ASTR - ASTRONOMY

ASTR Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/ASTR/)

Courses

ASTR 100 Introduction to Astronomy credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/100/)
[IAI Code: P1906] Introduces the student to the basic concepts of modern astronomy. Covers topics including the night sky; the solar system and its origin; the nature and evolution of stars; stellar remnants, including white dwarfs, neutron stars, and black holes; extrasolar planetary systems; galaxies and quasars; dark matter and dark energy; the Big Bang and the fate of the universe; and life in the universe. Students with credit in PHYS 211 are encouraged to take ASTR 210. Credit is not given toward graduation for: Credit is not given for ASTR 100 if credit in any of ASTR 121, ASTR 122, ASTR 210, or equivalent has been earned.
This course satisfies the General Education Criteria for:
Nat Sci Tech - Phys Sciences

ASTR 121 Solar System and Worlds Beyond credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/121/)
[IAI Code: P1906] Introductory survey of the Solar System; structure and motions of the Earth and Moon; planetary motions; natures and characteristics of the planets and smaller solar system bodies; planetary moons and rings; meteors, meteoroids, and meteorites; properties of the Sun; origin and evolution of the Solar System; discovery of extrasolar planetary systems; architecture of extrasolar planetary systems and comparison to our solar system; habitable extrasolar planets. Emphasis will be placed on problem-solving and scientific methods. Students with credit in PHYS 211 are encouraged to take ASTR 210. Credit is not given toward graduation for: Credit is not given for ASTR 121 if credit in either ASTR 100 or ASTR 210 has been earned.
This course satisfies the General Education Criteria for:
Nat Sci Tech - Phys Sciences
Quantitative Reasoning II

ASTR 122 Stars and Galaxies credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/122/)
Introduction to celestial objects and phenomena beyond the Solar System, and their governing basic physical principles; galaxies, quasars, and structure of the universe; dark matter and dark energy; the Big Bang and the fate of the universe; the Milky Way; the interstellar medium and the birth of stars; stellar distances, motions, radiation, structure, evolution, and remnants, including neutron stars and black holes. Emphasis will be placed on problem-solving and scientific methods. Credit is not given for ASTR 122 if credit in either ASTR 100 or ASTR 210 has been earned. Students with credit in PHYS 211 are encouraged to take ASTR 210.
This course satisfies the General Education Criteria for:
Nat Sci Tech - Phys Sciences
Quantitative Reasoning II

ASTR 150 Killer Skies: Astro-Disasters credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/150/)
Exploration of astronomical phenomena that have the potential to destroy our civilization, life on Earth, or even the entire planet, including asteroid impacts, solar storms, nearby supernovas, and rogue black holes. Emphasis is placed on understanding the nature of each phenomenon, assessing the potential risk(s) to our civilization, and describing mitigation strategies.
This course satisfies the General Education Criteria for:
Nat Sci Tech - Phys Sciences

ASTR 199 Undergraduate Open Seminar credit: 0 to 5 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/199/)
See course schedule for topics. Approved for Letter and S/U grading. May be repeated in the same term up to 5 hours or separate terms up to 8 hours, if topics vary.

ASTR 200 Smartphone Astronomy credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/200/)
Smartphone Astronomy turns your smartphone into a scientific tool for exploring the sky. Using the device in your pocket, you will measure Earth's radius, search for cosmic rays, compare the apparent sizes of the Moon and Sun, track lunar phases, and observe Earth's rotation and orbit. This course emphasizes hands-on observation, problem-solving, and the scientific method. Students must have access to a smartphone with a functioning camera; outdoor nighttime photography is required.
This course satisfies the General Education Criteria for:
Nat Sci Tech - Phys Sciences
Quantitative Reasoning II

ASTR 210 Introduction to Astrophysics credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/210/)
Survey of modern astronomy for students with background in physics. Topics include: the solar system; nature and evolution of stars; white dwarfs, neutron stars, and black holes; galaxies, quasars and dark matter; large scale structure of the universe; the Big Bang; and Inflation. Emphasis will be on the physical principles underlying the astronomical phenomena. Prerequisite: PHYS 211.

ASTR 310 Computing in Astronomy credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/310/)
An introduction to the use of computers in astrophysics research. Topics covered include a basic introduction to computing hardware concepts, Unix shell commands, programming in Python, data structures, astronomical libraries, modern software engineering concepts and tools, plotting and visualization of data, and fundamental numerical algorithms. Applications and examples drawn from astrophysics are stressed throughout. Prerequisite: PHYS 211; MATH 220; Credit or concurrent registration in ASTR 210.

ASTR 330 Extraterrestrial Life credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/330/)
Scientific discussion of the search for extraterrestrial life. Topics include: cosmic evolution (protons to heavy elements to molecules); terrestrial evolution (chemical, biological, and cultural); high technology searches for extraterrestrial life in the solar system (Mars, Venus, outer planets); and beyond the solar system (Drake equation and current SETI projects).

ASTR 350 The Big Bang, Black Holes, and the End of the Universe credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/350/)
Studies the origin, evolution, and eventual fate of the universe, and the scientific tools used to study these issues. Topics include aspects of special and general relativity; curved spacetime; the Big Bang; inflation; primordial element synthesis; the cosmic microwave background; dark matter and the formation of galaxies; observational evidence for dark matter, dark energy, and black holes. Credit is not given for ASTR 350 if credit in ASTR 406 has been earned. Prerequisite: ASTR 100, or ASTR 121, or ASTR 122, or ASTR 210, or consent of instructor.

ASTR 390 Individual Study credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/390/)
Individual study at an advanced undergraduate level. May be repeated in separate terms to a maximum of 8 hours. Prerequisite: Consent of advisor and of faculty member who supervises the work.

ASTR 401 Scientific Writing for Astronomy credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/401/)
Development of journal-style writing skills. Papers written in accordance with The Astrophysical Journal or The Monthly Notices of the Royal Astronomical Society Manuals of Style on topics approved by the instructor. Emphasis on developing adequate and critical coverage of the topic, brevity compatible with clarity, and effective presentation. Proper sentence, paragraph, section and subsection structure (including Abstract and Introduction, Figures and Captions), citation, footnotes, and bibliography are covered. 3 undergraduate hours. No graduate credit. Prerequisite: Completion of campus Composition I general education requirement, and completion of at least one of the ASTR 404, ASTR 405, ASTR 406, and ASTR 414 courses. Recommended: Credit or concurrent enrollment in a second one of the following courses: ASTR 404, ASTR 405, ASTR 406, and ASTR 414. Restricted to undergraduate students.
This course satisfies the General Education Criteria for:
Advanced Composition

ASTR 404 Stellar Astrophysics credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/404/)
Introduction to astrophysical problems, with emphasis on underlying physical principles; includes the nature of stars, equations of state, stellar energy generation, stellar structure and evolution, astrophysical neutrinos, binary stars, white dwarfs, neutron stars and pulsars, and novae and supernovae. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 212, ASTR 210, and ASTR 310 (or equivalent programming experience). Recommended: PHYS 213 and PHYS 214.

ASTR 405 Planetary Systems credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/405/)
Traces, from a physical perspective, the evolution of planetary systems from star formation in molecular clouds to the emergence of habitable worlds. Topics include the properties of HII regions and molecular clouds, gravitational collapse and disk formation, formation of planetesimals and planets, dynamics of the solar system, physics of planetary atmospheres, properties of individual planets and their rings and satellites, detection and characterization of extra-solar planets, and searches for life in the Solar System and beyond. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 212, ASTR 210, and ASTR 310 (or equivalent programming experience). Recommended: PHYS 213 and PHYS 214.

ASTR 406 Galaxies and the Universe credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/406/)
Nature of the Milky Way galaxy: stellar statistics and distributions, stellar populations, spiral structure, the nucleus and halo. Nature of ordinary galaxies; galaxies in our Local Group, structure of voids and superclusters. Nature of peculiar objects: Seyfert galaxies, starburst galaxies, and quasars. Elementary aspects of physical cosmology. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 212, ASTR 210, and ASTR 310 (or equivalent programming experience). Recommended: PHYS 213 and PHYS 214.

ASTR 414 Astronomical Techniques credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/414/)
Introduction to techniques used in modern optical and radio astronomy with emphasis on the physical and mathematical understanding of the detection of electromagnetic radiation; includes such topics as fundamental properties of radio and optical telescopes and the detectors that are used with telescopes. Lectures and laboratory. 4 undergraduate hours. 4 graduate hours. Prerequisite: PHYS 212, ASTR 210, and ASTR 310 (or equivalent programming experience). Recommended: PHYS 213 and PHYS 214.

ASTR 457 Foundations of Data Science in Astronomy credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/457/)
Introduction to statistical and data science methods used in modern astronomy. Topics include robust statistics, regression, model building and hypotheses testing, MCMC methods, parameter estimation, time series analysis, clustering and dimensionality reduction, and hierarchical modeling. Applications to astronomical data are emphasized, as well as best practices for writing code and version control. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ASTR 210, ASTR 310. Prior coursework in linear algebra, e.g. MATH 227 or MATH 257, recommended.

ASTR 471 Radio Astronomy Laboratory credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/471/)
Principles and techniques of modern radio astronomy. Covers basic concepts such as receivers, system temperature, filled aperture antennas, interferometers, and visibility data. How to analyze interferometer data, from data archive access to imaging, deconvolution, and cube analysis. Students will choose an astronomical source for imaging and reproduce results found in the professional literature. 4 undergraduate hours. 4 graduate hours. Prerequisite: ASTR 210 and ASTR 310.

ASTR 490 Senior Thesis credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/490/)
Research with thesis, under the direction of a faculty member in astronomy. This course is recommended for all students who plan to do research and graduate study, and it is a prerequisite for graduation with highest distinction in astronomy. In the term preceding their initial enrollment, those interested in taking the course should consult with an academic advisor as well as the potential research advisor. A thesis must be presented for credit to be received. 3 undergraduate hours. No graduate credit. Prerequisite: Two 400-level Astronomy courses and consent of academic advisor and of faculty member who supervises the work. Intended for Astronomy majors of senior standing.
This course satisfies the General Education Criteria for:
Advanced Composition

ASTR 496 Seminar in Astronomy credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/496/)
Lectures on topics of current interest in astronomy and astrophysics; for advanced undergraduates and graduates. See Class Schedule for current topics. 1 to 4 undergraduate hours. 1 to 4 graduate hours. Approved for both letter and S/U grading. May be repeated. Prerequisite: Consent of instructor.

ASTR 499 Astronomy Laboratory credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/499/)
Provides hands-on observational experience: how to use a telescope, how to image sources using a modern CCD camera, how to use a modern CCD spectrometer, and how to apply data analysis to astrophysical problems. 2 undergraduate hours. 2 graduate hours. Prerequisite: One 400-level astronomy course.

ASTR 501 Radiative Processes credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/501/)
Fundamentals of radiative processes in astronomy. Topics include radiative transfer, classical theory of radiation fields, relativistic covariance and kinematics, synchrotron emission and absorption, bremsstrahlung, plasma effects, atomic and molecular spectroscopy, and dust. Prerequisite: ASTR 404 or consent of instructor.

ASTR 502 Astrophysical Dynamics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/502/)
Introduction to stellar dynamics and fluid dynamics. Topics include two body collisions, two body relaxation, potential theory for stellar systems, adiabatic invariance, stellar system models, Jeans equations, and the virial theorem. Also hydrodynamics, magnetohydrodynamics, waves, instabilities, shocks, explosions, density waves, and wind-blown bubbles. Prerequisite: PHYS 436, PHYS 427, and PHYS 486; or consent of instructor.

ASTR 503 Observational Astronomy credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/503/)
Techniques and basic results of observational astronomy; gamma ray, x-ray, ultraviolet, visible, infrared, and radio astronomy; photometry, imaging, spectroscopy, and polarimetry; gravitational waves; cosmic rays; neutrinos; positional astronomy; noise; statistics; data analysis; optics. Prerequisite: Consent of instructor.

ASTR 504 Theoretical Stellar Physics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/504/)
Application of physical principles to energy generation and flow in astrophysical environments: equations of state; thermonuclear reactions; radiative transport; convection; stellar spectra; nebular spectra; evolution of both single and binary stars; compact stars; accretion disks; thermal and particle history of the universe. Same as PHYS 542. Prerequisite: PHYS 436, PHYS 427, and PHYS 486; or consent of instructor.

ASTR 505 Star Formation credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/505/)
Survey of the current state of astrophysical research into the topic of star formation. Particular emphasis placed on interpreting observations and how they relate to the theory of star formation. Prerequisite: ASTR 405 or consent of instructor.

ASTR 506 Galaxies credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/506/)
Survey of the different constituents of the Universe, including galaxies, active galaxies, galaxy clusters, and intergalactic gas. Particular emphasis will be placed on observable properties of the Milky Way and other galaxies, as well as relating such observations to the understanding of the dynamics and evolution of galaxies. Prerequisite: ASTR 406 or consent of instructor.

ASTR 507 Physical Cosmology credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/507/)
A survey of the essentials of modern cosmology, providing an overview of the state of the field, of open questions, and of observational and theoretical tools. Topics include: classical cosmology--the Friedmann universe; the early universe--inflation, nucleosynthesis, dark matter; the cosmic microwave background--basic physics, anisotropies, polarization; large scale structure formation--theoretical models and observational tests; dark energy--observational evidence, theoretical ideas. Emphasizes applying physical principles to understand observations, and on using observations to constrain the nature of matter and spacetime on cosmic scales--viewing the universe as a laboratory for fundamental physics. Course work focuses heavily on problem solving. Prerequisite: ASTR 406 or consent of instructor.

ASTR 510 Computational Astrophysics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/510/)
Prepares students to use numerical simulations to study complex problems in astrophysics and cosmology. Numerical methods and parallel computing will be covered together with the design, validation, and analysis of simulations. Emphasis is placed on solving ordinary and partial differential equations that arise in astrophysical contexts. Students work on assigned numerical problems and perform simulations using existing simulation codes, writing a final paper which presents the results of simulations using one of these codes. There are no formal prerequisites except knowledge of a scientific programming language such as Fortran, C, and C++. Familiarity with Unix/Linux and astronomical analysis tools is useful but not required.

ASTR 515 General Relativity I credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/515/)
Same as PHYS 515. See PHYS 515.

ASTR 516 General Relativity II credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/516/)
Same as PHYS 516. See PHYS 516.

ASTR 521 Artificial Intelligence and Big Data in Astronomy credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/521/)
Introduction to advanced artificial intelligence methods and their applications in astrophysics and astronomy. Topics include deep learning, generative models, uncertainty quantification, physics-informed learning, interpretable machine learning, and applications such as time series and galaxy morphological classification, deblending, photometric redshifts, and gravitational lensing inference. Students will gain hands-on experience through assignments and a final project. Prerequisite: Restricted to Graduate standing or consent of instructor.

ASTR 540 Astrophysics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/540/)
Same as PHYS 540. See PHYS 540.

ASTR 541 Physics of Compact Objects credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/541/)
Same as PHYS 541. See PHYS 541.

ASTR 555 Current Topics in Astronomical Research Literature credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ASTR/555/)
Discussion course on topics drawn from the current research literature in astronomy and astrophysics. Graduate students sign up for short presentations reviewing recent papers. Approved for S/U grading only. May be repeated in separate terms up to 4 hours.

ASTR 590 Individual Study credit: 2 to 16 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/590/)
Individual study or non-thesis research. May be repeated. Prerequisite: Consent of adviser and of faculty member who supervises the work.

ASTR 593 Astronomy Internship credit: 0 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/593/)
Full-time or part-time practice of graduate-level astronomy and astrophysics in an off-campus government, industrial, or research facility environment. Summary report required. Approved for S/U grading only. May be repeated in separate terms. Prerequisite: Instructor approval required. International students on the F-1 visa must also seek CPT approval. 12 months of full-time CPT eliminates a student's eligibility for OPT. Intended for graduate students who require an internship course.

ASTR 596 Seminar in Special Topics credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/596/)
Approved for both letter and S/U grading. May be repeated. Prerequisite: Consent of instructor.

ASTR 599 Thesis Research credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/ASTR/599/)
Approved for S/U grading only. May be repeated in the same term or in separate terms.