Astronomy

Overview

The Department of Astronomy offers undergraduate and graduate instruction in a wide variety of fields, including theoretical and observational astrophysics; infrared, optical, and radio astronomy; galactic structure and dynamics of stellar systems; high-energy astrophysics and cosmology; star and planet formation; and spectroscopy. A considerable amount of research and teaching related to astronomy is done in other units at UC Berkeley, including the Physics Department, Earth and Planetary Science, Space Science Laboratory, and the Lawrence Berkeley National Laboratory. Various professors in the Chemistry, Mathematics, Statistics, and Engineering departments have an active interest in astronomy and are available for consultation.

Facilities

Many instruments are available to students and staff, including two 10-meter telescopes at the Keck Observatory on Mauna Kea in Hawaii; 30-inch, 40-inch and 120-inch telescopes at Lick Observatory; a 16-element millimeter-wave interferometer in Southern California; the PAPER Array in South Africa; and a 30-inch telescope at Leuschner Observatory (near the campus). Laboratories are available for the development of radio, infrared, and optical instruments and for the precise measurement of images and spectra. For further information regarding these resources, please see the Facilities page on the department's website (http://astro.berkeley.edu/facilities) .

Physics-Astronomy Library

The Physics-Astronomy Library (http://www.lib.berkeley.edu/PHYS) is located in 351 LeConte Hall. The Physics-Astronomy Library has approximately 95,000 volumes available (on campus and at the NRLF) and 700 journal subscriptions.

Astronomy Reading Room

The Astronomy Reading Room is located in Campbell Hall and contains a selection of useful books and journals. For further information, please see the Reading Room Catalog (http://astro.berkeley.edu/facilities/library-catalogue.html) .

Organized Research Units

The Radio Astronomy Lab (http://ral.berkeley.edu) is involved with many instruments and projects including the Combined Array for Research in Millimeter-wave Astronomy (CARMA) and the Allen Telescope Array (ATA).

The Theoretical Astrophysics Center (http://astro.berkeley.edu/tac) includes faculty, research scientists, postdoctoral researchers, and students working on a wide variety of problems in theoretical astrophysics.

The Center for Integrative Planetary Science (http://cips.berkeley.edu) is involved in many research projects including the ongoing Extrasolar Planet Search, astrobiology, and research into planetary composition and formation.

Other Research Projects and Opportunities

For further information on other research projects and opportunities, including faculty research publications, please see the research page of the Department's website (http://astro.berkeley.edu/research) .

Undergraduate Program

Astrophysics (http://guide.berkeley.edu/archive/2014-15/undergraduate/degree-programs/astrophysics) : BA (major) or Minor

Graduate Program

Astrophysics (http://guide.berkeley.edu/archive/2014-15/graduate/degree-programs/astrophysics) : PhD

Astronomy

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.

ASTRON 201 Radiation Processes in Astronomy 4 Units
An introduction to the basic physics of astronomy and astrophysics at the graduate level. Principles of energy transfer by radiation. Elements of classical and quantum theory of photon emission; bremsstrahlung, cyclotron and synchrotron radiation. Compton scattering, atomic, molecular and nuclear electromagnetic transitions. Collisional excitation of atoms, molecules and nuclei.
Rules & Requirements

Prerequisites: PHYSICS 105, 110A; 110B concurrently; open to advanced undergraduates with GPA of 3.70

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, Quataert

ASTRON C202 Astrophysical Fluid Dynamics 4 Units
Principles of gas dynamics, self-gravitating fluids, magnetohydrodynamics and elementary kinetic theory. Aspects of convection, fluid oscillations, linear instabilities, spiral density waves, shock waves, turbulence, accretion disks, stellar winds, and jets.
Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, Kasen, Ma, Quataert, White

Also listed as: PHYSICS C202

ASTRON 203 Astrophysical Techniques 3 Units
Introduction to the flow of astronomical signals through telescope optics and into detectors; subsequent calibration, deconvolution of instrumental artifacts, and analysis. A broad wavelength approach is maintained with focus on shared fundamental concepts. Students "adopt a wavelength band" for assignments and presentations. Analysis and simulation of astronomical signals, noise, and errors.
Rules & Requirements

Prerequisites: 201 and 290A; 290B must 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/Graduate

Grading: Letter grade.

Instructors: Backer, Basri, Blitz, Graham, Marcy, Welch

ASTRON 204 Numerical Techniques in Astronomy 3 Units
Methods of data analysis, model fitting, and data display, all oriented towards the detailed analysis of astronomical observation data and/or numerical results from simulations. Specific topics include probability density functions, error propagation, maximum likelihood, least squares, data and function fitting, Fourier transforms, wavelets, principal components analysis, color images. The software language used is the Interactive Data Language (IDL).
Rules & Requirements

Prerequisites: Mathematics 54

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Heiles

ASTRON C207 Radiation Processes in Astronomy 4 Units
An introduction to the basic physics of astronomy and astrophysics at the graduate level. Principles of energy transfer by radiation. Elements of classical and quantum theory of photon emission; bremsstrahlung, cyclotron and synchrotron radiation. Compton scattering, atomic, molecular and nuclear electromagnetic transitions. Collisional excitation of atoms, molecules and nuclei.
Rules & Requirements

Prerequisites: PHYSICS 105, 110A; 110B concurrently; open to advanced undergraduates with GPA of 3.70

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Bower, Chiang, Kasen, Quataert

Also listed as: PHYSICS C207

ASTRON 216 Interstellar Matter 3 Units
A survey of the observational data and theoretical ideas on the interstellar medium, with emphasis on the inferred physical conditions.
Rules & Requirements

Prerequisites: 201

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Blitz, Heiles, Glassgold, Graham

ASTRON 218 Stellar Dynamics and Galactic Structure 3 Units
A basic course. Structure and kinematics of the galaxy; stellar population concepts; dynamics of stellar systems with and without encounters.
Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Blitz, Davis, Graham

ASTRON C228 Extragalactic Astronomy and Cosmology 3 Units
A survey of physical cosmology - the study of the origin, evolution, and fate of the universe. Topics include the Friedmann-Robertson-Walker model, thermal history and big bang nucleosynthesis, evidence and nature of dark matter and dark energy, the formation and growth of galaxies and large scale structure, the anisotropy of the cosmic microwave radiation, inflation in the early universe, tests of cosmological models, and current research areas. The course complements the material of Astronomy 218.
Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Davis, Holzapfel, Lee, Ma, Seljak, White

Also listed as: PHYSICS C228

ASTRON C249 Solar System Astrophysics 3 Units
The physical foundations of planetary sciences. Topics include planetary interiors and surfaces, planetary atmospheres and magnetospheres, and smaller bodies in our solar system. The physical processes at work are developed in some detail, and an evolutionary picture for our solar system, and each class of objects, is developed. Some discussion of other (potential) planetary systems is also included.
Rules & Requirements

Prerequisites: 149, 169, C160A or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, de Pater

Also listed as: EPS C249

ASTRON 250 Special Topics in Astrophysics 3 Units
Topics will vary from semester to semester. See department for announcements.
Rules & Requirements

Prerequisites: 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 - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

ASTRON 252 Stellar Structure and Evolution 3 Units
Equations of stellar structure, radiative transfer and convection, thermonuclear reactions and stellar energy generations; stellar models, degenerate configurations, evolutionary sequences, supernovae, neutron stars, black holes, nucleosynthesis.
Rules & Requirements

Prerequisites: PHYSICS 110A-110B, 112, 137A-137B

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Filippenko, Marcy

Formerly known as: C252 and Physics C252

ASTRON C254 High Energy Astrophysics 3 Units
Basic physics of high energy radiation processes in an astrophysics environment. Cosmic ray production and propagation. Applications selected from pulsars, x-ray sources, supernovae, interstellar medium, extragalactic radio sources, quasars, and big-bang cosmologies.
Rules & Requirements

Prerequisites: 201 or consent of instructor. 202 recommended

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Boggs, Quataert

Also listed as: PHYSICS C254

ASTRON 255 Computational Methods in Theoretical Astrophysics 3 Units
A broad in-depth survey of state-of-the-art numerical approaches to astrophysical self-gravitational gas dynamics with application to large scale simulation of coupled non-linear astrophysical flows. Finite-difference approaches for Lagrangian and Eulerian astrophysical hydrodynamics and coupled radiation-hydrodynamics. N-body gravitation techniques including direct N-body, P-M, P3M, and hierarchical Tree. Particle gas dynamics methods such as smooth particle hydrodynamics (SPH), adaptive SPH and unification of SPH, and gravity tree hierarchies (TREE-SPH). Advanced techniques such as higher order Godunov finite difference methods with adaptive mesh refinement (AMR). Applications of these approaches in three broad areas: cosmology, high energy astrophysics, and star formation and the interstellar medium.
Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Klein

ASTRON C285 Theoretical Astrophysics Seminar 1 Unit
The study of theoretical astrophysics.
Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Quataert

Also listed as: PHYSICS C285

ASTRON 290A Introduction to Current Research 1 Unit
Survey of research currently being performed in the Department or the University.
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: de Pater

ASTRON 290B Introduction to Current Research 1 Unit
Continuation of 290A. Study of a research topic with an individual staff member.
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: de Pater

ASTRON C290C Cosmology 2 Units
Rules & Requirements

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 - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: White, Cohn

Also listed as: PHYSICS C290C

ASTRON 292 Seminar 1 - 2 Units
In addition to the weekly colloquium, the Department offers seminars in advanced topics, several of which are announced at the beginning of each semester. A maximum of 5 units may be taken per semester with a limitation of 2 in any one section.
Rules & Requirements

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 - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ASTRON C292 Planetary Science Seminar 1 Unit
The departments of Astronomy and Earth and Planetary Science offer a joint research seminar in advanced topics in planetary science, featuring speakers drawn from graduate students, postdoctoral researchers, faculty, and visiting scholars. Topics will span planetary interiors; surface morphology; atmospheres; dynamics; planet formation; and astrobiology. Speakers will vary from semester to semester. Meetings will be held once a week for 1 hour each, and the schedule of speakers will be determined on the first day of class. To pass the class, participants will be required to give a 30-minute presentation, either on their own research or on recent results from the literature.
Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Also listed as: EPS C292

ASTRON 298 Directed Group Study 1 - 4 Units
Tutorial for groups of two or three students.
Rules & Requirements

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 - 0 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

ASTRON 299 Advanced Study and Research 2 - 12 Units
Rules & Requirements

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 - 2-12 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

ASTRON 301 Undergraduate Astronomy Instruction 1 - 2 Units
Open to a limited number of highly qualified undergraduate students interested in astronomy teaching at the college level. Students will participate in a seminar on educational methods and engage in tutorial or laboratory teaching under supervision of a faculty member.
Rules & Requirements

Prerequisites: An elementary astronomy course and consent of instructor

Repeat rules: Course may be repeated for a maximum of 4 units.Course may be repeated for a maximum of 4 units.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 3-6 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Professional course for teachers or prospective teachers

Grading: Offered for pass/not pass grade only.

ASTRON 375 Instruction Techniques in General Astronomy 2 - 6 Units
Discussion and practice of teaching techniques as applied to astronomy. Open to graduate students who are presently teaching assistants or associates. Two units for course plus one section; three units for two discussion sections.
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Astronomy/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Astronomy 300

ASTRON 602 Individual Study for Doctoral Students 1 - 8 Units
Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D. (and other doctoral degrees). May not be used for unit or residence requirement for the doctoral degree.
Rules & Requirements

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 - 1-8 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.