Physics (PHYS)

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5010. Independent Study

Variable (1-6) credits. Prerequisite: Instructor consent. May be repeated with a change of topic up to three times for a total of nine credits. Students taking this course will be assigned a final grade of S (satisfactory) or U (unsatisfactory).

A special reading course.

5020. Research in Physics

Variable (1-6) credits. Prerequisite: Instructor consent. May be repeated with a change of topic up to three times for a total of nine credits.

Experimental and theoretical research in selected topics in physics.

5050. Modern Physics for Teachers

Three credits.

New teaching materials and techniques as developed by the Physical Science Study Committee for secondary school teachers of physics.

5094. Physics Seminar

One credit. Prerequisite: Instructor consent. Students taking this course will be assigned a final grade of S (satisfactory) or U (unsatisfactory).

The treatment of special topics, primarily by individual readings and reports.

5101. Methods of Theoretical Physics I

Three credits.

Vector and tensor analysis, curvilinear coordinates, linear algebra, functions of complex variables, differential equations, special functions, elements of Green's functions.

5102. Methods of Theoretical Physics II

Three credits. Prerequisite: PHYS 5101.

Abstract vector spaces, Hilbert space, group theory. Fourier series and integral representations, Theory of Green's functions and integral equations. Complex function theory.

5201. Theoretical Mechanics I

Three credits.

Classical mechanics: Lagrange equations, central force motion, rigid body motions, small oscillations, Hamilton equations, canonical transformation.

5301. Electrodynamics I

Three credits. Prerequisite: PHYS 5101.

Differential formulations of electrostatics and magnetostatics, electromagnetic induction. Maxwell equations, electromagnetic waves, application to wave guides, cavities, and dispersive media. Foundations of special relativity.

5302. Electrodynamics II

Three credits. Prerequisite: PHYS 5201 and 5301.

Maxwell's equations with time dependent sources; radiation from relativistic charged particles; dynamical laws for charged particles; diffraction of electromagnetic waves.

5350. Computerized Modeling in Science

Four credits. Prerequisite: Instructor consent.

Development and computer-assisted analysis of mathematical models in chemistry, physics, and engineering. Typical topics include chemical equilibrium, reaction rates, particle scattering, vibrating systems, least square analysis and quantum chemistry.

5401. Quantum Mechanics I

Three credits. Prerequisite: PHYS 5101 and 5201.

Mathematical formulation and interpretation of quantum mechanics. Illustrative examples. Hydrogen atom. Dirac ket and bra vectors, matrix methods. Scattering theory.

5402. Quantum Mechanics II

Three credits. Prerequisite: PHYS 5401.

Symmetry and angular momentum. Approximation methods for stationary and time-dependent problems, with applications. Relativistic theory of the electron.

5403. Quantum Mechanics III

Three credits. Prerequisite: PHYS 5402.

Occupation number representation, electron gas, Hartree-Fock approximation, correlation energy, superconductivity, perturbation theory, Green's functions, Feynman diagrams.

5500. Statistical Mechanics

Three credits. Prerequisite: PHYS 5401.

Ensembles, distribution function, partition function. Bose-Einstein and Fermi-Dirac distributions, fluctuations, applications to the properties of solids and liquids and to the kinetic theory of gases.

5621. Advanced Topics in Physics I

Variable (1-6) credits. Prerequisite: Instructor consent. May be repeated for credit.

Selected topics in theoretical and experimental physics.

5622. Advanced Topics in Physics II

Variable (1-3) credits. Prerequisite: PHYS 5621; instructor consent required. May be repeated for a maximum of 12 credits.

Selected topics in theoretical and experimental physics.

6110. Atomic Physics

Three credits. Prerequisite: PHYS 5402.

Coupling of angular momenta. Hartree-Fock theory of many electron atoms, fine structure and hyperfine structure. Introduction to group theory.

6120. Molecular Physics

Three credits. Prerequisite: PHYS 6110.

Heitler-London and molecular orbital theories for diatomic molecules, semi-empirical methods of poly-atomic molecules.

6130. Quantum Optics

Three credits. Prerequisite: PHYS 5401.

Semiclassical theory of light-matter interactions. Quantum states of light. Generation, detection and interactions of nonclassical radiation.

6140. Principles of Lasers

Three credits.

The physics of lasers, including optical pumping and stimulated emission, laser rate equations, optical resonators, non-linear optics, the Kerr effect and Faraday rotation. Applications to gas, crystal, glass, liquid, dye, semiconductor, chemical and ultraviolet lasers, Q-switching, mode-locking, and parametric devices.

6150. Semiconductor Optical Devices

Three credits. Prerequisite: PHYS 6201.

Semiconductor based optical devices such as lasers, amplifiers, modulators, and photodetectors, and their application to optical fiber transmission systems.

6201. Fundamentals of Solid State Physics I

Three credits.

Crystal structure, phonons, electronic band structure, metals, insulators and semiconductors.

6211. Condensed Matter Physics I

Three credits. Prerequisite: PHYS 5402.

Crystal structure; lattice vibrations; electronic band structure of solids; transport theory; basic properties of metals, semi-conductors and insulators; magnetism; super-conductivity.

6212. Condensed Matter Physics II

Three credits. Prerequisite: PHYS 6211.

Crystal structure; lattice vibrations; electronic band structure of solids; transport theory; basic properties of metals, semi-conductors and insulators; magnetism; super-conductivity.

6244. The Electrical Properties of Polymers

Three credits.

Experimental and theoretical aspects of electrical phenomena in polymers: DC and AC conductivity, dielectric constant, electrical breakdown, photoconductivity, etc. Extended and localized electron wave functions; band and hopping conduction.

6247. Nuclear Magnetic Resonance II

Three credits. Prerequisite: PHYS 6246.

Basic theory and experimental methods of NMR with emphasis on resonance and relaxation in metals. Brief discussion of interpretation of NMR in non-metallic solids, liquids, and gases.

6264. Semiconductor Physics

Three credits. Prerequisite: PHYS 6201 and 5402, which may be taken concurrently.

Semiconductors and semiconductor devices. Band structure, phonon scattering, velocity-field relations, effects of doping and magnetic fields, optical and transport properties.

6310. Relativity

Three credits.

Special relativity, tensor analysis, foundations of general relativity, Petrov classification of curved spacetimes, Schwarzchild and Kerr solutions, experimental tests and recent developments.

6320. Nuclei and Particles

Three credits.

Properties of nuclei and particles, conserved quantities, isospin, quark model, Fermi gas model, electroweak interaction, high energy scattering.

6331. Nuclear Physics I

Three credits. Prerequisite: PHYS 5402.

A quantum mechanical treatment of nuclear forces and nuclear structure, including the shell and collective models, and of reaction and radiation phenomena. The second semester is reserved for a discussion of selected topics on an advanced level.

6332. Nuclear Physics II

Three credits. Prerequisite: PHYS 6331.

A quantum mechanical treatment of nuclear forces and nuclear structure, including the shell and collective models, and of reaction and radiation phenomena. The second semester is reserved for a discussion of selected topics on an advanced level.

6341. Quantum Theory of Fields I

Three credits. Prerequisite: PHYS 5403.

Local gauge invariance, Lagranian formulation, Noether currents, spontaneous breakdown of symmetry, Higgs mechanism and superconductivity, canonical quantization, Feynman diagrams, Green's functions.

6342. Quantum Theory of Fields II

Three credits. Prerequisite: PHYS 6341.

Topics chosen from the following: Path integral formalism, generating functionals, renormalization, abelian and non-abelian gauge theories (QED and QCD), electroweak theory, solitons, instantons.

6710. Stars and Compact Objects

Three credits. Not open for credit to students who have passed PHYS 4710.

The structure and evolution of stars. Gravitational collapse, hydrostatic equilibrium, novae and shocks, and compact objects with degenerate matter.

6720. Galaxies and the Interstellar Medium

Three credits. Recommended preparation: proficiency in calculus. May be taught with PHYS 4720. Not open for credit to students who have passed PHYS 4720.

Galaxy formation and evolution in the hierarchical expanding Universe. Properties of the interstellar medium, including star formation and radiative transfer; stellar populations, structure, kinematics and dynamics of galaxies.

6730. General Relativity and Cosmology

(Formerly offered as PHYS 6300.) Three credits. Not open for credit to students who have passed PHYS 4730.

Gravity and the problem of motion from the ancient Greeks to Newton to Einstein. Special relativity. General relativity. Curvature. Classic tests of general relativity. Gravitational waves. Black holes. Newtonian cosmology. Big Bang theory. Inflation. Dark matter. Dark energy. Accelerating universe.

6740. Observational Astrophysics

Three credits. Prerequisite: Open to Physics graduate students; others by permission. Not open for credit to students who have passed PHYS 4740.

Basic principles and techniques of observational astrophysics, from radio to optical wavelengths. Telescopes, detectors, and instrumentation, and the statistical techniques for astronomical data analysis and interpretation. Students will complete short research projects using real astronomical data.