correct sequence of courses is taken and a proper set of electives is chosen. It is also suggested that students consult with an advisor before selecting courses to meet the General Education requirements. (See program below for acceptable science electives.)

Students are encouraged to participate in the Computer Science Cooperative Education Program at SF State. Under this program, they may obtain industrial employment related to their academic studies. This combination of on-the-job training and academic experience can greatly enhance the value of an undergraduate degree in Computer Science.

An Endowed Scholarship Fund, established in the memory of Jules H. Strauss, offers an annual award to a computer science major who shows scholarly accomplishment and demonstrates financial need.

An Entrepreneurship Program and Developers Prize, funded by our alumni, encourage and support innovation and entrepreneurship among students.

Students are advised that CR/NC grades are not acceptable in courses to be counted for the Computer Science major or minor programs.

Program Learning Outcomes

1. Students will be able to design, develop, document, and test software using current techniques.
2. Students will understand the fundamentals of computer architecture and computing theory.
3. Students will be able to solve problems working in group settings.
4. Students will demonstrate the ability to give presentations and write technical reports.
5. Students will demonstrate an understanding of the importance of social and ethical issues related to the profession.

Computer Science (B.S.) – 71 units

Mathematics and Physics (22 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 226</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 227</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 324</td>
<td>Probability and Statistics with Computing</td>
<td>3</td>
</tr>
<tr>
<td>MATH 325</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 220</td>
<td>General Physics with Calculus I</td>
<td>3</td>
</tr>
</tbody>
</table>

Science Elective (3 units)

Science elective selected from the following GE Area B2, Life Science courses. Other science courses are subject to approval.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 100</td>
<td>Human Biology</td>
<td>3</td>
</tr>
<tr>
<td>or BIOL 176</td>
<td>Science and Politics of Stem Cell Biology</td>
<td></td>
</tr>
</tbody>
</table>

Core Computer Science Requirements (22 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 210</td>
<td>Introduction to Computer Programming</td>
<td>3</td>
</tr>
<tr>
<td>CSC 220</td>
<td>Data Structures</td>
<td>3</td>
</tr>
<tr>
<td>CSC 230</td>
<td>Discrete Mathematical Structures for Computer Science</td>
<td>3</td>
</tr>
<tr>
<td>CSC 256</td>
<td>Machine Structures</td>
<td>3</td>
</tr>
<tr>
<td>CSC 300GW</td>
<td>Ethics, Communication and Tools for Software Development - GWAR</td>
<td>3</td>
</tr>
<tr>
<td>CSC 340</td>
<td>Programming Methodology</td>
<td>3</td>
</tr>
<tr>
<td>CSC 412</td>
<td>Advanced Software Lab</td>
<td>1</td>
</tr>
<tr>
<td>CSC 413</td>
<td>Software Development</td>
<td>3</td>
</tr>
</tbody>
</table>

Advanced Computer Science Requirements (24 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 415</td>
<td>Operating System Principles</td>
<td>3</td>
</tr>
<tr>
<td>CSC 510</td>
<td>Analysis of Algorithms I</td>
<td>3</td>
</tr>
<tr>
<td>CSC 600</td>
<td>Programming Languages</td>
<td>3</td>
</tr>
<tr>
<td>CSC 648</td>
<td>Software Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Senior Presentations

Each major is required to make an oral presentation during his/her senior year. Guidelines for the presentations are available on the Computer Science website: cs.sfsu.edu (http://cs.sfsu.edu).

Electives

Select four 3-unit courses (12 units) See requirements below.

Elective Requirements

Electives are selected from the nine subareas of Computer Science listed below. Electives must meet the following requirements.

1. One of the electives must be CSC 520 or CSC 656. (CSC 520 and CSC 656 can be used to partially meet the depth and breadth requirements.)
2. Depth Requirement: two of the electives must be chosen from the same subarea of the discipline.
3. Breadth Requirement: electives must be chosen from three different subareas.

Note: It is recommended that students planning to continue their study of Computer Science in graduate school take both CSC 656 and CSC 520.

The same courses can be used to meet depth and breadth requirements.

However, a course cannot be counted towards more than one area of emphasis. For example, the following four electives can be used to
meet the requirements in different ways to highlight a different area of emphasis (areas of emphasis are shown in parentheses):

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing (Algorithms and Theory of Computing, Programming Languages)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 656</td>
<td>Computer Organization (Architecture)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 675</td>
<td>Introduction to Database Systems (Algorithms and Theory of Computing, Database)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 668</td>
<td>Advanced Object Oriented Software Design and Development (Programming Languages, Software Engineering)</td>
<td>3</td>
</tr>
</tbody>
</table>

The different ways in which these courses can meet the elective requirements are:

**Emphasis**

**Algorithms and Theory of Computing**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing (meets requirement 1)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 675</td>
<td>Introduction to Database Systems (meets requirement 2) (depth in Algorithms)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 668</td>
<td>Advanced Object Oriented Software Design and Development (Programming Languages, Software Engineering) (meets requirement 3)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Programming Languages**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing (meets requirement 1)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 675</td>
<td>Introduction to Database Systems (meets requirement 2) (depth in Algorithms)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 668</td>
<td>Advanced Object Oriented Software Design and Development (Programming Languages, Software Engineering) (meets requirement 3)</td>
<td>3</td>
</tr>
</tbody>
</table>

In contrast, for example, the following courses do not meet the elective requirements because CSC 520 cannot be double counted as Algorithms and Programming Languages:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing (Algorithms and Theory of Computing, Programming Languages)</td>
<td>3</td>
</tr>
<tr>
<td>CSC 645</td>
<td>Computer Networks (Operating Systems and Distributed Processing)</td>
<td>3</td>
</tr>
</tbody>
</table>

The courses listed below constitute a partial list of suitable courses for meeting the elective requirements. The department frequently offers, under the title of CSC 698, new courses that meet elective requirements. Many students also find that, by their senior year, they are prepared to undertake certain graduate courses in Computer Science. Occasionally, students in good academic standing may take CSC 699, instead of a regularly scheduled course. Students are advised to check university and college regulations regarding academic standing requirements. Finally, it is occasionally possible to use a course taken in a different department or at another university (but only if the course is not offered at San Francisco State University) to satisfy elective requirements. Any course substitutions must be approved in advance by a senior advisor.

**Areas of Special Emphasis**

**Algorithms and Theory of Computing**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing</td>
<td>3</td>
</tr>
<tr>
<td>CSC 621</td>
<td>Biomedical Imaging and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CSC 630</td>
<td>Computer Graphics Systems Design</td>
<td>3</td>
</tr>
<tr>
<td>CSC 637</td>
<td>Software Techniques for Computer Music</td>
<td>3</td>
</tr>
<tr>
<td>CSC 671</td>
<td>Neural Networks</td>
<td>3</td>
</tr>
<tr>
<td>CSC 675</td>
<td>Introduction to Database Systems</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400</td>
<td>Numerical Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

**Architecture**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 641</td>
<td>Computer Performance Evaluation</td>
<td>3</td>
</tr>
<tr>
<td>CSC 656</td>
<td>Computer Organization</td>
<td>3</td>
</tr>
</tbody>
</table>

**Artificial Intelligence**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 620</td>
<td>Natural Language Technologies</td>
<td>3</td>
</tr>
<tr>
<td>CSC 621</td>
<td>Biomedical Imaging and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CSC 665</td>
<td>Artificial Intelligence</td>
<td>3</td>
</tr>
<tr>
<td>CSC 671</td>
<td>Neural Networks</td>
<td>3</td>
</tr>
</tbody>
</table>

**Database**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 664</td>
<td>Multimedia Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSC 675</td>
<td>Introduction to Database Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

**Graphics and Multimedia**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 621</td>
<td>Biomedical Imaging and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CSC 630</td>
<td>Computer Graphics Systems Design</td>
<td>3</td>
</tr>
<tr>
<td>CSC 631</td>
<td>Multiplayer Game Development</td>
<td>3</td>
</tr>
<tr>
<td>CSC 637</td>
<td>Software Techniques for Computer Music</td>
<td>3</td>
</tr>
<tr>
<td>CSC 642</td>
<td>Human-Computer Interaction</td>
<td>3</td>
</tr>
<tr>
<td>CSC 664</td>
<td>Multimedia Systems</td>
<td>3</td>
</tr>
</tbody>
</table>
### Numerical and Symbolic Computing

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 400</td>
<td>Numerical Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

### Operating Systems and Distributed Processing

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 615</td>
<td>UNIX Programming</td>
<td>3</td>
</tr>
<tr>
<td>CSC 641</td>
<td>Computer Performance Evaluation</td>
<td>3</td>
</tr>
<tr>
<td>CSC 645</td>
<td>Computer Networks</td>
<td>3</td>
</tr>
<tr>
<td>CSC 650</td>
<td>Secure Networked Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSC 651</td>
<td>System Administration</td>
<td>3</td>
</tr>
<tr>
<td>CSC 667</td>
<td>Internet Application Design and Development</td>
<td>3</td>
</tr>
</tbody>
</table>

### Programming Languages

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 520</td>
<td>Theory of Computing</td>
<td>3</td>
</tr>
<tr>
<td>CSC 620</td>
<td>Natural Language Technologies</td>
<td>3</td>
</tr>
<tr>
<td>CSC 665</td>
<td>Artificial Intelligence</td>
<td>3</td>
</tr>
<tr>
<td>CSC 668</td>
<td>Advanced Object Oriented Software Design and Development</td>
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</tbody>
</table>

### Software Engineering

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 642</td>
<td>Human-Computer Interaction</td>
<td>3</td>
</tr>
<tr>
<td>CSC 667</td>
<td>Internet Application Design and Development</td>
<td>3</td>
</tr>
<tr>
<td>CSC 668</td>
<td>Advanced Object Oriented Software Design and Development</td>
<td>3</td>
</tr>
</tbody>
</table>

### General Education Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Course Level</th>
<th>Units</th>
<th>Area Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Communication</td>
<td>LD</td>
<td>3</td>
<td>A1</td>
</tr>
<tr>
<td>Written English Communication I</td>
<td>LD</td>
<td>3</td>
<td>A2</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>LD</td>
<td>3</td>
<td>A3</td>
</tr>
<tr>
<td>Written English Communication II</td>
<td>LD</td>
<td>3</td>
<td>A4</td>
</tr>
<tr>
<td>Physical Science</td>
<td>LD</td>
<td>3</td>
<td>B1</td>
</tr>
<tr>
<td>Life Science</td>
<td>LD</td>
<td>3</td>
<td>B2</td>
</tr>
<tr>
<td>Lab Science</td>
<td>LD</td>
<td>1</td>
<td>B3</td>
</tr>
<tr>
<td>Mathematics/Quantitative Reasoning</td>
<td>LD</td>
<td>3</td>
<td>B4</td>
</tr>
<tr>
<td>Arts</td>
<td>LD</td>
<td>3</td>
<td>C1</td>
</tr>
<tr>
<td>Arts or Humanities</td>
<td>LD</td>
<td>3</td>
<td>C1 or C2</td>
</tr>
<tr>
<td>Humanities: Literature</td>
<td>LD</td>
<td>3</td>
<td>C3</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>LD</td>
<td>3</td>
<td>D1</td>
</tr>
<tr>
<td>Social Sciences: US History</td>
<td>LD</td>
<td>3</td>
<td>D2</td>
</tr>
<tr>
<td>Social Sciences: US &amp; CA Government</td>
<td>LD</td>
<td>3</td>
<td>D3</td>
</tr>
<tr>
<td>Lifelong Learning and Self-Development (LLD)</td>
<td>LD or UD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physical and/or Life Science</td>
<td>UD</td>
<td>3</td>
<td>UD-B</td>
</tr>
<tr>
<td>Arts and/or Humanities</td>
<td>UD</td>
<td>3</td>
<td>UD-C</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>UD</td>
<td>3</td>
<td>UD-D</td>
</tr>
</tbody>
</table>

### SF State Studies

Courses certified as meeting the SF State Studies requirements may be upper or lower division in General Education (GE), in a major or minor, or an elective.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Course Level</th>
<th>Units</th>
<th>Area Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Ethnic and Racial Minorities (AERM)</td>
<td>LD or UD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Environmental Sustainability (ES)</td>
<td>LD or UD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Global Perspectives (GP)</td>
<td>LD or UD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Social Justice (S.J)</td>
<td>LD or UD</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Note: LD = Lower-Division; UD = Upper-Division.

### First-Time Student Roadmap (4 Year)

This roadmap opens in a new tab (bulletin.sfsu.edu/colleges/science-engineering/computer-science/bs-computer-science/roadmap).

### Transfer Student Roadmap (2 Year)

For students with an AS-T in Computer Science. This roadmap opens in a new tab (bulletin.sfsu.edu/colleges/science-engineering/computer-science/bs-computer-science/adt-roadmap).

This degree program is an approved pathway ("similar" major) for students earning the ADT in Computer Science

California legislation SB 1440 (2009) mandated the creation of the Associate Degree for Transfer (ADT) to be awarded by the California Community Colleges. Two types of ADTs are awarded: Associate in Arts for Transfer (AA-T) and Associate in Science for Transfer (AS-T). Note: no specific degree is required for admission as an upper-division student. However, the ADT includes specific guarantees related to admission and graduation and is designed to clarify the transfer process and strengthen lower-division preparation for the major.

An ADT totals 60 units and includes completion of all lower-division General Education requirements and at least 18 units in a specific major. Students pursuing an ADT are guaranteed admission to the CSU if minimum eligibility requirements are met, though not necessarily to the CSU campus of primary choice.

Upon verification that the ADT has been awarded prior to matriculation at SF State, students are guaranteed B.A. or B.S. completion in 60 units.
General Advising Information for Transfer Students

1. Before transfer, complete as many lower-division requirements or electives for this major as possible.
2. The following courses are not required for admission but are required for graduation. Students are strongly encouraged to complete these units before transfer; doing so will provide more flexibility in course selection after transfer.
   - a course in U.S. History
   - a course in U.S. & California Government
   - a 2nd-semester course in written English composition

For information about satisfying the requirements described in (1) and (2) above at a California Community College (CCC), please visit http://www.assist.org. Check any geographically accessible CCCs; sometimes options include more than one college. Use ASSIST to determine:

   - Which courses at a CCC satisfy any lower-division major requirements for this major, including 2nd-semester composition;

Remedial courses are not transferable and do not apply to the minimum 60 units/90 quarters required for admission.

Additional units for courses that are repeated do not apply to the minimum 60 units required for upper division transfer (for example, if course was not passed on the first attempt, or was taken to earn a better grade).

Before leaving the last California Community College of attendance, obtain a summary of completion of lower division General Education units (IGETC or CSU GE Breadth). This is often referred to as a GE certification worksheet. SF State does not require delivery of this certification to Admissions, but students should retain this document for verifying depth progress after transfer.

Credit for Advanced Placement, International Baccalaureate, or College-Level Examination Program courses: AP/IB/CLEP credit is not automatically transferred from the previous institution. Units are transferred only when an official score report is delivered to SF State.

Transferring from institutions other than CCCs or CSUs

Review SF State’s lower division General Education requirements. Note that, as described below, the four basic skills courses required for admission meet A1, A2, A3, and B4 in the SF State GE pattern. Courses that fulfill the remaining areas of SF State’s lower division GE pattern are available at most two-year and four-year colleges and universities.

Of the four required basic skills courses, a course in critical thinking (GE A3) may not be widely offered outside the CCC and CSU systems. Students should attempt to identify and take an appropriate course no later than the term of application to the CSU. To review more information about the A3 requirement, please visit http://bulletin.sfsu.edu/undergraduate-education/general-education/lower-division/#AAEL.

Identify and complete a 2nd-semester written English composition course before transfer. This is usually the next course after the typical “freshman comp” course, with a focus on writing, reading and critical analytical skills for academic purposes, and developing skills in composing, revising, and the use of rhetorical strategies.

Waiting until after transfer to take a single course at SF State that meets both US and CA/local government requirements may be an appropriate option, particularly if transferring from outside of California.

All students must meet the transfer eligibility requirements outlined below for admission. For more information, visit the Undergraduate Admissions section.

   - Complete 60 or more transferable semester units or 90 or more quarter units
   - Earn a college grade point average of 2.00 or better in all transferable courses. Non-local area residents may be held to a higher GPA standard.
   - Be in good standing at the last college or university attended
   - Complete 30-semester units (45-quarter units) of general education, including four basic skills courses:
      a. One course in oral communication (same as CSU GE Area A1)
      b. One course in written composition (same as CSU GE Area A2)
      c. One course in critical thinking (same as CSU GE Area A3)
      d. One course in mathematics or quantitative reasoning (same as CSU GE Area B4)
   - The four basic skills courses and a minimum of 60 transferable semester units (90-quarter units) must be completed by the spring semester prior to fall admission, or by the fall semester prior to spring admission. Earn a “C-” or better grade in each basic skills course.