Physics and Astronomy

Chair
• Frederick N. Skiff

Associate Chair
• Cornelia Lang

Undergraduate majors: physics (B.A., B.S.); applied physics (B.S.); astronomy (B.A., B.S.)

Undergraduate minors: physics; astronomy

Graduate degrees: M.S. in physics; M.S. in astronomy; Ph.D. in physics

Faculty: https://physics.uiowa.edu/people
Website: https://physics.uiowa.edu/

The Department of Physics and Astronomy provides comprehensive and rigorous instruction in all basic aspects of its subjects. It also provides research facilities and guidance in selected specialties for advanced individual scholarly work.

In addition to its undergraduate and graduate programs of study, the department offers several courses that undergraduate students in all majors may use to satisfy the GE CLAS Core Natural Sciences requirement. Look for courses with prefixes ASTR and PHYS under "Natural Sciences" in the GE CLAS Core section of the Catalog. The department also offers two First-Year Seminars designed for entering undergraduates.

The department also participates in an interdisciplinary doctoral program, the Program in Applied Mathematical and Computational Sciences (Graduate College).

All of the department’s courses and advanced laboratories are taught by faculty members. Faculty members also supervise associated laboratories taught by graduate students. Enrollment in courses beyond the elementary level is typically 15 to 20 students; there is ample opportunity for individual work. Special introductory courses are offered for students majoring in physics and astronomy and for others with a special interest in these subjects.

Total enrollment in physics and astronomy courses is approximately 2,200 each semester of the academic year and 150 during the summer session. The department has around 120 undergraduate majors, half of whom are honors students, and 75 graduate students.

Programs

Undergraduate Programs of Study

Majors
• Major in Physics (Bachelor of Arts)
• Major in Astronomy (Bachelor of Arts)
• Major in Physics (Bachelor of Science)
• Major in Applied Physics (Bachelor of Science)
• Major in Astronomy (Bachelor of Science)

Minors
• Minor in Physics
• Minor in Astronomy

Graduate Programs of Study

Majors
• Master of Science in Physics
• Master of Science in Astronomy
• Doctor of Philosophy in Physics

Facilities

The department has a number of well-equipped laboratories and observatories. Faculty, students, and staff access national supercomputers via the internet, and have access to high performance computing clusters on campus. The central machine shop is fully equipped and staffed by skilled instrument makers and machinists, and there are electronics and machine shops for use by advanced students and research staff.

Experimental research is conducted in astronomy (optical, radio, and X-ray), atomic and molecular physics, condensed matter physics, elementary particle physics, laser physics, medical physics, plasma physics, and space physics. Extensive facilities are available for construction of specialized research equipment and for data processing and analysis.

State-of-the-art semiconductor materials and devices are grown in two molecular beam epitaxy machines. Ultrafast laser techniques are developed and used to probe electron transport, energy relaxation, recombination, and spin dynamics in the novel nanostructures grown in these machines. Experiments also are conducted on laser-induced coherent phenomena and coherent control of charge carriers in semiconductor nanostructures. The experimental condensed matter program is closely coordinated with the condensed matter theory group.

Plasma physics is an active area of experimental and theoretical research. Laboratory experiments studying plasma processes of importance in various space and astrophysical plasmas are performed in a Q machine, including experiments on waves and instabilities in dusty plasmas. Additional laboratory and microgravity experiments with dusty plasmas include studies of Coulomb crystals, shocks, and complex fluids. Glow discharges for plasma processing applications are studied using laser diagnostics and numerical simulations. Wave propagation and plasma particle dynamics also are studied in collisionless plasmas through laboratory experiments. Laser techniques are developed for measuring plasma flow and following particle orbits. Plasma theory efforts include analytical and numerical investigations of magnetic reconnection and turbulence in space and astrophysical plasmas; collaboration with laboratory and space plasma experimental groups in strongly coupled dusty plasmas, waves, and instabilities; and free electron lasers and hydrodynamic turbulence.

State-of-the-art laser systems are available for high-resolution spectroscopic measurement and ultrafast studies of molecular structure, for collisional relaxation and nonlinear optical effects in atomic and molecular systems, and for plasma diagnostics.

Experimental research in elementary particle physics is carried out at Fermi National Accelerator Laboratory, Stanford
Linear Accelerator Center, CERN in Switzerland, and other international laboratories. The present generation of high-energy experiments has been designed to probe both the strong nuclear force and the weak interactions.

The department is well-equipped for research and instruction in observational astronomy. The primary optical instrument is a fully automated 15-inch telescope at a dark-sky site in Arizona. The telescope is equipped with CCD cameras and a variety of filters. There are 3-meter and 4.5-meter radio telescopes on the roof of Van Allen Hall, which are used for instruction and student research projects.

Research programs in galactic and extragalactic radio astronomy are carried out using the facilities of the National Radio Astronomy Observatory, including the Very Large Array and the Very Long Baseline Array, one element of which is 10 miles north of campus. Current long-term research activities include studies of the center of the Milky Way galaxy; investigations of extragalactic radio sources; the formation of powerful winds in young, luminous stars; radio-wave scattering in the interstellar and interplanetary media; and interacting binary stars. A research program in X-ray astronomy has been established, and there is a laboratory for instrument development. Research topics in X-ray astronomy concentrate on observations of X-ray emission from black holes and supernova remnants, using existing spacecraft.

Active theoretical research is carried on in astrophysics; atomic, molecular, and optical physics; condensed matter physics; elementary particle physics; laser physics; mathematical physics; nuclear physics; plasma physics; and space physics. An active mathematical physics seminar fosters the exchange of ideas between mathematics and physics.

The primary emphasis of Iowa's program in experimental and theoretical space physics is on studies of cosmic and heliospheric physics, magnetospheric physics, and magnetosphere-ionosphere interactions. Facilities are available for designing and constructing spaceflight instruments. Investigators in the department have flown instruments for studying plasmas, energetic charged particles, auroral images, plasma waves, and radio emissions on a wide variety of terrestrial and planetary spacecraft, including Pioneer 10 and 11, Dynamics Explorer, Voyager 1 and 2, Galileo, Polar, Cassini, and Mars Express.

Courses

• Physics Courses [p. 2]
• Astronomy Courses [p. 5]

Physics Courses

**PHYS:1000 First-Year Seminar** 1 s.h.
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

**PHYS:1100 From Quarks to Quasars** 3-4 s.h.
Conceptual explanations of the latest discoveries in physics—from the smallest objects, such as quarks and atoms, to the largest, such as galaxies, black holes, and quasars. Requirements: non-science major. GE: Natural Sciences with Lab; Natural Sciences without Lab.

**PHYS:1200 Physics of Everyday Experience** 3 s.h.
Principles of physics; basic motion, behavior of fluids, waves, temperature and heat, gravity and planetary motion, electricity and magnetism, optics, nuclear energy, radioactivity, and medical imaging technology; examples from everyday experience; for non-science majors. GE: Natural Sciences without Lab.

**PHYS:1300 Nanoscience** 3 s.h.
Properties of very small materials and structures; unique properties emerging at a length scale of one billionth of a meter, or one nanometer. GE: Natural Sciences without Lab.

**PHYS:1400 Basic Physics** 3-4 s.h.
Quantitative treatment of mechanics, electricity, heat, liquids, gases, and atomic, nuclear, and elementary particle physics. Requirements: must have completed high school trigonometry or achieved a minimum ALEKS score of 75%. GE: Natural Sciences with Lab; Natural Sciences without Lab.

**PHYS:1409 Basic Physics Lab** 1 s.h.
Laboratory for PHYS:1400. Corequisites: PHYS:1400 (if not taken as a prerequisite). GE: Natural Sciences Lab only.

**PHYS:1410 Physics of Sound** 3-4 s.h.
Acoustical foundations of music; production of sound by vibrating objects, properties of sound waves, vocal acoustics, hearing, room acoustics, principles of electroacoustics. GE: Natural Sciences with Lab; Natural Sciences without Lab.

**PHYS:1511 College Physics I** 4 s.h.
Algebra-based treatment of mechanics, waves, thermodynamics, and special relativity. Requirements: must have completed high school trigonometry or achieved a minimum ALEKS score of 75%. GE: Natural Sciences with Lab.

**PHYS:1512 College Physics II** 4 s.h.
Continuation of PHYS:1511; algebra-based treatment of electricity, magnetism, light, and modern physics. Prerequisites: PHYS:1611 or PHYS:1511. GE: Natural Sciences with Lab.

**PHYS:1611 Introductory Physics I** 4 s.h.

**PHYS:1612 Introductory Physics II** 3-4 s.h.
Continuation of PHYS:1611; calculus-based treatment of electricity, magnetism, and light. Prerequisites: PHYS:1611. Corequisites: MATH:1560 or MATH:1860. GE: Natural Sciences with Lab; Natural Sciences without Lab.

**PHYS:1619 Introductory Physics II Lab** 1 s.h.
Laboratory for PHYS:1612. Requirements: 3 s.h. in PHYS:1612. GE: Natural Sciences Lab only.

**PHYS:1701 Physics I** 4 s.h.
Introduction to physics; calculus-based treatment of Newtonian mechanics for point particles and rigid bodies; conservation laws. Offered fall semesters. Corequisites: MATH:1850. Requirements: physics or astronomy major. GE: Natural Sciences with Lab.

**PHYS:1702 Physics II** 4 s.h.

**PHYS:1999 Undergraduate Seminar** arr.
Selected topics in physics and astronomy; discussion, presentations.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS:2703</td>
<td>Physics III</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Continuation of PHYS:1702; introduction to physics; calculus-based treatment of electromagnetic waves and optics; mechanical and sound waves; thermal physics. Offered fall semesters. Prerequisites: PHYS:1702.</td>
<td></td>
</tr>
<tr>
<td>PHYS:2704</td>
<td>Physics IV</td>
<td>3-4</td>
</tr>
<tr>
<td></td>
<td>Introduction to quantum mechanics and other topics in modern physics, including special relativity, atomic and solid state physics. Offered spring semesters. Prerequisites: (PHYS:1612 or PHYS:2703) and (MATH:1860 or MATH:1550). Requirements: for 3 s.h. option—nonmajor.</td>
<td></td>
</tr>
<tr>
<td>PHYS:2990</td>
<td>Reading in Physics</td>
<td>arr.</td>
</tr>
<tr>
<td></td>
<td>Selected topics in physics.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3500</td>
<td>Undergraduate Practicum</td>
<td>arr.</td>
</tr>
<tr>
<td></td>
<td>Experiences that provide special opportunities for students to gain practical and hands-on training related to topics in physics; practicums typically arranged by individual faculty members. Requirements: application and acceptance into practicum.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3710</td>
<td>Intermediate Mechanics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Introduction to Newtonian mechanics; nonrelativistic systems; central forces, celestial mechanics; rigid body motion; Lagrangian and Hamiltonian equations of motion; small oscillations. Prerequisites: (PHYS:1611 or PHYS:1511 or PHYS:1701) and (MATH:1860 or MATH:1560).</td>
<td></td>
</tr>
<tr>
<td>PHYS:3730</td>
<td>Statistical Physics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Integrated introduction to subjects of thermodynamics, statistical mechanics, classical and quantum statistics of interacting particles; kinetic theory; emphasis on applications. Prerequisites: PHYS:2704.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3741</td>
<td>Introduction to Quantum Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Superposition principle, Stern-Gerlach experiment, linear operators, measurement theory, time evolution, angular momentum, wave mechanics in one dimension, one-dimensional harmonic oscillator, two-body problems with central forces, and the hydrogen atom. Prerequisites: MATH:2850 and PHYS:2704 and MATH:2700.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3742</td>
<td>Introduction to Quantum Mechanics II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Continuation of PHYS:3741; perturbation theory, variational methods, WKB approximation, scattering, Helium atom, periodic table, atomic spectroscopy, transition rates, and other selected applications. Prerequisites: PHYS:3741.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3750</td>
<td>Fundamentals of Micro and Nanofabrication</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Fundamentals of micro and nanofabrication processes; physical principles of photo and electron beam lithography, alternative nanolithography techniques, thin film deposition, molecular beam epitaxy, atomic layer deposition, self-assembly; metrology methods; physical and chemical processes of wet and plasma etching; clean room science, operations, safety protocols; sequential micro and nanofabrication processes involved in manufacture of semiconductor, photonic, nanoscale devices; imaging and characterization of micro and nanostructures; scientific and technological applications of emerging micro and nanodevices and systems. Prerequisites: BIOI:1141 or CHEM:1120 or PHYS:1612 or CHEM:1110 or CHEM:1060 or PHYS:1702 or PHYS:1611. Requirements: graduate lab course in chemistry, biology, physics, or engineering.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3756</td>
<td>Intermediate Laboratory</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Introduction to instruments and techniques of experimental physics and basic skills needed for carrying out experimental physics research; hands-on use of a variety of instruments and equipment. Corequisites: PHYS:3811.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3811</td>
<td>Electricity and Magnetism I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Introduction to electricity and magnetism; topics include electrostatics, magnetostatics, potential theory, and electric and magnetic fields in matter. Prerequisites: (MATH:3550 or MATH:2850) and (PHYS:1612 or PHYS:1702 or PHYS:1512).</td>
<td></td>
</tr>
<tr>
<td>PHYS:3812</td>
<td>Electricity and Magnetism II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Continuation of PHYS:3811; introduction to electricity and magnetism; topics include Maxwell's equations, electrodynamics, electromagnetic waves, radiation, and special relativity. Prerequisites: PHYS:3811.</td>
<td></td>
</tr>
<tr>
<td>PHYS:3850</td>
<td>Electronics</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Design and construction of small circuits; use of measurement instruments—oscilloscope, multimeter, function generator, circuits, including transistors, operational amplifiers, digital, analog-to-digital conversion. Prerequisites: PHYS:1512 or PHYS:1612 or PHYS:1702. Requirements: physics or astronomy major.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4720</td>
<td>Introductory Optics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Wave motion and superposition, electromagnetic theory, photons, propagation of light, geometrical and physical optics, interference, diffraction, polarization, and Fourier optics; optical components, devices, and systems. Prerequisites: (PHYS:1512 or PHYS:2703 or PHYS:1612) and (MATH:1560 or MATH:1860). Same as ECE:4720.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4726</td>
<td>Electro Optics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Wave equation solutions; optical birefringence; finite beam propagation in free space, dielectric waveguides and fibers; optical resonators; nonlinear phenomena; electro-optic, acousto-optic modulation; optical detection, noise; application to communication systems. Requirements: for ECE:5790—ECE:3700; for PHYS:4726—PHYS:3812. Same as ECE:5790.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4728</td>
<td>Introductory Solid State Physics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Phenomena associated with solid state; classification of solids and crystal structures, electronic and vibrational properties in solids; thermal, optical, magnetic, dielectric properties of solids. Prerequisites: PHYS:3741. Same as ECE:4728.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4730</td>
<td>Plasma Physics I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Physics of ionized gases, including orbit theory, guiding center motion, adiabatic invariants, ionization balance description of plasmas by fluid variables and distribution functions; linearized wave motions, instabilities; magnetohydrodynamics. Prerequisites: PHYS:3812.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4740</td>
<td>Elementary Particles and Nuclear Physics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Accelerators, particle detectors, passage of radiation through matter; nuclear structure, nuclear reactions; quark model of hadrons; strong, electromagnetic, weak interactions of elementary particles; gauge theories, intermediate vector bosons; unification of electromagnetic and weak interactions. Prerequisites: PHYS:3741.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4750</td>
<td>Advanced Laboratory</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Advanced experimental work and development of new experiments.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4761</td>
<td>Mathematical Methods of Physics I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Functions of complex variables, integration methods, linear vector spaces, tensors, matrix algebra. Prerequisites: MATH:2850.</td>
<td></td>
</tr>
<tr>
<td>PHYS:4762</td>
<td>Mathematical Methods of Physics II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Continuation of PHYS:4761; Hilbert space, special functions, Fourier transform and expansions in orthogonal polynomials, differential equations, Green's functions. Prerequisites: PHYS:4761.</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Name</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>PHYS:4820</td>
<td>Optical Signal Processing</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:4860</td>
<td>Computational Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:4905</td>
<td>Special Topics in Physics</td>
<td>arr.</td>
</tr>
<tr>
<td>PHYS:4990</td>
<td>Reading in Physics</td>
<td>arr.</td>
</tr>
<tr>
<td>PHYS:4999</td>
<td>Undergraduate Research</td>
<td>arr.</td>
</tr>
<tr>
<td>PHYS:5000</td>
<td>Workshops and Special Training in Physics</td>
<td>arr.</td>
</tr>
<tr>
<td>PHYS:5710</td>
<td>Classical Mechanics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5729</td>
<td>Fluid Mechanics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5730</td>
<td>Advanced Plasma Physics I</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5731</td>
<td>Physics of Strongly Coupled Plasmas</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5740</td>
<td>Introduction to Quantum Field Theory</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5746</td>
<td>Particle Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>PHYS:5760</td>
<td>General Relativity and Cosmology</td>
<td>2-3 s.h.</td>
</tr>
</tbody>
</table>
PHYS:7761 Cosmology 3 s.h.
Einstein’s theory of general relativity radically changed the way we understand the cosmos by providing a mathematical description of space-time itself—this is cosmology; the last three decades have shown remarkable evidence that cosmology is an experimentally testable theory; students explore mathematical underpinnings of cosmology by studying the early universe, the cosmic microwave background, inflation, big bang nucleosynthesis, neutrino physics, quantum field theory effects on space-time, and other issues. Prerequisites: PHYS:7760.

PHYS:7840 Quantum Gauge Theories 3 s.h.

PHYS:7905 Special Topics in Physics arr.

Current research.

Current research. Same as ECE:7930.

PHYS:7936 Seminar: Space Physics arr.
Current research.

PHYS:7945 Seminar: Math/Physics arr.
Current research.

PHYS:7946 Seminar: Nuclear and Particle Physics arr.
Current research.

PHYS:7990 Research: Physics arr.

PHYS:7992 Individual Critical Study arr.
Essay on topic chosen in consultation with faculty member. Requirements: candidacy for M.S. with critical essay.

Astronomy Courses

ASTR:1000 First-Year Seminar 1 s.h.
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities).

ASTR:1060 Big Ideas: Origins of the Universe, Earth, and Life 3 s.h.
Origin of the universe, the biochemistry of life, and the origin of life on Earth; for nonscience majors. Recommendations: first-year or sophomore standing. GE: Natural Sciences without Lab. Same as BIOL:1060, EES:1060.

ASTR:1061 Big Ideas: Evolution of Life on Earth and the Search for Life in the Universe 4 s.h.
Evolution of life on Earth, origins of plants and animals, origins of humans and humanity, and the search for life in the universe; for nonscience majors. GE: Natural Sciences with Lab. Same as ANTH:1061, BIOL:1061, EES:1061.

ASTR:1070 Stars, Galaxies, and the Universe 3-4 s.h.
Students survey topics including the Sun; life cycles of stars including black holes and pulsars; diversity of galaxies including the Milky Way and distant quasars; cosmology—the history, structure, and fate of the universe; current results from recent astronomical observations; for nonscience majors. Recommendations: closed to physics and astronomy majors. GE: Natural Sciences with Lab; Natural Sciences without Lab.

ASTR:1079 Introductory Astronomy Laboratory 1 s.h.
Laboratory for ASTR:1070. GE: Natural Sciences Lab only.

ASTR:1080 Exploration of the Solar System 3-4 s.h.
Survey of the solar system; topics include physical properties of the planets, comets, and asteroids; origin of the solar system; search for extrasolar planetary systems; search for life in the universe; current results of recent planetary space missions; night sky observation; for nonscience majors. Recommendations: closed to physics and astronomy majors. GE: Natural Sciences with Lab; Natural Sciences without Lab.

ASTR:1085 Citizen Astronomy 3 s.h.
Survey of topics in astronomy and astrophysics; topics include the Solar System and exoplanets, nearby stars in the Galaxy, distant galaxies and unseen black holes; focus on citizen science projects that allow students to examine real data; for nonscience majors. GE: Natural Sciences without Lab.

ASTR:1091 Life in the Universe 3 s.h.
Are we alone? Scientific foundations of this question, technology behind searches for extraterrestrial life in the solar system and on extrasolar planets; evolution of life on Earth, likelihood that such conditions exist elsewhere in the universe; cultural consequences of discovering extraterrestrial life. GE: Natural Sciences without Lab.

ASTR:1771 Introductory Astronomy I: Basic Astrophysics and Planetary Astronomy 4 s.h.
Quantitative introduction to physical principles needed to understand astronomical phenomena (e.g., laws of motion, gravitation, radiation), astronomical instrumentation, properties structure, and evolution of solar system bodies, exoplanets, and the search for life. Requirements: four years of high school math. GE: Natural Sciences with Lab.

ASTR:1772 Introductory Astronomy II: Stellar, Galactic, and Extragalactic Astronomy 4 s.h.
Continuation of ASTR:1771; quantitative introduction to stellar, Galactic, and extragalactic astronomy; topics include the Sun, stellar evolution, stellar corpses such as neutron stars and black holes, the Milky Way galaxy, the interstellar medium, galaxies, cosmology, and fate of the universe. Requirements: four years of high school math. GE: Natural Sciences with Lab.

ASTR:2991 Reading in Astronomy arr.
Selected topics in astronomy.

ASTR:3500 Undergraduate Practicum arr.
Undergraduate practicum experiences that provide special opportunities for students to gain practical and hands-on training related to topics in astronomy; practicums typically arranged by individual faculty members. Requirements: application and acceptance into practicum.

ASTR:3771 Introduction to Astrophysics I 3 s.h.
Topics include celestial mechanics, radiative transfer, stellar structure and evolution, and star formation; first in a two-semester sequence. Prerequisites: PHYS:2704 and ASTR:1772 and ASTR:1771 and (MATH:2850 or MATH:3550) and (MATH:2700 or MATH:2550). Recommendations: computer programming experience.

ASTR:3772 Introduction to Astrophysics II 3 s.h.
Continuation of ASTR:3771; topics include post-main-sequence stellar evolution, stellar remnants, close binary stars, the Milky Way and other galaxies, active galactic nuclei, galaxy evolution, and cosmology; second in a two-semester sequence. Prerequisites: ASTR:3771.
ASTR:4770 Radio Astronomy 3 s.h.
Survey of radio astronomy, emphasizing technical aspects; radiation, antennas, receivers, radio spectroscopy, interferometer arrays and aperture synthesis; emission mechanisms, pulsars, supernova remnants, radio galaxies.

ASTR:4850 Astronomical Laboratory 3 s.h.
Introduction to instruments of optical (and sometimes multi-wavelength) astronomy and basic skills needed for carrying out observational astronomical research; hands-on use of observing equipment; nighttime observing sessions. Prerequisites: PHYS:2704 and ASTR:1772 and ASTR:1771.

ASTR:4906 Special Topics in Astronomy arr.

ASTR:4996 Reading in Astronomy arr.

ASTR:6782 Extragalactic Astronomy 3 s.h.
Normal and active galaxies, large scale structure, the early Universe, cosmology.

ASTR:6785 The Interstellar Medium 3 s.h.
The interstellar medium; optical properties of small interstellar grains, radiative processes in interstellar gas, structure of HII regions, interstellar shock waves, supernova remnants, modification of interstellar medium by luminous stars, molecular clouds.

ASTR:6790 Stellar Astrophysics 3 s.h.
Stellar interiors, nuclear astrophysics; advanced topics.

ASTR:6870 Radiative Processes in Astrophysics 3 s.h.
Physics of stars including interiors, spectra, nuclear processes, plasma hydrodynamics, and the extreme physics of condensed final states.

ASTR:6880 High Energy Astrophysics 3 s.h.
Detection of X-rays and gamma-rays, black holes and neutron stars, accretion onto compact objects, pulsars, supernova remnants, cosmic rays, and gamma-ray bursts.

ASTR:7775 Special Topics in Astrophysics 1-3 s.h.
Advanced lectures.

ASTR:7830 Space and Astrophysical Plasma Physics 3 s.h.
Dynamics and evolution of space and astrophysical plasmas; heliosphere, planetary magnetospheres, accretion disks; plasma waves, shock waves, turbulence.

ASTR:7970 Seminar: Astrophysics arr.
Current research.

ASTR:7991 Research: Astronomy arr.
Original research in observational, theoretical astronomy.