PHY-201 Modern Physics

Credit Hours: 3-0

Pre-requisite: None

Course Objectives:

It is an undergraduate physics core course, which aims to introduce students to the basic concepts underlying the advent of Modern Physics. The course begins with relativity and ends at qualitative treatment of hydrogen atom. The course explains various quantization phenomena in electricity, light and energy and the atomic model and particle waves without extensive mathematics. The course introduces the concept of the Schrodinger equation and its solutions in various potentials qualitatively.

Core Contents: Basics of modern physics like relativistic concepts of Einstein, quantization, uncertainty and qualitative analysis of basic problems like one-dimensional box, simple harmonic motion and hydrogen atom.

Detailed Course Contents: Relativity, consequences of Einstein's postulates, time dilation and length contraction, Doppler effect, Lorentz transformation, twin paradox, relativistic momentum and energy, J. J. Thomson experiment, quantization of electric charge, blackbody radiation, the photoelectric effect, X-rays and Compton effect, quantization of energy states of matter, empirical spectral formula, Rutherford Scattering, the Bohr model of hydrogen atom, the Frank Hertz experiment, the Wilson-Sommerfeld quantization, the de Broglie relations, measurement of electron wavelength, electron wave packets, the probability interpretation of the wave function, the uncertainty principle, particle-wave duality, the Schrodinger equation in one dimension and its solutions for Infinite and finite square well, qualitative analysis of simple harmonic oscillator, Schrodinger equation for many dimensions and many particles, analysis of hydrogen atom mostly qualitative.

Course Outcomes: At the end of the course, students will have

- knowledge of relativistic effects
- knowledge of how electricity, light and energy are quantized
- knowledge of atomic model based on early quantum mechanics

- understanding of wave nature of particles
- the basic concept Schrodinger wave equation and qualitative analysis of its solutions for various potentials

Textbook: Paul A. Tipler and Ralph A. Llewellyn, Modern Physics, 6thed. W H Freeman and Company 2012. (referred as TL)

Reference Books: Arthur Beiser, Concepts of Modern Physics, 6thed. McGraw-Hill 2002.

Weekly Breakdown		
Week	Section	Topics
1	TL 1.1-1.4	The Michelson-Morley Experiment, consequences of Einstein's postulates, time dilation and length contraction, clock synchronization and Simultaneity
2	TL 1.5-1.9	The Doppler effect, the Lorentz transformation, the twin paradox, relativistic momentum, relativistic energy
3	TL 1.10-1.13	Mass and binding energy, experimental determination of relativistic momentum, introduction to general relativity
4	TL 3.1-3.3	Early estimation of e ande/m, the J. J. Thomson experiment, quantization of electric charge
5	TL 3.5-3.7	Black body radiation, the photoelectric effect, X rays and the Compton effect
6	TL 4.1-4.3	The Nuclear atom: empirical spectral formulas, Rutherford scattering, the Bohr Model of hydrogen atom
7	TL 4.4, 4.5, 4.7	X-Ray spectra, the Frank-Hertz experiment, critique of the Bohr theory and of old quantum mechanics
8	TL 5.1-5.5	Electron waves: the de Broglie relations, measurement of electron wavelengths, properties of classical waves, wave packets, electron wave packets
		Midterm exam
9	TL 5.6-5.9	The probabilistic interpretation of the wave function, the uncertainty principle and some of its consequences, particle wave duality,

10	TL 6.1-6.3	The Schrodinger equation in one dimension, the infinite square well, the finite square well
11	TL 6.6-6.7	Harmonic oscillator: qualitative analysis of Schrodinger equation and comparison with classical oscillator, Transmittance and reflectance of waves
12	TL 6.8-6.9	The Schrodinger equation in three dimensions and that for two or more particles
13	TL 7.1-7.2	The Schrodinger equation in spherical coordinates, quantization of angular momentum and energy in hydrogen atom
14	TL 7.3-7.5	The Hydrogen atom wave functions, electron spin, addition of angular momenta and the spin orbit effect
15	TL 7.6-7.9	Ground states and corresponding energies of atoms in the periodic table by qualitative analysis, the Zeeman effect.