Physics (PHY)

Courses

PHY 005 Concepts In Physics 4 Credits
Fundamental discoveries and concepts of physics and their relevance to current issues and modern technology. For students not intending to major in science or engineering. Lectures, demonstrations, group activities, and laboratories using modern instrumentation and computers. This is a non-calculus course; no previous background in physics is assumed. Three class meetings and one laboratory period per week.
Attribute/Distribution: NS

PHY 009 Introductory Physics I Completion 0-2 Credits
For students who have Advanced Placement or transfer credit for 2 or 3 credits of PHY 11. The student will be scheduled for the appropriate part of PHY 11 to complete the missing material. The subject matter and credit hours will be determined by the Physics Department for each student. Students with AP Physics C credit for mechanics will take the thermodynamics and kinetic theory part of PHY 11 for one credit. Consent of department required.
Prerequisites: MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075
Can be taken Concurrently: MATH 021, MATH 031, MATH 051, MATH 076, MATH 075
Attribute/Distribution: NS

PHY 010 General Physics I 0,4 Credits
Statics, dynamics, conservation laws, thermodynamics, kinetic theory of gases, fluids. Primarily for architecture, biological science, earth and environmental science students.
Prerequisites: MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075
Can be taken Concurrently: MATH 021, MATH 031, MATH 051, MATH 076, MATH 075
Attribute/Distribution: NS

PHY 011 Introductory Physics I 0,4 Credits
Kinematics, frames of reference, laws of motion in Newtonian theory and in special relativity, conservation laws, as applied to the mechanics of mass points; temperature, heat and the laws of thermodynamics; kinetic theory of gases. Two lectures and two recitations per week.
Prerequisites: MATH 021 or MATH 031 or MATH 051 or MATH 076 or MATH 075
Can be taken Concurrently: MATH 021, MATH 031, MATH 051, MATH 076, MATH 075
Attribute/Distribution: NS

PHY 012 Introductory Physics Laboratory I 1 Credit
A laboratory course taken concurrently with PHY 10 or 11. Experiments in mechanics, heat, and DC electrical circuits. One three-hour laboratory period per week.
Prerequisites: PHY 010 or PHY 011
Can be taken Concurrently: PHY 010, PHY 011
Attribute/Distribution: NS

PHY 013 General Physics II 0,3 Credits
A continuation of PHY 10, primarily for biological science and earth and environmental science students. Electrostatics, electromagnetism, light, sound, atomic physics, nuclear physics, and radioactivity.
Prerequisites: (PHY 010 or PHY 011) and (MATH 021 or MATH 031 or MATH 051)
Can be taken Concurrently: MATH 021, MATH 031, MATH 051
Attribute/Distribution: NS

PHY 019 Introductory Physics II Completion 0-2 Credits
For students who have Advanced Placement or transfer credit for 2 or 3 credits of PHY 21. The student will be scheduled for the appropriate part of PHY 21 to complete the missing material. The subject matter and credit hours will be determined by the Physics Department for each student. Students with AP Physics C credit for electricity and magnetism will take the optics and modern physics part of PHY 21 for one credit. Consent of instructor required.
Prerequisites: (PHY 010 or PHY 011) and (MATH 022 or MATH 032 or MATH 052)
Attribute/Distribution: NS

PHY 021 Introductory Physics II 0,4 Credits
A continuation of PHY 11. Electrostatics and magnetostatics; DC circuits; Maxwell's equations; waves; physical and geometrical optics; introduction to modern physics. Two lectures and two recitations per week.
Prerequisites: (PHY 010 or PHY 011) and (MATH 022 or MATH 032 or MATH 052)
Attribute/Distribution: NS

PHY 022 Introductory Physics Laboratory II 1 Credit
A laboratory course to be taken concurrently with PHY 13 or 21. One three-hour laboratory period per week.
Prerequisites: (PHY 012) and (PHY 021 or PHY 013)
Can be taken Concurrently: PHY 021, PHY 013
Attribute/Distribution: NS

PHY 031 Introduction to Modern Physics 3 Credits
Experimental basis and historical development of special relativity and quantum mechanics; the Schroedinger equation; one-dimensional problems; angular momentum and the hydrogen atom; many-electron systems; spectra; selected applications.
Prerequisites: PHY 013 or PHY 021
Attribute/Distribution: NS

PHY 091 Special Topics In Physics 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

PHY 120 Physics of Medical Imaging: Ultrasound and Radiography 2 Credits
An introduction and analysis of the physical principles and effects that underlay medical imaging techniques such as those using ultrasound, x-rays or other high-energy radiation. The course will serve as an introduction to intermediate quantum physics and electromagnetism concepts and discuss the effects and data collection techniques that ultimately allow to create an image that a physician can interpret for clinical purposes.
Prerequisites: PHY 021 or PHY 013
Attribute/Distribution: NS

PHY 121 Physics of Medical Imaging: Ultrasound and Radiography, Supplement 1 Credit
A supplementary course taken concurrently with PHY 120 [Physics of Medical Imaging: Ultrasound and Radiography]. Themes pertaining ultrasound and radiography will be covered more in depth, like for example: SPECT- and PET-scans, Beam forming and phased arrays, Dosimetry, Image formation (Radon transform and projection slice theorem).
Prerequisites: PHY 021 or PHY 013
Corequisites: PHY 120
Attribute/Distribution: NS

PHY 122 Physics of Medical Imaging: Magnetic Resonance 2 Credits
An introduction and analysis of the physical principles and effects that underlay medical imaging techniques based on nuclear magnetic resonance, such as MRI (Magnetic Resonance Imaging). The course will serve as an introduction to intermediate/advanced quantum physics and electromagnetism concepts and discuss the effects and data collection techniques that ultimately allow to create an image that a physician can interpret for clinical purposes.
Prerequisites: PHY 021 or PHY 013
Attribute/Distribution: NS

PHY 123 Physics of Medical Imaging: Magnetic Resonance, Supplement 1 Credit
A supplementary course taken concurrently with PHY 122 [Physics of Medical Imaging: Magnetic Resonance]. Themes pertaining magnetic resonance will be covered more in depth, like for example: Fourier analysis in spectroscopy, Advanced techniques in magnetic resonance (fMRI, DTI, mMRI, …).
Prerequisites: PHY 021 or PHY 013
Corequisites: PHY 122
Attribute/Distribution: NS

PHY 142 Special Relativity 3 Credits
A development of the special theory of relativity at an introductory/intermediate level. Starting from the equivalence between inertial reference frames, the course will introduce the Lorentz transformations, space and time in different reference frames, the new relativistic versions of kinematics and mechanics, and the relationship between relativity and electromagnetism. Topics include momentum and energy, four-vectors, acceleration and forces, the relativistic version of Newton's second law, zero-mass particles, and the relation between electric and magnetic fields.
Prerequisites: PHY 013 or PHY 021
Attribute/Distribution: NS

PHY 191 Special Topics In Physics 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

PHY 212 Electricity and Magnetism I 3 Credits
Electrostatics, magnetostatics, and electromagnetic induction.
Prerequisites: (PHY 021 or PHY 013) and MATH 205
Can be taken Concurrently: MATH 205
Attribute/Distribution: NS

PHY 213 Electricity and Magnetism II 3 Credits
Maxwell's equations, Poynting's theorem, potentials, the wave equation, waves in vacuum and in materials, transmission and reflection at boundaries, guided waves, dispersion, electromagnetic field of moving charges, radiation, Lorentz invariance and other symmetries of Maxwell's equations.
Prerequisites: PHY 212
Attribute/Distribution: NS

PHY 215 Classical Mechanics I 4 Credits
Kinematics and dynamics of point masses with various force laws; conservation laws; systems of particles; rotating coordinate systems; rigid body motions; topics from Lagrange's and Hamilton's formulations of mechanics; continuum mechanics.
Prerequisites: (PHY 021 or PHY 013) and MATH 205
Can be taken Concurrently: MATH 205
Attribute/Distribution: NS

PHY 220 Advanced Physics Laboratory I 3 Credits
In a lab/lecture format, students learn basic elements needed for experimental, observational and computational work in physics, astrophysics and other technical areas. This course and its continuation as PHY 221 include topics such as electronics, optics, vacuum systems, data acquisition and analysis, curve fitting, scientific computing, interfacing of computers to experiments, and modern machining. These methods will be utilized in the examination of various physical systems; e.g., atomic and molecular spectroscopy, astronomical observations, condensed-matter phenomena, and others.
Prerequisites: PHY 021 and (PHY 022 or CSE 003 or CSE 007)
Attribute/Distribution: NS

PHY 221 Advanced Physics Laboratory II 2 Credits
This is a continuation of PHY 220.
Prerequisites: PHY 021 and PHY 022 and PHY 220
Attribute/Distribution: NS

PHY 273 Research 2-3 Credits
Participation in current research projects being carried out within the department.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

PHY 291 Special Topics In Physics 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

PHY 300 Apprentice Teaching 1-4 Credits

PHY 332 (ASTR 332) High-Energy Astrophysics 3 Credits
Observation and theory of X-ray and gamma-ray sources, quasars, pulsars, radio galaxies, neutron stars, black holes. Results from ultraviolet, X-ray and gamma-ray satellites. Generally offered in the spring of odd-numbered years.
Prerequisites: (PHY 021) and (MATH 023 or MATH 033) and PHY 031 and PHY 215
Can be taken Concurrently: MATH 023, MATH 033
Attribute/Distribution: NS

PHY 340 Thermal Physics 3 Credits
Basic principles of thermodynamics, kinetic theory, and statistical mechanics, with emphasis on applications to classical and quantum mechanical physical systems.
Prerequisites: (PHY 013 or PHY 021) and (MATH 023 or MATH 032 or MATH 052)
Attribute/Distribution: NS

PHY 342 (ASTR 342) General Relativity 3 Credits
An introduction to Einstein's theory of general relativity. Topics covered: the geometry of spacetime; curvature and the gravitational field equations; the Schwarzschild and Kerr black holes and more general spacetime geometries; black hole thermodynamics; gravitational waves; the Friedmann–Robertson–Walker geometry and inflationary cosmology; dark energy and the cosmological constant problem.
Prerequisites: (PHY 021) and (MATH 023 or MATH 033) and PHY 215
Can be taken Concurrently: MATH 023, MATH 033, PHY 215
Attribute/Distribution: NS

PHY 348 Plasma Physics 3 Credits
Single particle behavior in electric and magnetic fields, plasmas as fluids, waves in plasmas, transport properties, kinetic theory of plasmas, controlled thermonuclear fusion devices. Must have senior standing or consent of the department chair.
Prerequisites: PHY 021 and MATH 205
Attribute/Distribution: NS

PHY 352 Modern Optics 3 Credits
Paraxial optics, wave and vectorial theory of light, coherence and interference, diffraction, crystal optics, and lasers.
Prerequisites: MATH 205 and (PHY 213 or ECE 203)
Can be taken Concurrently: PHY 213, ECE 203
Attribute/Distribution: NS

PHY 355 Nonlinear Optics 3 Credits
This course will introduce the fundamental principles of nonlinear optics. Topics include nonlinear interaction of optical radiation with matter, multi-photon interactions, electro-optics, self and cross phase modulation, and the nonlinear optical susceptibilities that describe all these effects in the mainframe of electromagnetic theory.
Prerequisites: PHY 031 and (PHY 213 or ECE 203)
Can be taken Concurrently: PHY 213, ECE 203
Attribute/Distribution: NS

PHY 362 Quantum Mechanics I 3 Credits
Principles and basic applications of quantum mechanics. The Schrödinger equation and one-dimensional problems. Observables as operators; eigenfunctions and eigenvalues. Angular momentum, central potentials, the hydrogen atom, and spin. Addition of angular momentum. Exchange symmetry, Pauli principle, and multi-electron atoms. Selected applications to atoms and molecules, solids, quantum technologies, nuclei, and elementary particles.
Prerequisites: (PHY 031 or CHM 341) and MATH 205
Attribute/Distribution: NS

PHY 363 Physics of Solids 3 Credits
Introduction to the theory of solids with particular reference to the physics of metals and semiconductors.
Prerequisites: (PHY 031 or MAT 316 or CHM 341) and PHY 340
Can be taken Concurrently: PHY 340
Attribute/Distribution: NS

PHY 364 Nuclear and Elementary Particle Physics 3 Credits
Models, properties, and classification of nuclei and elementary particles; nuclear and elementary particle reactions and decays; radiation and particle detectors; accelerators; applications.
Prerequisites: PHY 031 and MATH 205 and PHY 362
Attribute/Distribution: NS

PHY 365 Physics Of Fluids 3 Credits
Concepts of fluid dynamics; continuum and molecular approaches; waves, shocks and nozzle flows; nature of turbulence; experimental methods of study.
Prerequisites: (PHY 212 or ECE 202) and (PHY 340 or ME 104)
Can be taken Concurrently: PHY 212, ECE 202, PHY 340, ME 104
Attribute/Distribution: NS

PHY 366 Introduction to String Theory 3 Credits
Introduction to string theory for upper-level undergraduates and beginning graduate students. Building on Einstein's theory of general relativity and quantum theory, this course covers the fundamentals of string theory and the latest developments. Advanced topics such as D-branes, non-perturbative dualities and holography will also be covered. The course content is appropriate to students who have a working knowledge of quantum mechanics and special relativity, and have had some exposure to general relativity. Instructor permission required in lieu of Phy 362/369.
Prerequisites: PHY 031 and PHY 215 and (PHY 362 or PHY 369)
Can be taken Concurrently: PHY 369
Attribute/Distribution: NS

PHY 369 Quantum Mechanics II 3 Credits
Applications of quantum mechanics to more complex problems. Bose and Fermi statistics of identical particles. Perturbation theory and applications to atomic structure. Variational method, WKB approximation, and scattering theory. Time-dependent perturbation theory and Fermi's golden rule. Selection of special topics.
Prerequisites: PHY 031 and MATH 205 and PHY 215 and PHY 362
Attribute/Distribution: NS

PHY 380 Introduction to Computational Physics 3 Credits
Introduction to computational modeling of physical systems. Methods for systems of particles and fields with examples drawn from mechanics, chemical kinetics, planetary motion, chaotic dynamics, normal modes and waves, random walks, electrodynamics, biological, thermal and quantum systems. Converting models into well-documented code organized into manageable tasks. Extracting physical insight. Choice of numerical methods considering accuracy, speed, stability, and conservation laws.
Prerequisites: MATH 205
Can be taken Concurrently: MATH 205
Attribute/Distribution: NS

PHY 382 Physics of Cells 3 Credits
This course focuses on the physical principles underlying the organization of living cells, which spans several orders of magnitude in length and time. It provides an introduction to biological physics and relevant concepts of soft-matter physics. Topics include: self-organization of filaments and motor proteins of the cytoskeleton that determine cell shape and motion; the plasma membrane as a fluid responsive to environmental and biochemical signals; biological waves and pattern formation; mathematical modeling of biological systems; experimental methods and image analysis.
Prerequisites: (PHY 010 or PHY 011) and (PHY 013 or PHY 021)
Attribute/Distribution: NS

PHY 389 Honors Project 1-8 Credits
Repeat Status: Course may be repeated.

PHY 391 Special Topics In Physics 1-3 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

PHY 420 Mechanics 3 Credits
Includes the variational methods of classical mechanics, methods of Hamilton and Lagrange, canonical transformations, Hamilton-Jacobi Theory.

PHY 421 Electricity & Magnetism I 3 Credits
Electrostatics, magnetostatics, Maxwell's equations, dynamics of charged particles, multipole fields.

PHY 422 Electricity & Magnetism II 3 Credits
Electrodynamics, electromagnetic radiation, physical optics, electrodynamics in anisotropic media. Special theory of relativity.
Prerequisites: PHY 421

PHY 423 Quantum Mechanics I 3 Credits
The first course in a two-course sequence on quantum mechanics for graduate students. This course covers the fundamentals of quantum mechanics and quantum dynamics. Topics include matrix mechanics, wave mechanics, and the Dirac formulation; unitary time evolution in the Schrödinger and Heisenberg pictures; exactly solvable problems, such as the harmonic oscillator and the hydrogen atom; theory of angular momentum and addition of angular momentum; and time-independent approximation methods.

PHY 424 Quantum Mechanics II 3 Credits
The second course in a two-course sequence on quantum mechanics for graduate students. Topics include time-dependent approximation methods and the interaction picture, scattering theory, density matrices and entanglement, and a selection of advanced topics.
Prerequisites: PHY 423

PHY 425 Quantum Mechanics III 3 Credits
A continuation of Phys 424. Relativistic quantum theory of the electron; theory of radiation.
Prerequisites: PHY 424

PHY 428 Methods of Mathematical Physics I 3 Credits
Analytical and numerical methods of solving the ordinary and partial differential equations that occur in physics and engineering. Includes treatments of complex variables, special functions, product solutions and integral transforms.

PHY 431 Theory Of Solids 3 Credits
Advanced topics in the theory of the electronic structure of solids. Many-electron theory. Theory of transport phenomena. Magnetic properties, optical properties. Superconductivity. Point imperfections.
Prerequisites: PHY 363 and PHY 424

PHY 442 Statistical Mechanics 3 Credits
General principles of statistical mechanics with application to thermodynamics and the equilibrium properties of matter.
Prerequisites: PHY 340 and PHY 369

PHY 443 Nonequilibrium Statistical Mechanics 3 Credits
A continuation of PHY 442. Applications of kinetic theory and statistical mechanics to nonequilibrium processes; nonequilibrium thermodynamics.
Prerequisites: PHY 442

PHY 446 Atomic and Molecular Physics 3 Credits
Advanced topics in the experimental and theoretical study of atomic and molecular structure. Topics include fine and hyperfine structure, Zeeman effect, interaction of light with matter, multi-electron atoms, molecular spectroscopy, spectral line broadening atom-atom and electron-atom collisions and modern experimental techniques.
Prerequisites: PHY 424

PHY 455 Physics of Nonlinear Phenomena 3 Credits
Basic concepts, theoretical methods of analysis and experimental development in nonlinear phenomena and chaos. Topics include nonlinear dynamics, including period-multiplying routes to chaos and strange attractors, fractal geometry and devil's staircase. Examples of both dissipative and conservative systems will be drawn from fluid flows, plasmas, nonlinear optics, mechanics and waves in disordered media. Must have graduate standing in science or engineering, or consent of the chairman of the department.

PHY 462 Theories of Elementary Particle Interactions 3 Credits
Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles.
Prerequisites: PHY 425

PHY 472 Special Topics In Physics 1-3 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.

PHY 474 Seminar In Modern Physics 3 Credits
Discussion of important advances in experimental physics.
Repeat Status: Course may be repeated.

PHY 475 Seminar In Modern Physics 3 Credits
Discussion of important advances in theoretical physics.
Repeat Status: Course may be repeated.

PHY 490 Thesis 1-6 Credits

PHY 491 Research 3 Credits
Research problems in experimental or theoretical physics.

PHY 492 Research 3 Credits
Continuation of PHY 491.
Repeat Status: Course may be repeated.

PHY 499 Dissertation 1-15 Credits
Repeat Status: Course may be repeated.