

# ASTRONOMY (ASTR)

---

## **ASTR 101. Introduction to the Sun and Its Planets. 3 Units.**

This introductory astronomy course describes our solar system of planets and how astronomers develop our physical understanding about the universe. Topics include the properties of the Sun and planets; the formation of the solar system and how the planets have evolved over time; asteroids, comets, and dwarf planets; and a comparison of our solar system with new planetary systems being found around other stars. This course has no pre-requisites.

## **ASTR 103. Introduction to the Stars, Galaxies, and the Universe. 3 Units.**

This introductory astronomy course describes the universe we live in and how astronomers develop our physical understanding about it. Topics covered include: the properties of stars; the formation, evolution, and death of stars; white dwarfs, pulsars, and black holes; spiral and elliptical galaxies; the Big Bang and the expansion of the Universe. This course has no pre-requisites.

## **ASTR 105. Introduction to Einstein's Universe. 3 Units.**

This course is a descriptive introduction for the non-science major to Einstein's Special and General Theories of Relativity and how these theories have fundamentally altered our understanding of the universe. Topics discussed will include: time dilation, length contraction, the twin paradox, the warping of space-time, white dwarf stars, neutron stars, black holes, the structure and evolution of the universe. No mathematical background beyond simple algebra is needed. This course has no pre-requisites.

## **ASTR 107. Introduction to Life in the Universe. 3 Units.**

This course is intended to introduce the non-scientist to the field of astrobiology - the interdisciplinary study of, and the search for, extraterrestrial life and the conditions for extraterrestrial life in the Universe. This course has no pre-requisites.

## **ASTR 151. Doing Astronomy. 1 Unit.**

This course is intended to introduce students to how astronomy is done. The course will focus on the astronomical research process, the scientific community, and on career paths in astronomy. Course activities will include readings and class discussions focusing on various topics in modern astronomy, including ongoing research activity in the department. This course is largely intended for first- and second-year students considering majoring or minoring in astronomy, or pursuing a career in astronomy. Prereq: First- or second-year academic standing.

## **ASTR 221. Stars and Planets. 3 Units.**

This course is the first of two in a sequence covering introductory astronomy and astrophysics at an intermediate level. Throughout the course, an emphasis will be placed on data analysis and interpretation using real astronomical data and the Python programming language. This course is intended, designed, and required for Astronomy majors and minors. Topics covered include: orbits, gravity, and Kepler's Laws; the Solar System; planetary structure and formation; exoplanets; the celestial sphere and coordinate systems; blackbody radiation; emission and absorption spectra; telescopes; trigonometric parallax; the magnitude system; the Sun; stellar classification and spectral types; the H-R Diagram; stellar masses; stellar structure, energy production and transport; stellar evolution; supernovae, white dwarfs, neutron stars, and black holes; the interstellar medium; and star formation. Prereq: MATH 122 or MATH 124 or MATH 126. Prereq or Coreq: PHYS 116 or PHYS 122 or PHYS 124.

## **ASTR 222. Galaxies and Cosmology. 3 Units.**

This course is the second of two in a sequence covering introductory astronomy and astrophysics at an intermediate level. Throughout the course, an emphasis will be placed on data analysis and interpretation using real astronomical data and the Python programming language. This course is intended, designed, and required for Astronomy majors and minors. Topics covered include: the Milky Way; galaxy disks, bulges, halos, and interstellar media; metallicity and stellar populations; stellar velocities, rotation, and the solar motion; the Galactic center; the Local Group; galaxy morphology and classification; disk galaxies and spiral arms; elliptical, lenticular, dwarf, and irregular galaxies; integrated stellar populations and mass-to-light ratios; peculiar and interacting galaxies; active galaxies and quasars; galaxy clusters; galaxy formation and evolution; large-scale structure; Hubble's Law; the extragalactic distance scale; the expansion and age of the Universe; the cosmic microwave background; cosmological models; the early universe and inflation; particle production, Big Bang nucleosynthesis, and recombination. Prereq: ASTR 221.

## **ASTR 306. Astronomical Techniques. 3 Units.**

This course covers the techniques astronomers use to conduct research, including observations using ground-and space-based telescopes, computer simulations and other numerical methods, and statistical data mining of large on-line astronomical datasets. Offered as ASTR 306 and ASTR 406. Counts as a SAGES Departmental Seminar course. Prereq: ASTR 222.

## **ASTR 309. Astrophysics Seminar I. 1 Unit.**

Selected topics in astronomy not covered ordinarily in courses. Presentation of talks by the students. Prereq: ASTR 222 or Requisites Not Met permission.

## **ASTR 310. Astrophysics Seminar II. 1 Unit.**

Selected topics in astronomy not covered ordinarily in courses. Presentation of talks by students. Prereq: ASTR 222 or Requisites Not Met permission.

## **ASTR 311. Stellar Physics. 3 Units.**

Radiative transfer, atomic and molecular opacities, and the observable properties of stars. Stellar interiors, nuclear processes, and energy generation. The evolution of stars of varying mass and production of the elements within supernovae explosions. Offered as ASTR 311 and ASTR 411. Prereq: ASTR 222.

## **ASTR 323. The Local Universe. 3 Units.**

The Milky Way Galaxy. Galaxy populations. Quantitative structure and dynamics of galaxies. The interstellar medium of galaxies. Dark matter and stellar populations. The Local Group and Virgo cluster. Offered as ASTR 323 and ASTR 423. Prereq: ASTR 222.

## **ASTR 328. Cosmology and the Structure of the Universe. 3 Units.**

Distances to galaxies. The content of the distant universe. Large scale structure and galaxy clusters. Physical cosmology. Structure and galaxy formation and evolution. Testing cosmological models. Offered as ASTR 328, PHYS 328, ASTR 428, and PHYS 428. Prereq: ASTR 222.

## **ASTR 333. Dark Matter. 3 Units.**

This course will explore the evidence for dark matter in the universe. Necessary physical theory and astronomical concepts will be developed as appropriate. Topics to be covered include dynamics, lensing, and hydrostatic equilibrium as probes of the gravitational potentials of extragalactic systems. Examples include the rotation curves of spiral galaxies, the velocity dispersions of clusters of galaxies, and the growth of large scale structure. We will examine various hypothesized solutions to the missing mass problem. Offered as ASTR 333 and ASTR 433. Prereq: ASTR 222 or PHYS 310 or Requisites Not Met permission.

**ASTR 350. Science Communication. 3 Units.**

In this course, students will analyze and practice the genres of communication central to academic science writing, like literature reviews, poster presentations, funding proposals, and visualization and explanation of data. We will also experiment with how to communicate scientific findings in popular venues, like social media, documentaries, popular magazines, and health websites. Students will choose a research question that they work on all semester, writing and presenting in different popular and academic genres to communicate their research. The course content will draw from research work in the physical sciences, including Astronomy, Physics, Chemistry, and Environmental Sciences. Students cannot receive credit for both USNA 250 and ASTR 350. Counts as a Disciplinary Communication course. Prereq: ASTR 222.

**ASTR 351. Astronomy Capstone Project. 1 - 3 Units.**

In the Astronomy Capstone, students pursue scientific projects based on experimental, theoretical or pedagogical research under the supervision of an astronomy faculty member. Students will provide regular oral and written progress reports over the course of the project, and final results are presented in the form of a research paper (or other suitable technical report) as well as an oral summary presentation at a public symposium. For this course to satisfy the University's SAGES Capstone requirement, a total of three credit hours are needed. Counts as a SAGES Senior Capstone course. Prereq: ASTR 222.

**ASTR 369. Undergraduate Research. 1 - 3 Units.**

Supervised research on topics of interest. Can be used as a thesis course if desired. Students may register more than once for a maximum of 9 credits overall (1-3 credits each semester).

**ASTR 406. Astronomical Techniques. 3 Units.**

This course covers the techniques astronomers use to conduct research, including observations using ground-and space-based telescopes, computer simulations and other numerical methods, and statistical data mining of large on-line astronomical datasets. Offered as ASTR 306 and ASTR 406. Counts as a SAGES Departmental Seminar course.

**ASTR 411. Stellar Physics. 3 Units.**

Radiative transfer, atomic and molecular opacities, and the observable properties of stars. Stellar interiors, nuclear processes, and energy generation. The evolution of stars of varying mass and production of the elements within supernovae explosions. Offered as ASTR 311 and ASTR 411.

**ASTR 423. The Local Universe. 3 Units.**

The Milky Way Galaxy. Galaxy populations. Quantitative structure and dynamics of galaxies. The interstellar medium of galaxies. Dark matter and stellar populations. The Local Group and Virgo cluster. Offered as ASTR 323 and ASTR 423.

**ASTR 428. Cosmology and the Structure of the Universe. 3 Units.**

Distances to galaxies. The content of the distant universe. Large scale structure and galaxy clusters. Physical cosmology. Structure and galaxy formation and evolution. Testing cosmological models. Offered as ASTR 328, PHYS 328, ASTR 428, and PHYS 428.

**ASTR 433. Dark Matter. 3 Units.**

This course will explore the evidence for dark matter in the universe. Necessary physical theory and astronomical concepts will be developed as appropriate. Topics to be covered include dynamics, lensing, and hydrostatic equilibrium as probes of the gravitational potentials of extragalactic systems. Examples include the rotation curves of spiral galaxies, the velocity dispersions of clusters of galaxies, and the growth of large scale structure. We will examine various hypothesized solutions to the missing mass problem. Offered as ASTR 333 and ASTR 433.

**ASTR 497. Special Topics in Astronomy. 1 - 3 Units.****ASTR 601. Research. 1 - 18 Units.**

Original research under the guidance of the staff.

**ASTR 701. Dissertation Ph.D.. 1 - 9 Units.**

(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.