BACHELOR OF SCIENCE IN EARTH SCIENCES

The Bachelor of Science in Earth Sciences is designed for students intending to prepare for direct entry into a career as a professional in industry or government, or for graduate school in any of the earth sciences, such as geology, oceanography, and meteorology. Courses in the BS degree’s Earth Sciences core, supported by courses in the basic science and math foundation, give students a strong understanding of the structure and behavior of Earth’s systems (geosphere, hydrosphere, atmosphere, and biosphere) and the physical process through which they interact. The Earth Sciences core courses teach not only interdisciplinary science concepts but also skills in quantitative problem solving, fieldwork, and writing and oral communication, which are directly applicable to both graduate school and a career.

Students develop disciplinary depth by selecting an emphasis area: Geology, or Climate & Environmental Science

Program Learning Outcomes

1. Scientific principles and methods - graduates will be able to:
   - apply the scientific method to solve problems in the Earth sciences, which includes making observations, asking scientific questions, forming and testing hypotheses, and analyzing and evaluating the results.
   - collect, analyze, and interpret observations, and use field and laboratory equipment and data analysis software appropriate to their area of emphasis in the Earth sciences.
   - explain that all observations contain uncertainty, be able to quantitatively evaluate this uncertainty, and assess the implications of that uncertainty.
   - retrieve, use, and critically interpret the scientific literature.
   - create and interpret graphical representations of data.
   - create, manipulate, and interpret mathematical representations of Earth systems.

2. Process-level understanding - graduates will be able to:
   - demonstrate a qualitative understanding of the processes driving the major Earth systems, including within the lithosphere, the hydrosphere, the atmosphere, and Earth’s energy budget, as well as the fluxes of mass and energy within and between Earth systems, such as plate tectonics and climate system.
   - demonstrate a quantitative understanding of the processes driving the Earth systems in their area of emphasis.
   - demonstrate an understanding of the widely varying temporal and spatial scales of surface, subsurface, and deep-Earth processes that control changes in the Earth systems.

3. Application to societal issues - graduates will be able to:
   - use scientific principles and the understanding of physical processes to interpret the societal implications arising from anthropogenic and environmental change, such as natural hazards, resource management, and climate change.
   - Give an informed critique of the scientific data and literature underlying current policy discussions that relate to their emphasis area.

4. Communication - graduates will be able to:
   - collaborate effectively
   - effectively communicate scientific information in a variety of oral, visual, and written formats.
   - accurately and effectively record and document data, evidence, and findings.

Earth Science (B.S.) — 69–70 units

Basic Science and Math Foundation (17 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 115</td>
<td>General Chemistry I: Essential Concepts of Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>MATH 226</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 111</td>
<td>General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PHYS 112</td>
<td>General Physics I Laboratory</td>
<td></td>
</tr>
<tr>
<td>or PHYS 220</td>
<td>General Physics with Calculus I</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 222</td>
<td>General Physics with Calculus I Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHYS 121</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PHYS 122</td>
<td>General Physics II Laboratory</td>
<td></td>
</tr>
<tr>
<td>or PHYS 240</td>
<td>General Physics with Calculus III</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 242</td>
<td>General Physics with Calculus III Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

Earth Sciences Core (14 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 205</td>
<td>Techniques in Earth Sciences</td>
<td>2</td>
</tr>
<tr>
<td>ERTH 400</td>
<td>Earth Systems I</td>
<td>3</td>
</tr>
<tr>
<td>ERTH 500</td>
<td>Earth Systems II</td>
<td>3</td>
</tr>
<tr>
<td>ERTH 505</td>
<td>Quantitative Methods in Earth Sciences</td>
<td>3</td>
</tr>
<tr>
<td>ERTH 600GW</td>
<td>Earth’s Climate History - GWAR</td>
<td>3</td>
</tr>
</tbody>
</table>

Culminating Experience (4–5 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 690</td>
<td>Earth Sciences Capstone Presentation</td>
<td>1</td>
</tr>
<tr>
<td>and one of the following options:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERTH 695</td>
<td>Senior Project</td>
<td>3</td>
</tr>
<tr>
<td>or an honors thesis consisting of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERTH 697</td>
<td>Undergraduate Research</td>
<td>4</td>
</tr>
<tr>
<td>&amp; ERTH 698</td>
<td>and Senior Thesis</td>
<td></td>
</tr>
<tr>
<td>or (for Geology emphasis and Hydrology emphasis only):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Geology or equivalent (at another institution)</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Emphasis (34 units)

Students must select one of the following emphases

Geology Emphasis

The Geology emphasis provides students with an in-depth understanding of the solid Earth and process that shape it and skills to conduct field investigations of geologic problems. Students who complete these emphasis requirements will be prepared for graduate school in geology or to enter the workforce directly as a professional geologist. The coursework prepares students to pass the Association of State Board Geology (ASBOG) exam to be a licensed the professional geologist.
Bachelor of Science in Earth Sciences

**Required Courses (22–23 units)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 210</td>
<td>Physical Geology</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 420</td>
<td>Mineralogy and Petrology I</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 510</td>
<td>Structural Geology</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 515</td>
<td>Sedimentology and Stratigraphy</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 620</td>
<td>Field Methods in Geology</td>
<td>2</td>
</tr>
<tr>
<td>ERTH 522</td>
<td>Geochemistry</td>
<td>4-5</td>
</tr>
</tbody>
</table>

**Electives**

Select (upon advisement) additional Geology emphasis electives needed to reach 34 units.

**Hydrology Emphasis**

The Hydrology emphasis provides students with in-depth understanding of the behavior of water on and beneath Earth’s surface, how water shapes the solid earth, and environmental problems associated with water. Students who complete these emphasis requirements will be prepared for graduate school in hydrology or to enter the workforce directly as a professional hydrologist.

**Requirements (21–22 units)**

Select one of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 210</td>
<td>Physical Geology</td>
<td>3-4</td>
</tr>
<tr>
<td>ERTH 230</td>
<td>Environmental Geology</td>
<td></td>
</tr>
<tr>
<td>ERTH 330</td>
<td>California Water</td>
<td></td>
</tr>
<tr>
<td>ERTH 430</td>
<td>Fluid Dynamics in Earth Systems</td>
<td>3</td>
</tr>
<tr>
<td>ERTH 425</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 442/ GEOG 342</td>
<td>Surface Water Hydrology</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 444</td>
<td>Hydrogeology</td>
<td>4</td>
</tr>
<tr>
<td>ERTH 544</td>
<td>Groundwater Contamination</td>
<td>3</td>
</tr>
</tbody>
</table>

**Electives (12–13 units)**

Select (upon advisement) additional Hydrology emphasis electives needed to reach 34 units. (May include courses from the list above not selected to meet emphasis requirements.)

**Ocean, Weather & Climate Emphasis (34 units)**

The Ocean, Weather & Climate emphasis provides students with an understanding of the structure and behavior of oceans, the atmosphere, and climate, and the physical processes that shape and change them. Students who complete these emphasis requirements will be prepared for graduate school work in Earth sciences disciplines such as oceanography, meteorology, or climate science, or to enter the workforce directly.

**Requirements**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 260</td>
<td>Physical Processes in the Atmosphere</td>
<td>4</td>
</tr>
</tbody>
</table>

and five courses selected from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 335</td>
<td>Global Warming</td>
<td></td>
</tr>
<tr>
<td>or ERTH 360</td>
<td>California Weather Events</td>
<td></td>
</tr>
<tr>
<td>or ERTH 365</td>
<td>Extreme Weather in a Warming World</td>
<td></td>
</tr>
</tbody>
</table>

**Electives**

Select (upon advisement) additional Ocean, Weather, and Climate emphasis electives needed to reach 34 units. (May include courses from the list above not selected to meet emphasis requirements.)

**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</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>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>Humanities</td>
<td>LD</td>
<td>3</td>
<td>C2</td>
</tr>
<tr>
<td>Arts or Humanities</td>
<td>LD</td>
<td>3</td>
<td>C1 or C2</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>Lifelong Learning and Self-Development (LLD)</td>
<td>LD</td>
<td>3</td>
<td>E</td>
</tr>
<tr>
<td>Ethnic Studies</td>
<td>LD</td>
<td>3</td>
<td>F</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), 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</td>
<td>LD or UD</td>
<td>3</td>
<td>AERM</td>
</tr>
<tr>
<td>Environmental Sustainability</td>
<td>LD or UD</td>
<td>3</td>
<td>ES</td>
</tr>
<tr>
<td>Global Perspectives</td>
<td>LD or UD</td>
<td>3</td>
<td>GP</td>
</tr>
<tr>
<td>Social Justice</td>
<td>LD or UD</td>
<td>3</td>
<td>SJ</td>
</tr>
</tbody>
</table>

Note: LD = Lower-Division; UD = Upper-Division.
First-Time Student Roadmap (4 Year)

Find the correct roadmap (A, B, C, or D):

1. Select the row that matches your English Course choice for A2.*
2. Select the column that matches your QR Category (found at your student center under Math Alert).
3. Click the Roadmap that lines up with your row and column.

For example, if you are taking ENG 104 as your first English course and your student center math alert says you are QR Category III, you should choose Roadmap D.

<table>
<thead>
<tr>
<th>Course Choice</th>
<th>One-Semester Course</th>
<th>Two-Semester Sequence or Support Course</th>
</tr>
</thead>
</table>

*Composition for Multilingual Students: If taking ENG 209 as your first English course, choose the ENG 114 row. If taking ENG 204 for your first English course, choose the ENG 104/ENG 105 row.

SF State Scholars

The San Francisco State Scholars program provides undergraduate students with an accelerated pathway to a graduate degree. Students in this program pursue a bachelor’s and master’s degree simultaneously. This program allows students to earn graduate credit while in their junior and/or senior year, reducing the number of semesters required for completion of a master’s degree.

This roadmap opens in a new tab. (http://bulletin.sfsu.edu/colleges/science-engineering/earth-climate-science/bs-earth-sciences/scholars-roadmap/)

Transfer Student Roadmap (2 Year)

For students with an AS-T in Geology. This Geology Emphasis roadmap opens in a new tab (http://bulletin.sfsu.edu/colleges/science-engineering/earth-climate-science/bs-earth-sciences/adt-geology-roadmap/).

For students with an AS-T in Geology. This Hydrology Emphasis roadmap opens in a new tab (http://bulletin.sfsu.edu/colleges/science-engineering/earth-climate-science/bs-earth-sciences/adt-hydrology-roadmap/).

For students with an AS-T in Geology. This Ocean, Weather & Climate roadmap opens in a new tab (http://bulletin.sfsu.edu/colleges/science-engineering/earth-climate-science/bs-earth-sciences/adt-ocean-roadmap/).

This degree program is an approved pathway (“similar” major) for students earning the ADT in Geology

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 in most cases includes completion of all lower-division General Education requirements and at least 18 units in a specific major. (The Biology, Chemistry, and Environmental Science AS-T degrees defer 3 units in lower-division GE area C and 3 units in lower-division GE area D until after transfer.) 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 if pursuing a “similar” major after transfer. Determinations about “similar” majors at SF State are made by faculty in the discipline.

Degree completion in 60 units cannot be guaranteed when a student simultaneously pursues an additional major, a minor, certificate, or credential.

A sample advising roadmap for students who have earned an ADT and continue in a “similar” major at SF State is available on the Roadmaps tab on the degree requirements page for the major. The roadmap displays:

- How many lower-division units required for the major have been completed upon entry based on the award of a specific ADT;
- Which lower-division requirements are considered complete upon entry based on the award of a specific ADT;
- How to complete the remaining 60 units for the degree in four semesters.

Students who have earned an ADT should seek advising in the major department during the first semester of attendance.

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

For information about satisfying the requirements described in (1) and (2) above at a California Community College (CCC), please visit http://www.assist.org (http://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;

Remedial courses are not transferable and do not apply to the minimum 60 semester units/90 quarter units 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 a 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 degree 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. Credit is based on the academic year during which exams were taken. Refer to the University Bulletin in effect during the year of AP/IB/CLEP examination(s) for details regarding the award of credit for AP/IB/CLEP.

Students pursuing majors in science, technology, engineering, and mathematics (STEM) disciplines often defer 6-9 units of lower-division General Education in Areas C and D until after transfer to focus on preparation courses for the major. This advice does not apply to students pursuing associate degree completion before transfer.

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 (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 bulletin.sfsu.edu/undergraduate-education/general-education/lower-division/#AAEL.

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 (http://bulletin.sfsu.edu/undergraduate-admissions/).