**BACHELOR OF SCIENCE IN PHYSICS: CONCENTRATION IN ASTROPHYSICS**

**Undergraduate Programs in Physics and Astronomy**

High school preparation for these programs should include two years of algebra, one year of geometry, one semester of trigonometry, one year of chemistry, and one year of physics. Some experience in computer programming is encouraged. All students, especially those who have not completed a high school-level chemistry course, should take CHEM 115, CHEM 215, and CHEM 216 in their first year of college.

Students in these programs should consult with their advisor before selecting courses to meet General Education requirements. Unnecessary repetition of elementary topics might be avoided by careful selection of courses. A plan of study prepared in consultation with a department advisor is a prerequisite for upper-division study. Students who are considering teaching physics at the secondary school-level should see a credential advisor in the department before planning their major coursework. A competency assessment is required for admission to the credential program.

- A maximum of 6 units taken CR/NC may be counted toward an undergraduate degree.
- All prerequisites for upper-division courses must be completed with a grade of C- or better. See course descriptions for prerequisite requirements.

**Program Learning Outcomes**

Upon completion of the Bachelor of Science in Physics: Concentration in Astrophysics a student will demonstrate:

1. knowledge and understanding of, and ability to use, essential concepts and methods in physics, astronomy, and astrophysics.
2. strong ability to utilize mathematical relationships and methods to describe physical and astrophysical phenomena.
3. ability to solve problems of moderate difficulty in physics and astronomy by integrating conceptual understanding, quantitative understanding, logical reasoning, and use of mathematical methods.
4. good ability to analyze and interpret data, with proper treatment of measurement uncertainties.
5. good ability to design and implement experimental investigations, with proper use of instrumentation.
6. good ability to communicate knowledge and results to others in written and oral form.
7. good ability to utilize print and electronic resources, computers, and software to gain information and perform calculations.

**Physics (B.S.): Concentration in Astrophysics — 71 units**

**Prerequisites (27 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>
</tbody>
</table>

**Upper-Division Requirements (44 units)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 300</td>
<td>Stars, Planets, and the Milky Way</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 301</td>
<td>Observational Astronomy Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>ASTR 340GW</td>
<td>The Big Bang - GWAR</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 400</td>
<td>Stellar Astrophysics</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 470</td>
<td>Observational Techniques in Astronomy</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 498</td>
<td>Astronomy Research Literature and Culminating Experience in Physics</td>
<td>3</td>
</tr>
<tr>
<td>&amp; PHYS 695</td>
<td>or ASTR 697</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 430</td>
<td>Quantum Mechanics I</td>
<td>3</td>
</tr>
</tbody>
</table>

**Electives** 6

1 Chosen from upper-division courses in Physics or Astronomy with consent of an advisor. Three of the 6 units must be in a course(s) numbered 400–499. Up to 1 unit of a 600 level course in ASTR may count toward this requirement.

**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>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>
</tbody>
</table>
Social Sciences:  LD  3  D3
US & CA Government
Lifelong Learning and Self-Development (LLD)
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)
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>Pathway</th>
<th>QR Cat I/II</th>
<th>QR Cat III/IV</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.

Transfer Student Roadmap (2 Year)

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

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
Bachelor of Science in Physics: Concentration in Astrophysics

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. 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/).

- Complete 60 or more transferable semester units or 90 or more quarter units.
- Earn a college grade point average of 2.0 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.