Astrophysics

Bachelor of Arts (BA)

The Department of Astronomy offers an undergraduate major and minor in Astrophysics. This program prepares students for astrophysics graduate work or other advanced degrees in related science and engineering fields. It also prepares students for careers in teaching or for working in data science, the tech industry, and other technical fields.

Declaring the Major

Students can apply to declare the major after completing all lower division requirements (see major requirements tab). For applicants with prerequisites in progress, applications will be reviewed after the grades for all prerequisites are available. All the courses applied to the astrophysics major must be taken for a letter grade. A minimum grade point average of 2.0 is required for all prerequisites as well as for upper-division courses used for the major. Additional information including a list of required courses, electives and forms to complete prior declaring can be found on our website here (https://astro.berkeley.edu/programs/undergraduate-program/).

Minor Program

The Department of Astronomy offers a minor program in Astrophysics. All courses applied to the astrophysics minor must be taken for a letter grade. A minimum grade point average of 2.0 is required for the lower-division minor requirements as well as for the five upper-division courses used for the minor. Only one upper-division class may overlap between your major and the Astrophysics Minor. Students must complete the College of Letters and Science Completion of L&S Minor form (https://ls.berkeley.edu/sites/default/files/minor.2019.pdf).

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

- All courses taken to fulfill the major requirements below must be taken for graded credit. Exception will be made for coursework taken between Spring 2020 and Summer 2021.
- Only 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 & Science. Only two upper-division courses can overlap between two majors.
- 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 residency requirements and unit requirements, please see the College Requirements tab.

Lower Division Major Requirements

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations [1]	4
or PHYSICS 89	Introduction to Mathematical Physics	
PHYSICS 7A	Physics for Scientists and Engineers	4
or PHYSICS 5A	Introductory Mechanics and Relativity	
PHYSICS 7B	Physics for Scientists and Engineers	4
Or PHYSICS 5B and PHYSICS 5BL		
PHYSICS 7C	Physics for Scientists and Engineers	4
Or PHYSICS 5C and PHYSICS 5CL		

[1] If you are planning to double major with Physics, We recommend PHYSICS 89

Upper Division Major Requirements

Optional:

These courses are not required but strongly recommended for anyone considering the Astrophysics major. Please consult with the Undergraduate Adviser.

ASTRON 7A	Introduction to Astrophysics [4]
ASTRON 7B	Introduction to Astrophysics [4]
PHYSICS 88	Data Science Applications in Physics [2]
Or COMPSCI 61A	
Or PHYSICS 77	

Required (choose one of the following):

ASTRON 120	Optical and Infrared Astronomy Laboratory [4]
ASTRON 121	Radio Astronomy Laboratory [4]
ASTRON 128	Astronomy Data Science Laboratory [4]

Required (choose two of the following):

ASTRON 160	Stellar Physics [4]
ASTRON C161	Relativistic Astrophysics and Cosmology [4]
ASTRON C162	Planetary Astrophysics [4]

Required (as needed):

Upper division electives so that the total is 30 units for a single major and 24 units for a double major.

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 12A	Organic Chemistry [5]
CHEM 12B	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]
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 189	Introduction to Machine Learning [4]
EECS 120	Course Not Available
EECS 150	Course Not Available
EPS 108	Geodynamics [4]
EPS 109	Computer Simulations with Jupyter Notebooks [4]

EPS 122	Physics of the Earth and Planetary Interiors [3]
EPS C181	Atmospheric Physics and Dynamics [3]
MATH 104	Introduction to Analysis [4]
MATH 110	Linear Algebra [4]
MATH 113	Introduction to Abstract 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]
NUC ENG 100	Introduction to Nuclear Energy and Technology [3]
PHYSICS 105	Analytic Mechanics [4]
PHYSICS 110A	Electromagnetism and Optics [4]
PHYSICS 110B	Electromagnetism and Optics [4]
PHYSICS 111A	Instrumentation Laboratory [4]
PHYSICS 111B	Advanced Experimentation Laboratory [1-3]
PHYSICS 112	Introduction to Statistical and Thermal Physics [4]
PHYSICS 129	Particle Physics [4]
PHYSICS 137A	Quantum Mechanics [4]
PHYSICS 137B	Quantum Mechanics [4]
PHYSICS 139	Special Relativity and General Relativity [3]
PHYSICS 141A	Solid State Physics [4]
PHYSICS 141B	Solid State Physics [3]
PHYSICS 142	Introduction to Plasma Physics [4]
PHYSICS 151	Elective Physics: Special Topics [3]
STAT 134	Concepts of Probability [4]
STAT 135	Concepts of Statistics [4]
STAT 153	Introduction to Time Series [4]

[1] ASTRON 7A and ASTRON 7B are recommended prerequisites for all upper division courses.

[2] The 30 unit requirement (or 24 units for double majors with another major) is the sum of astronomy upper division courses and the electives.

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

- All courses taken to fulfill the minor requirements below must be taken for graded credit.
- A minimum of three of the upper division courses taken to fulfill the minor requirements must be completed at UC Berkeley.
- A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
- Courses used to fulfill the minor requirements may be applied toward the Seven-Course Breadth requirement, for Letters & Science students.
- Only one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
- 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 & Science adviser.
- All minor requirements must be completed within the unit ceiling. (For further information regarding the unit ceiling, please see the College Requirements tab)

Lower Division Minor Requirements

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
PHYSICS 7C	Physics for Scientists and Engineers	4

Upper Division Minor Requirements

Optional:

The following are recommended for the minor, but are not required.

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

Required (choose two of the following):

ASTRON 120	Optical and Infrared Astronomy Laboratory [4]
ASTRON 121	Radio Astronomy Laboratory [4]
ASTRON 128	Astronomy Data Science Laboratory [4]
ASTRON 160	Stellar Physics [4]
ASTRON C161	Relativistic Astrophysics and Cosmology [4]
ASTRON C162	Planetary Astrophysics [4]

Required (choose three of the following electives):

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 12A	Organic Chemistry [5]
CHEM 12B	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]
EPS 108	Geodynamics [4]
EPS 109	Computer Simulations with Jupyter Notebooks [4]
EPS 122	Physics of the Earth and Planetary Interiors [3]
EPS C181	Atmospheric Physics and Dynamics [3]
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 189	Introduction to Machine Learning [4]
MATH 104	Introduction to Analysis [4]
MATH 110	Linear Algebra [4]
MATH 113	Introduction to Abstract 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]
NUC ENG 100	Introduction to Nuclear Energy and Technology [3]
PHYSICS 105	Analytic Mechanics [4]
PHYSICS 110A	Electromagnetism and Optics [4]
PHYSICS 110B	Electromagnetism and Optics [4]
PHYSICS 111A	Instrumentation Laboratory [4]
PHYSICS 111B	Advanced Experimentation Laboratory [1-3]
PHYSICS 112	Introduction to Statistical and Thermal Physics [4]
PHYSICS 129	Particle Physics [4]
PHYSICS 137A	Quantum Mechanics [4]
PHYSICS 137B	Quantum Mechanics [4]
PHYSICS 139	Special Relativity and General Relativity [3]
PHYSICS 141A	Solid State Physics [4]
PHYSICS 141B	Solid State Physics [3]
PHYSICS 142	Introduction to Plasma Physics [4]
PHYSICS 151	Elective Physics: Special Topics [3]
STAT 134	Concepts of Probability [4]
STAT 135	Concepts of Statistics [4]
STAT 153	Introduction to Time Series [4]

Undergraduate students must fulfill the following requirements in addition to those required by their major program.

For detailed lists of courses that fulfill college requirements, please review the College of Letters & Sciences (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/) page in this Guide. For College advising appointments, please visit the L&S Advising (https://lsadvising.berkeley.edu/home/) Pages.

University of California Requirements

Entry Level Writing **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/entry-level-writing-requirement/**)**

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 **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/american-history-institutions-requirement/**)**

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

Berkeley Campus Requirement

American Cultures **(**http://americancultures.berkeley.edu/students/courses/**)**

All undergraduate students at Cal need to take and pass this course 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.

College of Letters & Science Essential Skills Requirements

Quantitative Reasoning **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/quantitative-reasoning-requirement/**)**

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 **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/foreign-language-requirement/**)**

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 **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/reading-composition-requirement/**)**

In order to provide a solid foundation in reading, writing, and critical thinking the College requires two semesters of lower division work in composition in sequence. Students must complete parts A & B reading and composition courses in sequential order by the end of their fourth semester.

College of Letters & Science 7 Course Breadth Requirements

Breadth Requirements **(**http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/#breadthrequirementstext**)**

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
- 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 & 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 UC Extension during your senior year. In these cases, you should make

an appointment to meet 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 BA 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), Berkeley Summer Abroad, 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 UCEAP units), 12 of which must satisfy the requirements for your major.

Major Maps help undergraduate students discover academic, co-curricular, and discovery opportunities at UC Berkeley based on intended major or field of interest. Developed by the Division of Undergraduate Education in collaboration with academic departments, these experience maps will help you:

- **Explore** your major and gain a better understanding of your field of study
- **Connect** with people and programs that inspire and sustain your creativity, drive, curiosity and success
- **Discover** opportunities for independent inquiry, enterprise, and creative expression
- **Engage** locally and globally to broaden your perspectives and change the world
- **Reflect** on your academic career and prepare for life after Berkeley

Use the major map below as a guide to planning your undergraduate journey and designing your own unique Berkeley experience.

View the Astrophysics Major Map PDF. **(**https://ue.berkeley.edu/sites/default/files/astrophysics.pdf**)**

Undergraduate Advising

Brianna Franklin (https://astro.berkeley.edu/people/brianna-franklin/) is the Department of Astronomy's undergraduate advisor. Students are encouraged to see the undergraduate advisor for information on major and minor requirements, policies, procedures, department resources, events and activities as well as certifying degrees and majors. Advising appointments can be made using Calcentral. Drop-in advising is also available. For general information, please contact astroadvising@berkeley.edu.

Undergraduate Faculty Advisor

Eugene Chiang (https://astro.berkeley.edu/people/eugene-chiang/) is the Department of Astronomy's undergraduate faculty advisor. He is a great resource for content of courses, research, and career development in the field of astrophysics. Office hours are available here (https://docs.google.com/spreadsheets/d/1OP-hD_L-bAqgjuDRShHXIUPeRbEnn1GgZt287sKaAHs/edit/#gid=1).

Astrophysics

Expand all course descriptions [+]Collapse all course descriptions [-]

ASTRON 3 Introduction to Modern Cosmology 2 Units

Terms offered: Fall 2015, Spring 2015, Spring 2014
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.
Introduction to Modern Cosmology: Read More [+]
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, Ma

Introduction to Modern Cosmology: Read Less [-]

ASTRON 7A Introduction to Astrophysics 4 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
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.
Introduction to Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: Math 1A -1B. Physics 5A, 5B/5BL or Physics 7A/B (5B or 7B can be taken concurrently)

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, Kriek, Weisz, Dressing

Introduction to Astrophysics: Read Less [-]

ASTRON 7B Introduction to Astrophysics 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
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.
Introduction to Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: Math 1A -1B. Physics 5A, 5B/5BL, 5C/5CL, or Physics 7A/B/C (5C or 7C can be taken concurrently)

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

Introduction to Astrophysics: Read Less [-]

ASTRON 9 Selected Topics in Astronomy 3 Units

Terms offered: Summer 2022 First 6 Week Session, Summer 2022 Second 6 Week Session, Summer 2021 First 6 Week Session
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.
Selected Topics in Astronomy: Read More [+]

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

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.

Selected Topics in Astronomy: Read Less [-]

ASTRON 10 Introduction to General Astronomy 4 Units

Terms offered: Summer 2022 Second 6 Week Session, Summer 2021 First 6 Week Session, Summer 2021 Second 6 Week Session
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.
Introduction to General Astronomy: Read More [+]
Rules & Requirements

Credit Restrictions: Students will receive no credit for ASTRON 10 after completing ASTRON C10, ASTRON N10, ASTRON S10, or ASTRON 10S. A deficient grade in ASTRON 10 may be removed by taking XASTRON 10, or ASTRON 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.

Instructor: Bloom

Introduction to General Astronomy: Read Less [-]

ASTRON C10 Introduction to General Astronomy 4 Units

Terms offered: Fall 2022, Spring 2022, Fall 2020
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.
Introduction to General Astronomy: Read More [+]
Rules & Requirements

Credit Restrictions: Students will receive no credit for ASTRON C10 after completing ASTRON N10, ASTRON 10S, ASTRON 7S, or ASTRON 10.

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

Introduction to General Astronomy: Read Less [-]

ASTRON N10 Introduction to General Astronomy 3 Units

Terms offered: Prior to 2007
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.
Introduction to General Astronomy: Read More [+]
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.

Introduction to General Astronomy: Read Less [-]

ASTRON C12 The Planets 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
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.
The Planets: Read More [+]

Hours & Format

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

Summer: 6 weeks - 7.5 hours of lecture and 2.5 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

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

Instructors: Jeanloz, Dressing

Also listed as: EPS C12/L & S C70T

The Planets: Read Less [-]

ASTRON W12 The Planets 3 Units

Terms offered: Summer 2022 8 Week Session, Summer 2021 8 Week Session, Summer 2020 8 Week Session
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.
The Planets: Read More [+]

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.

Instructor: Militzer

Formerly known as: Astronomy W12/Earth and Planetary Science W12

Also listed as: EPS W12

The Planets: Read Less [-]

ASTRON C13 Origins: from the Big Bang to the Emergence of Humans 4 Units

Terms offered: Fall 2018, Fall 2016, Fall 2014
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.
Origins: from the Big Bang to the Emergence of Humans: Read More [+]

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

Origins: from the Big Bang to the Emergence of Humans: Read Less [-]

ASTRON 24 Freshman Seminars 1 Unit

Terms offered: Fall 2015, Fall 2011, Spring 2011
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.
Freshman Seminars: Read More [+]

Rules & Requirements

Repeat rules: 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.

Freshman Seminars: Read Less [-]

ASTRON 39 Seminar 1.5 Unit

Terms offered: Spring 2011, Spring 2008, Spring 2007
A small-size undergraduate seminar exploring one astronomical topic in depth. Students are responsible for much of the presentation.
Seminar: Read More [+]

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

Seminar: Read Less [-]

ASTRON 84 Sophomore Seminar 1 or 2 Units

Terms offered: Spring 2023, Spring 2021, Spring 2020
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.
Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: At discretion of instructor

Repeat rules: 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.

Sophomore Seminar: Read Less [-]

ASTRON 98 Directed Group Study 1 - 4 Units

Terms offered: Fall 2022, Spring 2022, Fall 2021
Topics will vary with instructor.
Directed Group Study: Read More [+]

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 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.

Directed Group Study: Read Less [-]

ASTRON 99 Directed Study in Astronomy 1 - 3 Units

Terms offered: Fall 2022, Spring 2022, Fall 2021
Supervised observational studies or directed reading for lower division students.
Directed Study in Astronomy: Read More [+]

Rules & Requirements

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

Repeat rules: Course may be repeated for credit without restriction.

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.

Directed Study in Astronomy: Read Less [-]

ASTRON C101 Order-Of-Magnitude Physics 4 Units

Terms offered: Spring 2023
Learn how to understand the world around you to within a factor of 10, how to solve real-life problems from physical first principles, how to make ill-posed questions well-posed, and how to sketch solutions quickly and avoid long and formal derivations. These skills build physical intuition and are crucial for all lines of work, especially research. You will learn how to guess intelligently, how to follow your hunches while guided by the laws of physics, and how to maximize understanding from just a modicum of information --- how to reason inductively and quantitatively. All of undergraduate physics --- mechanics, E&M, quantum mechanics, statistical mechanics --- will be covered in useful, memorable, and entertaining ways.
Order-Of-Magnitude Physics: Read More [+]
Rules & Requirements

Prerequisites: Physics 7A, 7B, 7C (7C 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, with common exam group.

Also listed as: PHYSICS C101

Order-Of-Magnitude Physics: Read Less [-]

ASTRON 120 Optical and Infrared Astronomy Laboratory 4 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
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.
Optical and Infrared Astronomy Laboratory: Read More [+]
Rules & Requirements

Prerequisites: Astronomy 7A-7B recommended; Mathematics 54 or Physics 89 (may be taken concurrently); Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C may be taken concurrently)

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Undergraduate

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

Instructors: Graham, Duchene

Optical and Infrared Astronomy Laboratory: Read Less [-]

ASTRON 121 Radio Astronomy Laboratory 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
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 Python language, and high-quality written reports.
Radio Astronomy Laboratory: Read More [+]

Rules & Requirements

Prerequisites: Astro 7A-7B recommended; Mathematics 53; Mathematics 54 or Physics 89; Physics 7A-7B-7C or Physics 5A-5B-5C

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.

Instructor: Parsons

Radio Astronomy Laboratory: Read Less [-]

ASTRON 128 Astronomy Data Science Laboratory 4 Units

Terms offered: Fall 2022, Spring 2021, Spring 2020
This course features 3 data-centric laboratory experiments that draw on a variety of tools used by professional astronomers. Students will learn to procure and clean data (drawn from a variety of world-class astronomical facilities), assess the fidelity/quality of data, build and apply models to describe data, learn statistical and computational techniques to analyze data (e.g., Bayesian inference, machine learning, parallel computing), and effectively communicate data and scientific results. There is a heavy emphasis on software development in the Python language, statistical techniques, and high-quality communication (e.g., written reports, oral presentations, and data visualization).
Astronomy Data Science Laboratory: Read More [+]

Rules & Requirements

Prerequisites: Astro 7A-7B; Mathematics 53; Mathematics 54 or Physics 89; Astro 160; Astro C161 (may be taken concurrently) and Data C8 or C100 (or equivalent level of fluency of the Python programming language)

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructors: Weisz, Bloom

Astronomy Data Science Laboratory: Read Less [-]

ASTRON 160 Stellar Physics 4 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
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.
Stellar Physics: Read More [+]
Rules & Requirements

Prerequisites: Astro 7A recommended; Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C 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: Filippenko, Quataert, Lu

Stellar Physics: Read Less [-]

ASTRON C161 Relativistic Astrophysics and Cosmology 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
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.
Relativistic Astrophysics and Cosmology: Read More [+]
Rules & Requirements

Prerequisites: Astro 7B recommended; Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C 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: Lee, Ma, Kasen

Also listed as: PHYSICS C161

Relativistic Astrophysics and Cosmology: Read Less [-]

ASTRON C162 Planetary Astrophysics 4 Units

Terms offered: Spring 2022, Fall 2020, Fall 2019
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.
Planetary Astrophysics: Read More [+]
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, Dressing, Militzer

Also listed as: EPS C162

Planetary Astrophysics: Read Less [-]

ASTRON 190 Undergraduate Special Topics 3 Units

Terms offered: Prior to 2007
Rotating astronomy topics for undergraduate students. This course meets for three hours per week. The focus will be not only on the formal subject matter, but also on the nature of scientific inquiry itself.
Undergraduate Special Topics: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing

Repeat rules: Course may be repeated for credit without restriction. Students may enroll in multiple sections of this course within the same semester.

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.

Undergraduate Special Topics: Read Less [-]

ASTRON H195 Special Study for Honors Candidates 2 - 4 Units

Terms offered: Spring 2023, Fall 2022, Spring 2022
Individual project of research or study.
Special Study for Honors Candidates: Read More [+]
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.

Special Study for Honors Candidates: Read Less [-]

ASTRON 198 Directed Group Study 1 - 4 Units

Terms offered: Spring 2022, Fall 2021, Fall 2020
Topics will vary with instructor.
Directed Group Study: Read More [+]
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 without restriction.

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.

Directed Group Study: Read Less [-]

ASTRON 199 Supervised Independent Study and Research 1 - 4 Units

Terms offered: Spring 2023, Fall 2022, Summer 2022
Supervised Independent Study and Research: Read More [+]
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 without restriction.

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.

Supervised Independent Study and Research: Read Less [-]