ASTRONOMY (ASTR)

* ASTR 030b, Search for Extraterrestrial Life  Debra Fischer  
Introduction to the search for extraterrestrial life. Review of current knowledge on the origins and evolution of life on Earth; applications to the search for life elsewhere in the universe. Discussion of what makes a planet habitable, how common these worlds are in the universe, and how we might search for them. Survey of past, current, and future searches for extraterrestrial intelligence. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program.  WR, SC

* ASTR 040a / PHYS 040a, Expanding Ideas of Time and Space  Meg Urry  
Discussions on astronomy, and the nature of time and space. Topics include the shape and contents of the universe, special and general relativity, dark and light matter, and dark energy. Observations and ideas fundamental to astronomers’ current model of an expanding and accelerating four-dimensional universe. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program.  SC

ASTR 110a, Planets and Stars  Michael Faison  
Astronomy introduction to stars and planetary systems. Topics include the solar system and extrasolar planets, planet and stellar formation, and the evolution of stars from birth to death. No prerequisite other than a working knowledge of elementary algebra.  QR, SC

ASTR 120b, Galaxies and the Universe  Robert Zinn  
An introduction to stars and stellar evolution; the structure and evolution of the Milky Way galaxy and other galaxies; quasars, active galactic nuclei, and supermassive black holes; cosmology and the expanding universe. No prerequisite other than a working knowledge of elementary algebra.  QR, SC

ASTR 130b, Archaeoastronomy  Michael Faison  
An introduction to how celestial patterns and events were observed and interpreted up to the Copernican revolution. Ancient observatories, calendar systems, records of astronomical events, and the role of astronomical knowledge in culture. Exercises in naked-eye observation of the sky. No prerequisites.  SC

ASTR 153a, Introduction to Astronomical Observing  Michael Faison  
A hands-on introduction to techniques used in astronomy to observe astronomical objects. Observations of planets, stars, and galaxies using on-campus facilities and remote observing with Yale’s research telescopes. Use of electronic detectors and computer-aided data processing. Evening laboratory hours required. One previous college-level science laboratory or astronomy course recommended.  SC ½ Course cr

ASTR 160b, Frontiers and Controversies in Astrophysics  Marla Geha  
A detailed study of three fundamental areas in astrophysics that are currently subjects of intense research and debate: planetary systems around stars other than the sun; pulsars, black holes, and the relativistic effects associated with them; and the age and ultimate fate of the universe. No prerequisite other than a working knowledge of elementary algebra.  QR, SC

ASTR 180a, Introduction to Relativity and Black Holes  Charles Bailyn  
Introduction to the theories of special and general relativity, and to relativistic astronomy and astrophysics. Topics include time dilation and length contraction; mass-energy equivalence; space-time curvature; black holes; wormholes; pulsars; quasars; gravitational waves; Hawking radiation. For students not majoring in the physical sciences; some previous acquaintance with high-school physics and/or calculus may be helpful, but is not required.  QR, SC

ASTR 210a, Stars and Their Evolution  Robert Zinn  
Foundations of astronomy and astrophysics, focusing on an intensive introduction to stars. Nuclear processes and element production, stellar evolution, stellar deaths and supernova explosions, and stellar remnants including white dwarfs, neutron stars, and black holes. A close look at our nearest star, the sun. How extrasolar planets are studied; the results of such studies. Prerequisite: a strong background in high school calculus and physics. May not be taken after ASTR 220.  QR, SC

ASTR 253a / PHYS 253a, Research Methods in Astrophysics  Marla Geha  
An introduction to research methods in astronomy and astrophysics. The acquisition and analysis of astrophysical data, including the design and use of ground- and space-based telescopes, computational manipulation of digitized images and spectra, and confrontation of data with theoretical models. Examples taken from current research at Yale and elsewhere. Use of the Python programming language. Prerequisite: background in high school calculus and physics. No previous programming experience required.  QR, SC RP

ASTR 310b, Galactic and Extragalactic Astronomy  Jeffrey Kenney  
Structure of the Milky Way galaxy and other galaxies; stellar populations and star clusters in galaxies; gas and star formation in galaxies; the evolution of galaxies; galaxies and their large-scale environment; galaxy mergers and interactions; supermassive black holes and active galactic nuclei. Prerequisites: MATH 115, PHYS 201, and ASTR 210 or 220, or equivalents, or with permission of instructor.  QR, SC

ASTR 320a, Physical Processes in Astronomy  Gregory Laughlin  
Introduction to the physics required for understanding current astronomical problems. Topics include basic equations of stellar structure, stellar and cosmic nucleosynthesis, radiative transfer, gas dynamics, and stellar dynamics. Numerical methods for solving these equations.
Prerequisites: MATH 120 and PHYS 201 or equivalents, or permission of instructor. Previous experience with computer programming recommended. Taught in alternate years. QR, SC

**ASTR 343b / PHYS 343b, Gravity, Astrophysics, and Cosmology**  Staff
Introduction to frontier areas of research in astrophysics and cosmology exploring ideas and methods. In–depth discussion of the physics underlying several recent discoveries including extrasolar planets—their discovery, properties, and issues of habitability; black holes—prediction of their properties from GR, observational signatures, and detection; and the accelerating universe—introduction to cosmological models and the discovery of dark energy. Prerequisites: PHYS 170, 171, or 180, 181, or 200, 201, or 260, 261, or permission of instructor. QR, SC

**ASTR 360b, Interstellar Matter and Star Formation**  Hector Arce
The composition, extent, temperature, and density structure of the interstellar medium (ISM). Excitation and radiative processes; the properties of dust; the cold and hot ISM in the Milky Way and other galaxies. Dynamics and evolution of the ISM, including interactions between stars and interstellar matter. Physics and chemistry of molecular clouds and the process of star formation. Prerequisites: MATH 120 and PHYS 201 or equivalents. Taught in alternate years. QR, SC RP

**ASTR 420a, Computational Methods for Astrophysics**  Paolo Coppi
The analytic, numerical, and computational tools necessary for effective research in astrophysics and related disciplines. Topics include numerical solutions to differential equations, spectral methods, and Monte Carlo simulations. Applications to common astrophysical problems including fluids and N-body simulations. Prerequisites: ASTR 320, MATH 120, 222 or 225, and 246. QR RP

**ASTR 450a, Stellar Astrophysics**  Sarbani Basu
The physics of stellar atmospheres and interiors. Topics include the basic equations of stellar structure, nuclear processes, stellar evolution, white dwarfs, and neutron stars. Prerequisites: PHYS 201 and MATH 120. Taught in alternate years. QR, SC

**ASTR 465b, The Evolving Universe**  Pieter van Dokkum
Overview of cosmic history from the formation of the first star to the present day, focusing on direct observations of the high-redshift universe. Prerequisites: MATH 120, PHYS 201, and one astronomy course numbered above 200. Taught in alternate years. QR, SC RP