PHYC 260 Introduction to Modern Physics

Course Description

Basic concepts, underlying principles, theories, and applications of modern physics. Topics include special relativity, quantum physics, atomic structure and models, molecules, solids, nanomaterials, nuclei, particles, statistical mechanics, astrophysics and cosmology. Applications include lasers, scanning tunneling microscopes, semiconductor devices, nanoelectronics, nuclear power reactors and accelerators. (3 credit hours)

Prerequisite: PHYC 122.

Course Objectives

The introductory modern physics course will provide opportunity to learn about principles and theories of modern physics. Upon completion of this course the student will be able to utilize concepts of relativity, atomic, molecular and nuclear structure, quantum theory and theory of solids to other higher level courses in physics, engineering and related fields.

Course Rationale

This introductory modern physics course is offered for the sophomore-level physics and chemistry majors and minors. It is a one-semester, four credit hour course. It provides a rapid overview of quantum physics, atomic models and structures, molecular, solid state, nuclear, particle and statistical mechanics. This course is a foundation for other upper level physics courses such as modern lab (Phyc-262), classical mechanics (Phyc-330), electricity and magnetism (Phyc-450), Introduction to Nanoscience and Technology (Aphy-310), Condensed Matter Physics (Phyc-466), and thermodynamics (Phyc-434). The problem solving and critical thinking skills developed in this introductory course are necessary for success in the advanced level physics courses.

This introductory modern physics course is a foundation course for physicists, chemists, engineers, high school physical science teachers and computer scientists.

Course Content, Format, and Bibliography

Content

Relativity: Classical relativity, Einstein's postulates, the Lorentz and velocity transformations, the twin paradox, the Doppler effect, and relativistic energy and momentum.

The Origin of Quantum Theory: Blackbody radiation, photoelectric effect, Compton scattering, x-rays, Bohr model.

Quantum Mechanics: de Broglie hypothesis, electron wave functions, electron wave packets, uncertainty principle, wave-particle duality, Schrödinger equation, probabilities, normalization, a particle in a box, Schrödinger equation for two and three dimensions, and simple harmonic oscillator.

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Atoms: Basic properties of atoms, atomic models of Thomson, Rutherford and Bohr, optical and X-ray spectra, quantum theory of hydrogen atom, hydrogen atom wave functions and atomic quantum numbers, angular momentum, magnetic moments, electron spin, many-electron atoms and the periodic table.

Molecular Structure: Molecular bonding, energy levels and spectra of polyatomic molecules.

Solids: The structure of solids, band theory of solids, classical and quantum theory of electrons, semiconductors, nanoparticles, semiconductor junctions and devices, and superconductors.

Nuclear Reactions and Applications: Properties of nuclei, types of nuclear reactions, radioactivity, fission, fusion and nuclear reactors.

Elementary Particles: The four basic forces, particles and antiparticles, families of particles, conservation laws, particle interactions and decays, and the quark model.

Statistical Mechanics: Classical versus quantum statistics, the Maxwell-Boltzmann distribution, Bose-Einstein and Fermi-Dirac statistics.

Astrophysics and Cosmology: The stars, the evolution of stars, galaxies, gravitation and cosmology.

Format

Homework, Examinations, and Presentations

Bibliography

Modern Physics for Scientists and Engineers by Stephen T. Thornton and Andrew Rex, 4th Edition, 2006.

Modern Physics by Kenneth Krane, 2nd Edition, 1996.

Elementary Modern Physics by Paul A. Tipler, 1996.