Physics Courses (Physics and Astronomy) (PHYS)

PHYS Courses

This is a list of courses with the subject code PHYS. For more information, see Physics and Astronomy (College of Liberal Arts and Sciences) in the catalog.

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: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: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.**
Calculus-based treatment of mechanics, waves, and thermodynamics. Corequisites: MATH:1550 or MATH:1850. GE: Natural Sciences with Lab.

PHYS:1612 Introductory Physics II **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.

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.**
Continuation of PHYS:1701; introduction to fluid mechanics, electricity, magnetism (Maxwell's equations). Offered spring semesters. Prerequisites: PHYS:1701. Corequisites: MATH:1860. Requirements: physics or astronomy major. GE: Natural Sciences with Lab.

PHYS:1999 Undergraduate Seminar **arr.**
Selected topics in physics and astronomy; discussion, presentations.

PHYS:2703 Physics III **4 s.h.**
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.

PHYS:2704 Physics IV **3-4 s.h.**
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.

PHYS:2905 Programming for Physics **2 s.h.**
Introduction to scientific programming for applications in physics.

PHYS:2990 Reading in Physics **arr.**
Selected topics in physics.

PHYS:3710 Intermediate Mechanics **3 s.h.**
Introduction to Newtonian mechanics; noninertial reference 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).

PHYS:3730 Statistical Physics **3 s.h.**
Integrated introduction to subjects of thermodynamics, statistical mechanics, classical and quantum statistics of interacting particles; kinetic theory; emphasis on applications. Prerequisites: PHYS:2704.

PHYS:3741 Introduction to Quantum Mechanics I **3 s.h.**
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.

PHYS:3742 Introduction to Quantum Mechanics II **3 s.h.**
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.

PHYS:3756 Intermediate Laboratory **3 s.h.**
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. Prerequisites: PHYS:2704. Corequisites: PHYS:3811.

PHYS:3811 Electricity and Magnetism I 3 s.h.
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).

PHYS:3812 Electricity and Magnetism II 3 s.h.
Continuation of PHYS:3811; introduction to electricity and magnetism; topics include Maxwell's equations, electrodynamics, electromagnetic waves, radiation, and special relativity. Prerequisites: PHYS:3811.

PHYS:3850 Electronics 4 s.h.
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.

PHYS:4720 Introductory Optics 3 s.h.
Wave motion and superposition, electromagnetic theory, photons, propagation of light, geometrical and physical optics, interference, diffraction, polarization, Fourier optics, coherence, lasers, a and nonlinear optics. Prerequisites: (PHYS:1512 or PHYS:2703 or PHYS:1612) and (MATH:1560 or MATH:1860). Same as ECE:4720.

PHYS:4726 Electro Optics 3 s.h.
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.

PHYS:4728 Introductory Solid State Physics 3 s.h.
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.

PHYS:4731 Plasma Physics I 3 s.h.
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.

PHYS:4740 Elementary Particles and Nuclear Physics 3 s.h.
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.

PHYS:4750 Advanced Laboratory 3 s.h.
Advanced experimental work and development of new experiments. Prerequisites: PHYS:3756.

PHYS:4761 Mathematical Methods of Physics I 3 s.h.
Functions of complex variables, integration methods, linear vector spaces, tensors, matrix algebra. Prerequisites: MATH:2850.

PHYS:4762 Mathematical Methods of Physics II 3 s.h.
Continuation of PHYS:4761; Hilbert space, special functions, Fourier transform and expansions in orthogonal polynomials, differential equations, Green's functions. Prerequisites: PHYS:4761.

PHYS:4820 Optical Signal Processing 3 s.h.
Linear systems description of optical propagation; diffraction and angular plane wave spectrum; lenses as Fourier transformers, lens configurations as generalized optical processors; lasers, coherence, spatial frequency analysis; holography; convolvers, correlators, matched filters; synthetic aperture radar; optical computing. Requirements: for ECE:5780—ECE:3700; for PHYS:4820—PHYS:3812. Same as ECE:5780.

PHYS:4860 Computational Physics 3 s.h.
Introduction to contemporary use of computers by physicists; topics such as numerical solutions of ordinary differential equations in classical mechanics, boundary value problems in electricity and magnetism, eigenvalue problems in quantum mechanics, Monte Carlo simulations in statistical mechanics, methods of data analysis. Prerequisites: PHYS:3741 and PHYS:3811 and PHYS:3710.

PHYS:4905 Special Topics in Physics arr.
Introduction to scientific programming using the Python language and linear algebra for applications in physics.

PHYS:4990 Reading in Physics arr.
Selected topics in physics.

PHYS:4999 Undergraduate Research arr.
Supervised research leading to written report or oral presentation.

PHYS:5000 Workshops and Special Training in Physics arr.
Workshops and special training opportunities for postbaccalaureate students; may include collaborations with other departments, institutions, or externally funded research organizations.

PHYS:5466 Optical Components, Alignment, and Instrumentation for Remote Sensing 3 s.h.
Explore optical components including lenses, mirrors, beam splitters, fiber optics, and filters, and optical assemblies including beam expanders, interferometers, and laser cavities; assess and align optical assemblies using metrology equipment including collimators, autocollimators, and wavemeters; hands-on laboratory work. Work with optics, optical devices, and metrology equipment; learn how to handle, work with, and assess optics and optical components and how to align complex assemblages of components in a sensor. Recommendations: basic or introductory physics course with applications to atmospheric chemistry. Same as CBE:5466, ECE:5466.

PHYS:5710 Classical Mechanics 3 s.h.
Dynamics of mass points; Lagrange multipliers, small oscillations, Hamilton's equations; canonical transformations, Hamilton-Jacobi theory; chaos. Prerequisites: PHYS:3710.

PHYS:5730 Statistical Mechanics I 3 s.h.
Probability concepts; kinetic equations; classical and quantum equilibrium statistical mechanics with applications, including ideal and imperfect gases and phase transitions, irreversible processes, fluctuation-dissipation theorems. Prerequisites: PHYS:3730 and PHYS:3741.

PHYS:5741 Quantum Mechanics I 3 s.h.
Nonrelativistic quantum mechanics, Schrödinger wave mechanics, Hilbert space methods, perturbation theory, scattering, spin and angular momentum, identical particles, selected applications, introduction to relativistic theory. Prerequisites: PHYS:3741 and PHYS:3742.

PHYS:5742 Quantum Mechanics II 3 s.h.
Continuation of PHYS:5741. Prerequisites: PHYS:5741.

PHYS:5805 Advanced Programming for Physics 2 s.h.
Introduction to scientific programming for applications in physics.

PHYS:5811 Classical Electrodynamics I 3 s.h.
Advanced electromagnetostatics, boundary value problems, Green's functions, Maxwell's equations, radiation theory, physical optics, multipole expansion of radiation field.

PHYS:5812 Classical Electrodynamics II 3 s.h.
Special relativity, motion of charges in fields, theories of radiation reaction, special topics. Prerequisites: PHYS:5811.

PHYS:5905 Special Topics in Physics 3 s.h.
Selected topics in physics.

PHYS:6723 Quantum Optics and Nanophotonics 3 s.h.
Classical theory of emission and absorption of light, classical dispersion, semiclassical approach, thermal and laser sources, photons, photon statistics, quantization of electromagnetic fields, quantum coherence, noise, Jaynes-Cummings model, squeezed light, metamaterials, plasmonics, and polaritons. Prerequisites: PHYS:3741 and PHYS:3812.

PHYS:6725 Microfabrication and Thin Film Materials 3 s.h.
Microfabrication and nanofabrication techniques and thin film materials growth used to create micro-, nano-, and opto-electronic devices that underlie modern technology; introduction to microfabrication techniques, physics, and chemistry; growth and properties of thin film materials upon which fabrication is performed; review of materials science; introduction to vacuum science and technology; survey of micro- and nano-devices; examination of thin film growth and deposition science, plasma etching and sputtering, micro- and nano-patterning and characterization, and film nucleation, growth, structure, and properties. Prerequisites: (PHYS:2704 or ENGR:2130 or CHEM:1120) and (MATH:1560 or MATH:1860) and (PHYS:1612 or PHYS:2703) and CHEM:1110. Recommendations: background in thermal and statistical physics, introductory quantum mechanics, and introductory chemistry. Same as ECE:6725, ME:6725.

PHYS:7270 Ethics in Physics for Graduate Students arr.
Responsible conduct and ethics training.

PHYS:7604 Ethics in Physics for Postdocs 0 s.h.
Responsible conduct and ethics training.

PHYS:7720 Semiconductor Physics 3 s.h.
Electronic, optical, and materials properties of semiconductors. Prerequisites: PHYS:4728 and PHYS:5742. Same as ECE:7720.

PHYS:7722 Advanced Condensed Matter 3 s.h.
Elementary excitations, plasmonics, exchange/magnetism, hyperfine interactions, resonance, superconductivity, topological materials. Prerequisites: PHYS:7720.

PHYS:7729 Plasma Physics II 3 s.h.
Continuation of PHYS:4731; cold plasma waves, MHD stability, kinetic theory of plasmas, including Landau damping and velocity space instabilities; nonlinear evolution. Prerequisites: PHYS:4731.

PHYS:7730 Advanced Plasma Physics I 3 s.h.
Microscopic plasma behavior: statistical mechanics of plasmas; Liouville equation; BBGKY hierarchy; Fokker-Planck equation and relaxation processes; Balescu-Lenard equation; Vlasov equation and linearized wave motion; shocks, nonlinear plasma motions, and instabilities; fluctuations and radiation processes; topics from recent literature.

PHYS:7740 Introduction to Quantum Field Theory 3 s.h.
Quantization of relativistic and nonrelativistic field theories, covariant perturbation theory, theory of renormalization, dimensional regularization, renormalization group theory, introduction to gauge theories and anomalies. Prerequisites: PHYS:5742.

PHYS:7746 Particle Physics 3 s.h.
Elementary particle properties and phenomenology, quark-parton models, quantum chromodynamics, unified theory of weak and electromagnetic interactions.

PHYS:7760 General Relativity 2-3 s.h.
Einstein's theory of gravitation; principles of general relativity.

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.
Gauge invariance, introductory group theory, Yang-Mills theories, electroweak theory, quantum chromodynamics, running coupling constants, operator product expansions, Ward identities, spontaneous symmetry breaking, chiral anomalies, instantons, monopoles, effective Lagrangians, supersymmetry, quantum gravity, introduction to string theory. Prerequisites: PHYS:7740.

PHYS:7905 Special Topics in Physics arr.

PHYS:7920 Seminar: Condensed Matter Physics arr.
Current research.

PHYS:7930 Seminar: Plasma Physics arr.
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 MS with critical essay.