

# 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 emphases area: Geology; Hydrology; or Oceans, Weather, and Climate

## 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.) – 68-70 units

### Basic Science and Math Foundation (16 units)

Code	Title	Units
CHEM 115	General Chemistry I	4
MATH 226	Calculus I	4
Select One Physics Sequence:		8
PHYS 111 & PHYS 112 & PHYS 121 & PHYS 122	General Physics I and General Physics I Laboratory and General Physics II and General Physics II Laboratory	
PHYS 220 & PHYS 222 & PHYS 240 & PHYS 242	General Physics with Calculus I and General Physics with Calculus I Laboratory and General Physics with Calculus III and General Physics with Calculus III Laboratory	

### Earth Sciences Core (14 units)

Code	Title	Units
ERTH 205	Techniques in Earth Sciences	2
ERTH 400	Earth Systems I	3
ERTH 500	Earth Systems II	3
ERTH 505	Quantitative Methods in Earth Sciences	3
ERTH 600GW	Earth's Climate History - GEAR	3

### Culminating Experience (4–5 units)

Code	Title	Units
ERTH 690	Earth Sciences Capstone Presentation	1
and one of the following options:		3-4
ERTH 695	Senior Project	
ERTH 697 & EARTH 698	Undergraduate Research and Senior Thesis	
Field Geology or equivalent (at another institution, Geology emphasis and Hydrology emphasis only)		

### 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.

#### Required Courses (22 units)

Code	Title	Units
CHEM 215	General Chemistry II	4
ERTH 210	Physical Geology	4

ERTH 420	Mineralogy and Petrology I	4
ERTH 510	Structural Geology	4
ERTH 515	Sedimentology and Stratigraphy	4
ERTH 620	Field Methods in Geology	2

**Electives (11–12 units)**

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 (18-19 units)**

Code	Title	Units
Select one of the following:		
ERTH 210	Physical Geology	3-4
ERTH 230	Environmental Geology	
ERTH 330	California Water	
ERTH 425	Geomorphology	4
ERTH 442/ GEOG 342	Surface Water Hydrology	4
ERTH 444	Hydrogeology	4
ERTH 544	Groundwater Contamination	3

**Electives (15-16 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**

Code	Title	Units
ERTH 260	Physical Processes in the Atmosphere	4
and five courses selected from the following:		
ERTH 335	Global Warming	
	or EARTH 360 California Weather Events	
	or EARTH 365 Extreme Weather in a Warming World	
ERTH 434	Coastal Processes	
ERTH 465	Weather Analysis and Forecasting I	
ERTH 470	Physical Oceanography	
ERTH 535	Planetary Climate Change	
MATH 227	Calculus II	

**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**

Requirement	Course Level	Units	Area Designation
Oral Communication	LD	3	A1
Written English Communication	LD	3	A2
Critical Thinking	LD	3	A3
Physical Science	LD	3	B1
Life Science	LD	3	B2
Lab Science	LD	1	B3
Mathematics/Quantitative Reasoning	LD	3	B4
Arts	LD	3	C1
Humanities	LD	3	C2
Arts or Humanities	LD	3	C1 or C2
Social Sciences	LD	3	D1
Social Sciences: US History	LD	3	D2
Lifelong Learning and Self-Development (LLD)	LD	3	E
Ethnic Studies	LD	3	F
Physical and/or Life Science	UD	3	UD-B
Arts and/or Humanities	UD	3	UD-C
Social Sciences	UD	3	UD-D

**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.

American Ethnic and Racial Minorities	LD or UD	3	AERM
Environmental Sustainability	LD or UD	3	ES
Global Perspectives	LD or UD	3	GP
Social Justice	LD or UD	3	SJ

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

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

The roadmaps presented in this Bulletin are intended as suggested plans of study and do not replace meeting with an advisor. For a more personalized roadmap, please use the Degree Planner (<https://registrar.sfsu.edu/degreeplanner/>) tool found in your [Student Center](#).

First-Time Student Roadmap (<http://bulletin.sfsu.edu/colleges/science-engineering/environment/bs-earth-sciences/roadmap-i-ii-eng/>)

## 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.

SF State Scholars Roadmap (<http://bulletin.sfsu.edu/colleges/science-engineering/environment/bs-earth-sciences/scholars-roadmap/>)

## Transfer Student Roadmap (2 Year)

For students with an AS-T in **Geology**.

**Geology Emphasis GEOL ADT Roadmap** (<http://bulletin.sfsu.edu/colleges/science-engineering/environment/bs-earth-sciences/adt-geology-roadmap/>)

For students with an AS-T in **Geology**.

**Hydrology Emphasis GEOL ADT Roadmap** (<http://bulletin.sfsu.edu/colleges/science-engineering/environment/bs-earth-sciences/adt-hydrology-roadmap/>)

For students with an AS-T in **Geology**.

**Ocean, Weather & Climate GEOL ADT Roadmap** (<http://bulletin.sfsu.edu/colleges/science-engineering/environment/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

- Before transfer, complete as many lower-division requirements or electives for this major as possible.
- 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;
- Which courses at a CCC satisfy CSU GE, US History, and US & CA Government requirements.

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](https://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.