### ASTRONOMY (ASTR)

**ASTR 001 A Survey of the Universe**
A general survey, designed for the non-major, of the facts and theories of the astronomical universe, from solar system, to stars, to galaxies and cosmology. Topics include planets, satellites, small objects in the solar system, and extraterrestrial life; stars, their evolution, and their final state as white dwarfs, neutron stars, or black holes; galaxies, quasars, large structures, background radiation, and big bang cosmology. Elementary algebra and geometry will be used. This course is not recommended for physical-science majors or engineering students. Engineering students receive no credit for this course. Fulfills quantitative data analysis requirement.

For BA Students: Physical World Sector
Course offered summer, fall and spring terms
Activity: Lecture
1 Course Unit
Notes: Only one ASTR course below ASTR 211 may be taken for credit. Engineering students receive no credit for this course.

**ASTR 006 The Solar System, Exoplanets, and Life**
A survey course on planets and life covering our own Solar System and exoplanets orbiting other stars. Topics include the latest results and theories about: the origin and evolution of planetary systems around our Sun and other stars; the detection of exoplanets; the implications of planetary atmospheres for life; and the search for life on other planets in our Solar System. This course is designed for the non-major and elementary algebra and geometry will be used. Physical science majors and engineering students should prefer ASTR 211 to this course.

For BA Students: Natural Science and Math Sector
One-term course offered either term
Activity: Lecture
1 Course Unit
Notes: Also fulfills General Requirement in Physical World for Class of 2009 and prior. Only one ASTR course below ASTR 211 may be taken for credit. Fulfills quantitative data analysis requirement.

**ASTR 007 The Big Bang and Beyond**
An introductory course for students who do not intend to major in a physical science or engineering, covering theories of the Universe ranging from the ancient perspective to the contemporary hot big bang model, including some notions of Einstein's special and general theories of relativity. Topics will include the solar system, stars, black holes, galaxies, and the structure, origin and future of the Universe itself. Elementary algebra is used. Fulfills quantitative data analysis requirement.

For BA Students: Natural Science and Math Sector
One-term course offered either term
Activity: Lecture
1 Course Unit
Notes: Also fulfills General Requirement in Physical World for Class of 2009 and prior. Only one ASTR course below ASTR 211 may be taken for credit.

**ASTR 211 Introduction to Astrophysics I**
A basic course for majors in physical sciences and engineering; required for the astrophysics concentration. The course provides fundamental knowledge of Newtonian gravity and the properties of light and matter as they are relevant for understanding astrophysical objects. Application is made to the observed features of planetary motion, the atmospheres and stars and planets, and the structure and evolution of stars.

For BA Students: Physical World Sector
Course usually offered in fall term
Prerequisites: MATH 104, PHYS 150, or concurrently.
Activity: Lecture
1 Course Unit

**ASTR 212 Introduction to Astrophysics II**
A basic course for majors in physical sciences and engineering; required for the astrophysics concentration. The course covers fundamental knowledge of Einstein's gravity, the contents of the universe, and the structure and distribution of galaxies. Emphasis is on the key elements of modern cosmology: the mathematical model of the expanding universe, the cosmic microwave background, the early universe and the emergence of large-scale structure in the present universe.

For BA Students: Physical World Sector
Course usually offered in spring term
Prerequisites: MATH 114, PHYS 151, or concurrently.
Activity: Lecture
1 Course Unit

**ASTR 250 Astronomical Techniques**
A laboratory course in astronomical observations and data reduction. This course satisfies one of the requirements for the astrophysics concentration. Topics vary, but include spherical astronomy, timekeeping and coordinate systems, astro-statistics, telescopes, CCD’s, signal processing, imaging, spectroscopy, radio astronomy and data reduction techniques using custom software. Attendance at observatory sessions outside of the scheduled class time is required, but times are uncertain due to weather conditions. The course requires small-group work in-class, and substantial out-of-class time. Notes: Course not offered every year. The observatories at DRL are used for experimental and observational practice.

Course offered spring; even-numerated years
Prerequisites: ASTR 001, or ASTR 007, or ASTR 211, or ASTR 212. If a student has only taken ASTR 001 or ASTR 007, MATH 240-241 will also be required.
Activity: Lecture
1 Course Unit
Notes: The observatories at DRL are used for experimental and observational practice.

**ASTR 392 Life and Death of Stars**
This is an advanced undergraduate course on the life and death of stars. The course will cover the structure of stellar interiors, nuclear reactions and the formation of elements, stellar evolution, supernovae, and the physics of white dwarfs, neutron stars, and black holes. We will approach these topics from both theoretical and observational perspectives.

One-term course offered either term
Activity: Lecture
1 Course Unit
ASTR 503 Astronomical Methods and Instrumentation
Techniques of modern astronomical observations, including: detection of light from the radio through gamma rays; sources of noise in astronomical measurements; image analysis and reduction techniques; telescope optics and adaptive optics; spectroscopic measurements; radio interferometry and spectroscopy.
Course offered spring; even-numbered years
Activity: Lecture
1 Course Unit

ASTR 533 Galaxies: Structure, Dynamics and Formation
Galactic structure and dynamics. Observed scaling relations. Models and observations of galaxy formation and evolution. Enrollment restricted to graduate students.
Course offered fall; odd-numbered years
Activity: Lecture
1 Course Unit