# Physics

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The Physics Department offers a flexible program of study in physics that may be designed to suit the individual needs of the student. The curriculum leading to the bachelor degree in physics is intended to provide a thorough foundation in the principles of physics. With appropriately selected advanced courses, a student is well prepared for graduate study in physics, applied physics, engineering, medicine, or law, or for entry-level positions in research, business, teaching, and other fields.

Students required to take a one-year course in General Physics as part of their academic program have two options: the traditional General Physics (lecture course with laboratory) or General Physics in Daily Life (with interactive experiments integrated into the lecture). General Physics in Daily Life emphasizes the applications of physics to natural phenomena and devices of everyday life. Both sequences are calculus-based and satisfy the requirements for science majors, the premedical program, and ROTC.

The requirements for a major in physics consist of both physics and mathematics courses. Physics majors must take three semesters of calculus (Math 131, 132, and 241) or the equivalent. The required physics courses are General Physics 1, 2 (Physics 111, 112) or General Physics in Daily Life 1, 2 (Physics 115, 116), Methods of Physics (Physics 221), Modern Physics with the laboratory (Physics 223, 225), Classical Mechanics 1 (Physics 342), Thermal Physics (Physics 344), Electromagnetic Theory (Physics 351), and Quantum Mechanics 1 (Physics 353). In consultation with their advisors, physics majors must choose at least two additional lecture courses and one advanced laboratory above the 200 level. A laboratory course is taken as a fifth course in any given semester. A minimum grade of C in General Physics 1, 2 or General Physics in Daily Life 1, 2 is required to continue in the major. Mathematics majors are not required to take Methods of Physics.

Advanced electives offered by the Department include Optics with the laboratory (Physics 231, 233), Electronics with the laboratory (Physics 234, 236), Classical Mechanics 2 (Physics 343), Quantum Mechanics 2 (Physics 354), Introduction to Astrophysics (Physics 355), and Experimental Solid State Physics (Physics 356). General Physics 1, 2 or General Physics in Daily Life 1, 2 are prerequisites for all physics courses above the 200 level; Multivariable Calculus (Math 241) and Methods of Physics (Physics 221) are prerequisites for all physics courses above the 300 level.

Programs of supervised research in theoretical or experimental physics (Physics 471, 472) are available for qualified physics majors. Students may also take Independent Study (Physics 461, 462) under faculty guidance to pursue topics of interest that fall outside the curriculum.

Two special academic programs may be of interest to Physics majors. The 3-2 Program in Engineering provides the opportunity to combine the study of physics with training in engineering. The Teacher Education Program leads to state licensure as a secondary school teacher of physics. Students interested in one of these programs should consult with the Department Chair and either the 3-2 Program Advisor or the Director of the Teacher Education Program.

A minor in physics is also offered for interested students. Physics minors must take two semesters of calculus (Math 131, 132) or the equivalent. The required physics courses are General Physics 1, 2 (Physics 111, 112) or General Physics in Daily Life 1, 2 (Physics 115, 116), and Modern Physics (Physics 223). In consultation with their physics advisors, minors are required to choose three additional physics courses, two of which must be lecture courses above the 200 level.

**Advanced Placement Credit:** Students with AP credit in Physics do not receive credit toward the minimum number of courses required for the major or advanced standing in the Physics curriculum.

# Courses

**Physics 100 — Topics in Physics** *Fall, spring*
Recent offerings: How Things Work; Gravity and Science in Orbit; Light, Color, and Vision. Non-science majors only. One unit.

**Physics 101 — Introduction to Astronomy** *Annually*
Motions of celestial bodies; the sun, Earth and moon; other terrestrial planets; Jovian planets; asteroids and comets; nebular model for the origin of the solar system; stars and stellar systems; Milky Way galaxy; the universe and the big-bang model. Non-science majors only. One unit.

**Physics 102 — Introduction to Meteorology** *Alternate years*
Atmospheric properties; solar and terrestrial radiation; cloud types and their formation; thunderstorms, mid-latitude cyclones, anticyclones (low and high pressure systems) and tropical cyclones; forecasting; climate and climatic changes (ice ages); stratospheric ozone; optical atmospheric phenomena. Non-science majors only. One unit.

**Physics 111 — General Physics 1** *Fall*
Kinematics in one and two dimensions; vectors; Newton's laws; work and energy; linear momentum and collisions; rotational motion; static equilibrium; oscillatory motion; gravitation; fluid mechanics; waves. Calculus-based. Includes a two-hour laboratory session per week. One and one-quarter units.

**Physics 112 — General Physics 2** *Spring*
Electric fields; electric potential; capacitance; DC circuits; magnetic fields; Faraday's law and inductance; AC circuits; geometric optics; wave optics; modern physics. Calculus-based. Includes a two-hour laboratory session per week. One and one-quarter units.

**Physics 115 — General Physics in Daily Life 1** *Fall*
Kinematics in one and two dimensions; vectors; Newton's laws; work and energy; linear momentum and collisions; rotational motion; static equilibrium; oscillatory motion; gravitation; fluid mechanics; waves. Calculus-based. One and one-quarter units.

**Physics 116 — General Physics in Daily Life 2** *Spring*
Electric fields; electric potential; capacitance; DC circuits; magnetic fields; Faraday's law and inductance; AC circuits; geometric optics; wave optics; modern physics. Calculus-based. One and one-quarter units.

**Physics 221 — Methods of Physics** *Fall*
Mathematical techniques needed for the study of physics at the intermediate and advanced level. Ordinary differential equations; vector calculus; partial differential equations; matrices; Fourier series; and complex variables. One unit.

**Physics 223 — Modern Physics** *Fall*
Special relativity; the particle aspects of electromagnetic radiation; the wave aspects of material particles; atomic structure; nuclear structure and reactions; elementary particles. One unit.

**Physics 225 — Modern Physics Laboratory*** *Fall*
Millikan oil-drop experiment; gamma-ray spectroscopy and absorption; the Franck-Hertz experiment; measurements of e/m for the electron, Planck's constant, the hydrogen Balmer lines, the speed of light, and the Cavendish experiment. Taken concurrently with Physics 223. Overload. One unit.

**Physics 231 — Optics** *Alternate years in spring*
Fermat's Principle; laws of reflection and refraction; image-forming properties of mirrors and lenses; analysis of optical systems; interference; diffraction; thin films; polarization; scattering of light; optical spectra; lasers and holography. One unit.

**Physics 233 — Optics Laboratory*** *Alternate years in spring*
Image formation by lens systems; spherical and chromatic aberrations; determination of refractive index, optical activity; diffraction and interference of light waves; spectrometer and polarimeter; lasers, holography and optical fibers. Taken concurrently with Physics 231. Overload. One unit.

**Physics 234 — Electronics** *Alternate years in spring*
Kirchhoff's laws applied to DC and AC network analysis; the physics of semiconductors; properties of diodes and transistors; circuit applications including rectifiers, regulators, amplifiers, and oscillators; principles

of feedback systems; operational amplifier circuits. One unit.

**Physics 236 — Electronics Laboratory*** *Alternate years in spring*
AC and DC circuits; low- and high-pass filters; diode characteristics; rectifiers; transistor characteristics; multiple stage amplifiers with feedback; oscillators; operational amplifiers; TTL integrated circuits. Taken concurrently with Physics 234. Overload. One unit.

**Physics 342 — Classical Mechanics 1** *Spring*
Motion of a particle in one dimension, including the damped, forced harmonic oscillator; vector analysis; motion of a particle in two or three dimensions, including motion under a central force; motion of a system of particles, including the two-body problem and coupled harmonic oscillators; rotation about an axis; introduction to Lagrangian dynamics. One unit.

**Physics 343 — Classical Mechanics 2** *Alternate years*
Rigid bodies; statics; moving coordinate systems; mechanics of continuous media; generalized coordinates and constraints; relativistic dynamics. Prerequisite: Physics 342. One unit.

**Physics 344 — Thermal Physics** *Fall*
The laws of thermodynamics applied to various systems in equilibrium, including gases, magnetic materials, and solids; the concepts of temperature, heat, work, entropy, and the thermodynamic potential; reversible and irreversible processes. One unit.

**Physics 351 — Electromagnetic Theory** *Spring*
The electrostatic field and potential; divergence and curl of E-field; work and energy in electrostatics; special techniques for calculating potentials; E-fields in matter; the Lorentz force and Biot-Savart law; divergence and curl of B-field; magnetic vector potential; magnetostatic fields in matter; EMF and Faraday's law; Maxwell's equations. One unit.

**Physics 353 — Quantum Mechanics 1** *Fall*
The formalism of quantum mechanics; solutions of the one-dimensional Schrödinger equation including the infinite square well, the harmonic oscillator, and the finite well/barrier; solutions of the three-dimensional Schrödinger equation; the hydrogen atom; angular momentum and spin. Prerequisite: Physics 223. One unit.

**Physics 354 — Quantum Mechanics 2** *Alternate years*
Time-independent perturbation theory and applications including the fine structure of hydrogen, Zeeman effect, and Stark effect; the variational method; the WKB approximation; time-dependent perturbation theory and the emission/absorption of radiation; the adiabatic approximation; three-dimensional scattering with partial wave analysis. Prerequisite: Physics 353. One unit.

**Physics 355 — Introduction to Astrophysics** *Alternate years*
Celestial mechanics; spectra; solar physics; equations of stellar structure; thermonuclear reactions; stars and stellar systems; polytropes; stellar evolution; white dwarfs, neutron stars, and black holes; Milky Way galaxy; Hubble's law; active galactic nuclei; big-bang model. Prerequisite: Physics 223. One unit.

**Physics 356 — Experimental Solid State Physics** *Alternate years*
Crystal structure; free-electron energy bands; semiconductors and metals; superconductivity; magnetic materials. Experiments include X-ray diffraction, optical spectroscopy, Mössbauer spectrometry, and resonance methods. Prerequisite: Physics 353. One unit.

**Physics 461, 462 — Independent Study** *Fall, spring*
One unit each semester.

**Physics 471, 472 — Undergraduate Research** *Fall, spring*
Supervised research in theory or experiment. One unit each semester.

**Each of these laboratory courses is taken as a fifth course and, as such, is figured in the GPA, but does not count toward the 32 courses required for graduation.*