Astrophysics

Bachelor of Arts (BA)

The Department of Astronomy offers an undergraduate major and minor in Astrophysics. This major program prepares students for astrophysics graduate work or other advanced degrees in related fields, teaching, working in the field of computer applications, scientific and technical writing, a career as a field engineer, and other technical fields.

Declaring the Major

For information on declaring the major, please contact the Astronomy department.

Honors Program

For honors in astrophysics a student must fulfill the following additional requirements:

1. Maintain a grade-point average of at least 3.5 in all courses in astronomy and related fields, and an overall grade-point average of at least 3.3 in the University
2. Carry out an individual research or study project, involving at least three units of ASTRON H195

The student's project is chosen in consultation with a departmental adviser, and the written report is judged by the student's research supervisor and by a departmental adviser.

Minor Program

Students may petition for the minor in Astrophysics only after they have completed all required courses for the minor in Astrophysics. Graduating seniors must petition no later than two weeks after the end of the term. To petition students must fill out a "Completion of L&S Minor" form available from the College of Letters and Science Advising Office in 206 Evans or from the L&S Advising website (http://ls-advise.berkeley.edu/fp/00minor.pdf) . Turn in to the Undergraduate Adviser:

1. The completed petition for the minor
2. A copy of transcripts (unofficial transcripts are OK) showing your completed astrophysics courses

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All courses taken to fulfill the major requirements below must be taken for graded credit, other than courses listed which are offered on a *Pass/Fail* basis only. Other exceptions to this requirement are noted as applicable.
2. No more than one upper-division course may be used to simultaneously fulfill requirements for a student's major and minor programs, with the exception of minors offered outside of the College of Letters and Science.
3. A minimum grade point average (GPA) of 2.0 must be maintained in both upper- and lower-division courses used to fulfill the major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

Minimum Prerequisites for Astronomy Courses

The following courses are the minimum required prerequisites for the upper- and lower-division Astronomy courses required for the major:

PHYSICS 7A	Physics for Scientists and Engineers	4
	(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
PHYSICS 7B	Physics for Scientists and Engineers	4
	(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
PHYSICS 7C	Physics for Scientists and Engineers	4
	(Prerequisite for: ASTRON 7B (or concurrent), ASTRON 120 (or concurrent), ASTRON 121, and ASTRON C162)	
PHYSICS 110A	Electromagnetism and Optics	4
	(Prerequisite for: ASTRON 120 (recommended), ASTRON 160, and ASTRON C161 [1]	
PHYSICS 110B	Electromagnetism and Optics	4
	(Prerequisite for: ASTRON 120 (or concurrent, recommended) and ASTRON 160 [1]	
MATH 1A	Calculus	4
	(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
MATH 1B	Calculus	4
	(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
MATH 53	Multivariable Calculus	4
	(Prerequisite for: ASTRON 7A (or concurrent), ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
MATH 54	Linear Algebra and Differential Equations	4
	(Prerequisite for: ASTRON 7B (or concurrent), ASTRON 120 (or concurrent), ASTRON 121, and ASTRON C162)	

[1] PHYSICS 137A and PHYSICS 137B can also be substituted for PHYSICS 110A and PHYSICS 110B, as a prerequisite to ASTRON 160.

Recommended Lower-division Astronomy Courses

The following courses are recommended prerequisites for all upper-division courses, and strongly recommended for majors, but are not required:

ASTRON 7A	Introduction to Astrophysics	4
ASTRON 7B	Introduction to Astrophysics	4

Upper-division Major Requirements

ASTRON 120	Optical and Infrared Astronomy Laboratory	4
or ASTRON 121	Radio Astronomy Laboratory	
Select two of the following:		8
ASTRON 160	Stellar Physics	
ASTRON C161	Relativistic Astrophysics and Cosmology	

ASTRON C162	Planetary Astrophysics [2]	
Upper-division electives:		
Select elective units so that the total of all upper-division Astronomy courses and electives is 30 units (or 24 units for a double major)		
See below for a list of approved electives		

Approved Electives

PHYSICS 105	Analytic Mechanics	4
PHYSICS 110A	Electromagnetism and Optics	4
PHYSICS 110B	Electromagnetism and Optics	4
PHYSICS 111	Course Not Available	1-3
PHYSICS 112	Introduction to Statistical and Thermal Physics	4
PHYSICS 124	Course Not Available	4
PHYSICS 129	Particle Physics	4
PHYSICS 137A	Quantum Mechanics	4
PHYSICS 137B	Quantum Mechanics	4
PHYSICS 142	Introduction to Plasma Physics	4
PHYSICS 150	Course Not Available	4
MATH 104	Introduction to Analysis	4
MATH 110	Linear Algebra	4
MATH 121A	Mathematical Tools for the Physical Sciences	4
MATH 121B	Mathematical Tools for the Physical Sciences	4
MATH 128A	Numerical Analysis	4
MATH 128B	Numerical Analysis	4
MATH 160	History of Mathematics	4
MATH 185	Introduction to Complex Analysis	4
COMPSCI 150	Components and Design Techniques for Digital Systems	5
COMPSCI 160	User Interface Design and Development	4
COMPSCI 164	Programming Languages and Compilers	4
COMPSCI 169	Software Engineering	4
COMPSCI 184	Foundations of Computer Graphics	4
COMPSCI 186	Introduction to Database Systems	4
COMPSCI 188	Introduction to Artificial Intelligence	4
COMPSCI 195	Social Implications of Computer Technology	1
STAT 101	Course Not Available	4
STAT 102	Course Not Available	4
STAT 134	Concepts of Probability	3
STAT 135	Concepts of Statistics	4
STAT 153	Introduction to Time Series	4
EPS 108	Geodynamics	4
EPS 122	Physics of the Earth and Planetary Interiors	3
GEOG 146	Course Not Available	4
CHEM 104A	Advanced Inorganic Chemistry	3
CHEM 104B	Advanced Inorganic Chemistry	3
CHEM 105	Instrumental Methods in Analytical Chemistry	4
CHEM 108	Inorganic Synthesis and Reactions	4
CHEM 112A	Organic Chemistry	5
CHEM 112B	Organic Chemistry	5
CHEM 120A	Physical Chemistry	3
CHEM 120B	Physical Chemistry	3
CHEM 122	Quantum Mechanics and Spectroscopy	3
CHEM 125	Physical Chemistry Laboratory	3
CHEM 143	Nuclear Chemistry	2
HISTORY 181B	Topics in the History of the Physical Sciences: Modern Physics: From the Atom to Big Science	4

Students who have a strong interest in an area of study outside their major often decide to complete a minor program. These programs have set requirements and are noted officially on the transcript in the memoranda section, but are not noted on diplomas.

General Guidelines

1. All courses taken to fulfill the minor requirements below must be taken for graded credit.
2. A minimum of three of the upper-division courses taken to fulfill the minor requirements must be completed at UC Berkeley.
3. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
4. Courses used to fulfill the minor requirements may be applied toward the Seven-Course Breadth Requirement, for Letters and Science students.
5. No more than one upper-division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
6. All minor requirements must be completed prior to the last day of finals during the semester in which you plan to graduate. If you cannot finish all courses required for the minor by that time, please see a College of Letters and Science adviser.
7. All minor requirements must be completed within the unit ceiling. (For further information regarding the unit ceiling, please see the College Requirements tab.)

Minimum Prerequisites for Astronomy Courses

The following courses are the minimum required prerequisites for the upper- and lower-division Astronomy courses required for the minor:

PHYSICS 7A	Physics for Scientists and Engineers	4
(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)		
PHYSICS 7B	Physics for Scientists and Engineers	4
(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)		
PHYSICS 7C	Physics for Scientists and Engineers	4
(Prerequisite for: ASTRON 7B (or concurrent), ASTRON 120 (or concurrent), ASTRON 121, and ASTRON C162)		
PHYSICS 110A	Electromagnetism and Optics	4
(Prerequisite for: ASTRON 120 (recommended), ASTRON 160, and ASTRON C161 [1]		
PHYSICS 110B	Electromagnetism and Optics	4
(Prerequisite for: ASTRON 120 (or concurrent, recommended) and ASTRON 160 [1]		
MATH 1A	Calculus	4
(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)		
MATH 1B	Calculus	4

	(Prerequisite for: ASTRON 7A, ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
MATH 53	Multivariable Calculus	4
	(Prerequisite for: ASTRON 7A (or concurrent), ASTRON 7B, ASTRON 120, ASTRON 121, and ASTRON C162)	
MATH 54	Linear Algebra and Differential Equations	4
	(Prerequisite for: ASTRON 7B (or concurrent), ASTRON 120 (or concurrent), ASTRON 121, and ASTRON C162)	

[1] PHYSICS 137A and PHYSICS 137B can also be substituted for PHYSICS 110A and PHYSICS 110B, as a prerequisite to ASTRON 160.

Recommended Lower-division Astronomy Courses

The following courses are recommended prerequisites for all upper-division courses, and strongly recommended for minors, but are not required:

ASTRON 7A	Introduction to Astrophysics	4
ASTRON 7B	Introduction to Astrophysics	4

Minor Requirements

Select two of the following:		8
ASTRON 120	Optical and Infrared Astronomy Laboratory	
ASTRON 121	Radio Astronomy Laboratory	
ASTRON 160	Stellar Physics	
ASTRON C161	Relativistic Astrophysics and Cosmology	
ASTRON C162	Planetary Astrophysics	
Select three electives: See below for approved list [1]		12

[1] All upper-division courses must be taken for a letter grade; thus ASTRON H195 Special Study for Honors Candidates, ASTRON 198 Directed Group Study and ASTRON 199 Supervised Independent Study and Research will not count toward the minor program).

Approved Electives

PHYSICS 105	Analytic Mechanics	4
PHYSICS 110A	Electromagnetism and Optics	4
PHYSICS 110B	Electromagnetism and Optics	4
PHYSICS 111	Course Not Available	1-3
PHYSICS 112	Introduction to Statistical and Thermal Physics	4
PHYSICS 124	Course Not Available	4
PHYSICS 129	Particle Physics	4
PHYSICS 137A	Quantum Mechanics	4
PHYSICS 137B	Quantum Mechanics	4
PHYSICS 142	Introduction to Plasma Physics	4
PHYSICS 150	Course Not Available	4
MATH 104	Introduction to Analysis	4
MATH 110	Linear Algebra	4
MATH 121A	Mathematical Tools for the Physical Sciences	4
MATH 121B	Mathematical Tools for the Physical Sciences	4
MATH 128A	Numerical Analysis	4
MATH 128B	Numerical Analysis	4
MATH 160	History of Mathematics	4
MATH 185	Introduction to Complex Analysis	4
COMPSCI 150	Components and Design Techniques for Digital Systems	5
COMPSCI 160	User Interface Design and Development	4
COMPSCI 164	Programming Languages and Compilers	4
COMPSCI 169	Software Engineering	4
COMPSCI 184	Foundations of Computer Graphics	4
COMPSCI 186	Introduction to Database Systems	4
COMPSCI 188	Introduction to Artificial Intelligence	4
COMPSCI 195	Social Implications of Computer Technology	1
STAT 101	Course Not Available	
STAT 102	Course Not Available	4
STAT 134	Concepts of Probability	3
STAT 135	Concepts of Statistics	4
STAT 153	Introduction to Time Series	3
EPS 108	Geodynamics	3
EPS 122	Physics of the Earth and Planetary Interiors	3
GEOG 146	Course Not Available	4
CHEM 104A	Advanced Inorganic Chemistry	3
CHEM 104B	Advanced Inorganic Chemistry	3
CHEM 105	Instrumental Methods in Analytical Chemistry	4
CHEM 108	Inorganic Synthesis and Reactions	4
CHEM 112A	Organic Chemistry	5
CHEM 112B	Organic Chemistry	5
CHEM 120A	Physical Chemistry	3
CHEM 120B	Physical Chemistry	3
CHEM 122	Quantum Mechanics and Spectroscopy	3
CHEM 125	Physical Chemistry Laboratory	3
CHEM 143	Nuclear Chemistry	2
HISTORY 181B	Topics in the History of the Physical Sciences: Modern Physics: From the Atom to Big Science	4

Undergraduate students in the College of Letters and Science must fulfill the following requirements in addition to those required by their major program.

For detailed lists of courses that fulfill college requirements, please see the College of Letters and Sciences (http://guide.berkeley.edu/archive/2014-15/undergraduate/colleges-schools/letters-science) page in this bulletin.

Entry Level Writing

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Fulfillment of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

American History and American Institutions

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

American Cultures

American Cultures is the one requirement that all undergraduate students at Cal need to take and pass in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity and culture of the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

Quantitative Reasoning

The Quantitative Reasoning requirement is designed to ensure that students graduate with basic understanding and competency in math, statistics, or computer science. The requirement may be satisfied by exam or by taking an approved course.

Foreign Language

The Foreign Language requirement may be satisfied by demonstrating proficiency in reading comprehension, writing, and conversation in a foreign language equivalent to the second semester college level, either by passing an exam or by completing approved course work.

Reading and Composition

In order to provide a solid foundation in reading, writing and critical thinking the College requires two semesters of lower division work in composition. Students must complete a first-level reading and composition course by the end of their second semester and a second-level course by the end of their fourth semester.

Breadth Requirements

The undergraduate breadth requirements provide Berkeley students with a rich and varied educational experience outside of their major program. As the foundation of a liberal arts education, breadth courses give students a view into the intellectual life of the University while introducing them to a multitude of perspectives and approaches to research and scholarship. Engaging students in new disciplines and with peers from other majors, the breadth experience strengthens interdisciplinary connections and context that prepares Berkeley graduates to understand and solve the complex issues of their day.

Unit Requirements

- 120 total units, including at least 60 L&S units
- Of the 120 units, 36 must be upper division units
- Of the 36 upper division units, 6 must be taken in courses offered outside your major department

Residence Requirements

For units to be considered in "residence," you must be registered in courses on the Berkeley campus as a student in the College of Letters and Science. Most students automatically fulfill the residence requirement by attending classes here for four years. In general, there is no need to be concerned about this requirement, unless you go abroad for a semester or year or want to take courses at another institution or through University Extension during your senior year. In these cases, you should make an appointment to see an adviser to determine how you can meet the Senior Residence Requirement.

Note: Courses taken through UC Extension do not count toward residence.

Senior Residence Requirement

After you become a senior (with 90 semester units earned toward your B.A. degree), you must complete at least 24 of the remaining 30 units in residence in at least two semesters. To count as residence, a semester must consist of at least 6 passed units. Intercampus Visitor, EAP, and UC Berkeley-Washington Program (UCDC) units are excluded.

You may use a Berkeley summer session to satisfy one semester of the Senior Residence Requirement, provided that you successfully complete 6 units of course work in the Summer Session and that you have been enrolled previously in the College.

Modified Senior Residence Requirement

Participants in the UC Education Abroad Program (EAP) or the UC Berkeley-Washington Program (UCDC) may meet a Modified Senior Residence Requirement by completing 24 (excluding EAP) of their final 60 semester units in residence. At least 12 of these 24 units must be completed after you have completed 90 units.

Upper Division Residence Requirement

You must complete in residence a minimum of 18 units of upper division courses (excluding EAP units), 12 of which must satisfy the requirements for your major.

Astrophysics

ASTRON 3 Introduction to Modern Cosmology 2 Units
Description of research and results in modern extragalactic astronomy and cosmology. We read the stories of discoveries of the principles of our Universe. Simple algebra is used.
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bloom, Davis, Ma

ASTRON 7A Introduction to Astrophysics 4 Units
This is the first part of an overview of astrophysics, with an emphasis on the way in which physics is applied to astronomy. This course deals with the solar system and stars, while 7B covers galaxies and cosmology. Solar system topics include orbital mechanics, geology of terrestrial planets, planetary atmospheres, and the formation of the solar system. The study of stars will treat determination of observations, properties and stellar structure, and evolution. The physics in this course includes mechanics and gravitation; kinetic theory of gases; properties of radiation and radiative energy transport; quantum mechanics of photons, atoms, and electrons; and magnetic fields.
Rules & Requirements

Prerequisites: PHYSICS 7A-7B (7B can be concurrent), or consent of the instructor

Credit Restrictions: Students will receive 2 units of credit for 7A after taking 10; 6 units of credit for both 7A-7B after taking 10.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Chiang, Marcy, Quataert

ASTRON 7B Introduction to Astrophysics 4 Units
This is the second part of an overview of astrophysics, which begins with 7A. This course covers the Milky Way galaxy, star formation and the interstellar medium, galaxies, black holes, quasars, dark matter, the expansion of the universe and its large-scale structure, and cosmology and the Big Bang. The physics in this course includes that used in 7A (mechanics and gravitation; kinetic theory of gases; properties of radiation and radiative energy transport; quantum mechanics of photons, atoms, and electrons; and magnetic fields) and adds the special and general theories of relativity.
Rules & Requirements

Prerequisites: PHYSICS 7A-7B (7B can be concurrent) or consent of the instructor

Credit Restrictions: Students will receive 2 units of credit for 7B after taking 10; 6 units of credit for both 7A-7B after taking 10.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bloom, Chiang, Marcy, Quataert

ASTRON 9 Selected Topics in Astronomy 3 Units
This seminar will explore one of a variety of subjects in greater depth than in introductory courses. Possible topics include stars, galaxies, the solar system, the interstellar medium, relativity and cosmology, history of astronomy, observational astronomy, and life in the universe.
Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture per week

Summer: 6 weeks - 7.5 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

ASTRON 10 Introduction to General Astronomy 4 Units
A description of modern astronomy with emphasis on the structure and evolution of stars, galaxies, and the Universe. Additional topics optionally discussed include quasars, pulsars, black holes, and extraterrestrial communication, etc. Individual instructor's synopses available from the department.
Rules & Requirements

Credit Restrictions: Students will receive no credit for Astronomy 10 after taking Astronomy 7A or 7B, XAstronomy 10. Students can remove a deficient grade in XAstronomy 10 by taking Astronomy 10, Letter and Science C70U or Astronomy C10.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
6 weeks - 8 hours of lecture and 2.5 hours of discussion per week
8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Basri, Blitz, Bloom, Davis

ASTRON C10 Introduction to General Astronomy 4 Units
A description of modern astronomy with emphasis on the structure and evolution of stars, galaxies, and the Universe. Additional topics optionally discussed include quasars, pulsars, black holes, and extraterrestrial communication, etc. Individual instructor's synopses available from the department.
Rules & Requirements

Credit Restrictions: Students will receive no credit for 10 after taking 7A or 7B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
6 weeks - 8 hours of lecture and 2.5 hours of discussion per week
8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Filippenko

Also listed as: L & S C70U

ASTRON N10 Introduction to General Astronomy 3 Units
The nature and evolution of the universe: history of astronomical knowledge; overall structure of the universe; galaxies, radio galaxies, peculiar galaxies, and quasars; structure and evolution of stars; exploding stars, pulsars, and black holes; exploration of the solar system; the search for extraterrestrial life.
Rules & Requirements

Prerequisites: High school algebra will be presumed but used sparingly

Credit Restrictions: Students will receive no credit for 10 after taking 7.

Hours & Format

Summer: 8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

ASTRON C12 The Planets 3 Units
A tour of the mysteries and inner workings of our solar system. What are planets made of? Why do they orbit the sun the way they do? How do planets form, and what are they made of? Why do some bizarre moons have oceans, volcanoes, and ice floes? What makes the Earth hospitable for life? Is the Earth a common type of planet or some cosmic quirk? This course will introduce basic physics, chemistry, and math to understand planets, moons, rings, comets, asteroids, atmospheres, and oceans. Understanding other worlds will help us save our own planet and help us understand our place in the universe.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Summer: 6 weeks - 7.5 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Also listed as: EPS C12/L & S C70T

ASTRON W12 The Planets 3 Units
A tour of the mysteries and inner workings of our solar system. What are planets made of? Why do they orbit the sun the way they do? How do planets form, and what are they made of? Why do some bizarre moons have oceans, volcanoes, and ice floes? What makes the Earth hospitable for life? Is the Earth a common type of planet or some cosmic quirk? This course will introduce basic physics, chemistry, and math to understand planets, moons, rings, comets, asteroids, atmospheres, and oceans. Understanding other worlds will help us save our own planet and help us understand our place in the universe. This course is web-based.
Hours & Format

Summer: 8 weeks - 6 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Marcy, Militzer

Also listed as: EPS W12

ASTRON C13 Origins: from the Big Bang to the Emergence of Humans 4 Units
This course will cover our modern scientific understanding of origins, from the Big Bang to the formation of planets like Earth, evolution by natural selection, the genetic basis of evolution, and the emergence of humans. These ideas are of great intrinsic scientific importance and also have far reaching implications for other aspects of people's lives (e.g., philosophical, religious, and political). A major theme will be the scientific method and how we know what we know.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Marshall, Quataert

Also listed as: INTEGBI C13

ASTRON 24 Freshman Seminars 1 Unit
The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley Seminars are offered in all campus departments, and topics vary from department to department and semester to semester.
Rules & Requirements

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

ASTRON 39 Seminar 1.5 Unit
A small-size undergraduate seminar exploring one astronomical topic in depth. Students are responsible for much of the presentation.
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Instructors: Basri, Filippenko, Davis

ASTRON 84 Sophomore Seminar 1 or 2 Units
Sophomore seminars are small interactive courses offered by faculty members in departments all across the campus. Sophomore seminars offer opportunity for close, regular intellectual contact between faculty members and students in the crucial second year. The topics vary from department to department and semester to semester. Enrollment limited to 15 sophomores.
Rules & Requirements

Prerequisites: At discretion of instructor

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
5 weeks - 3-6 hours of seminar per week
10 weeks - 1.5-3 hours of seminar per week
15 weeks - 1-2 hours of seminar per week

Summer:
6 weeks - 2.5-5 hours of seminar per week
8 weeks - 1.5-3.5 hours of seminar and 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

ASTRON 98 Directed Group Study 1 - 4 Units
Topics will vary with instructor.
Rules & Requirements

Prerequisites: Restricted to freshmen and sophomores; consent of instructor

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

ASTRON 99 Directed Study in Astronomy 1 - 3 Units
Supervised observational studies or directed reading for lower division students.
Rules & Requirements

Prerequisites: 7A-B, 10 and consent of instructor

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of independent study per week

Summer: 6 weeks - 2.5-7.5 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

ASTRON 120 Optical and Infrared Astronomy Laboratory 4 Units
This course requires four to six experiments such as the following: accurate position and brightness measurements of stars; laboratory exploration of the characteristics of two-dimensional charge-coupled devices (CCDs) and infrared detectors; measurement of the distance, reddening, and age of a star cluster; measurement of the Stokes parameters and linear polarization of diffuse synchrotron and reflection nebulae; measurement of the period and pulse shape of the Crab pulsar using Fourier techniques. Professional telescopes will be used such as those at Leuschner Observatory and Lick Observatory. There is a emphasis on error analysis, software development in the IDL language, and high-quality written reports.
Rules & Requirements

Prerequisites: 7A-7B; Mathematics 53, 54; PHYSICS 7A-7B-7C (7C may be taken concurrently)

Credit Restrictions: Students will receive no credit for 120 after taking 120A or 122.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bower, Marcy

Formerly known as: 120A

ASTRON 121 Radio Astronomy Laboratory 4 Units
Several basic laboratory experiments that concentrate on microwave electronics and techniques; construction of receiving, observing, and data analysis systems for two radioastronomical telescopes, a single-dish 21-cm line system and a 12-GHz interferometer; use of these telescopes for astronomical observing projects including structure of the Milky Way galaxy, precise position measurement of several radio sources, and measurement of the radio brightness distributions of the sun and moon with high angular resolution. There is a heavy emphasis on digital data acquisition, software development in the IDL language, and high-quality written reports.
Rules & Requirements

Prerequisites: 7A-7B; Mathematics 53, 54; PHYSICS 7A-7B-7C; PHYSICS 110B recommended

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of discussion and 1 hour of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bower, Heiles

Formerly known as: 120B

ASTRON 160 Stellar Physics 4 Units
Topics covered include some, but not necessarily all, of the following. Observational constraints on the properties and evolution of stars. Theory of stellar structure and evolution. Stellar atmospheres and stellar spectroscopy. Stellar nucleosynthesis. Supernovae. Degeneracy of matter and structure of collapsed stars. Elements of gas dynamics, accretion onto compact objects, and x-ray sources. Dynamics and evolution of close binary systems. Stellar pulsation.
Rules & Requirements

Prerequisites: Senior standing in astronomy/physics or consent of instructor. PHYSICS 112 (may be taken concurrently) and either PHYSICS 110A-110B or PHYSICS 137A-137B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Filippenko, Quataert, Stahler

Formerly known as: C160A and Physics C160A

ASTRON C161 Relativistic Astrophysics and Cosmology 4 Units
Elements of general relativity. Physics of pulsars, cosmic rays, black holes. The cosmological distance scale, elementary cosmological models, properties of galaxies and quasars. The mass density and age of the universe. Evidence for dark matter and dark energy and concepts of the early universe and of galaxy formation. Reflections on astrophysics as a probe of the extrema of physics.
Rules & Requirements

Prerequisites: 110A-110B; 112 (may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Boggs, Davis, Holzapfel, A. Lee, Ma, Quataert

Formerly known as: C160B and Physics C160B

Also listed as: PHYSICS C161

ASTRON C162 Planetary Astrophysics 4 Units
Physics of planetary systems, both solar and extra-solar. Star and planet formation, radioactive dating, small-body dynamics and interaction of radiation with matter, tides, planetary interiors, atmospheres, and magnetospheres. High-quality oral presentations may be required in addition to problem sets and a final exam.
Rules & Requirements

Prerequisites: Mathematics 53, 54; PHYSICS 7A-7B-7C

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Chiang, de Pater, Marcy

Formerly known as: C149

Also listed as: EPS C162

ASTRON H195 Special Study for Honors Candidates 2 - 4 Units
Individual project of research or study.
Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

ASTRON 198 Directed Group Study 1 - 4 Units
Topics will vary with instructor.
Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

ASTRON 199 Supervised Independent Study and Research 1 - 4 Units
Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.