PHY-302 Quantum Mechanics I

Credit Hours: 3-0

Pre-requisite: PHY-312 Methods of Mathematical Physics II

Course Objectives: It is an undergraduate course aims to make students understand basics of quantum mechanics by detailed discussion of the physics of intrinsic spin and Hermitian operators, eigenvalues and eigenstates are introduced. Operators are introduced in position and momentum basis. Application of laws of quantum mechanics to one- and three-dimensional including hydrogen atom are studied.

Core Contents: Basics of quantum mechanics with application to one-, two- and three-dimensional problems

Detailed Course Contents: The original Stern-Gerlach experiment, four experiments, the quantum state vector, analysis of experiment 1 and 2, Matrix mechanics, General Quantum systems, Postulates, Matrix representation of operators, Measurements, Commuting observables, Uncertainty principle, spin-1 system, general quantum system, Schrodinger equation, Spin precession, Time dependent Hamiltonian, Magnetic resonance, Particle in a box, Infinite square well, finite square well, Analysis, superposition states and time dependence, Unbounded states: Free particle states, scattering, tunnelling, Angular momentum: Energy eigen value equation, Angular momentum, spherical coordinates, motion of a particle on a ring and sphere, Hydrogen atom: Radial eigen value equation and its solution, Hydrogen energies and its solutions, Hydrogen atom: The radial wave function, The full hydrogen wave function, Superposition states, Harmonic oscillator: Wave functions, Dirac notation, Harmonic oscillator: Momentum space wave function, the uncertainty principle, time dependence, Raising Lowering operator treatment of Harmonic Oscillator.

Course Outcomes: At the end of the course, students will be able to:

- understand the postulates of quantum mechanics
- solve Schrodinger equation for various quantum systems
- understand angular momentum and its conservation by rotational invariance
- understand quantum mechanical treatment of hydrogen atom and its various energy levels.

Textbook: D. H. McIntyre, Quantum Mechanics, 2nded. Pearson Addison Wesley 2012. (Referred as Mc)

Reference Books:

R. Shankar, Principles of Quantum Mechanics, 2nded. Springer 1994. (referred as RS)

R. Liboff, Introductory Quantum Mechanics, 4thed, Addison-Wesley 2002.

N. Zettili, Quantum Mechanics Concepts and Applications, 3rded, Jon Wiley 2009.

Weekly Breakdown		
Week	Section	Topics
1	Mc 1.1-1.2	The original Stern-Gerlach experiment, four experiments, the quantum state vector, analysis of experiment 1 and 2
2	Mc 1.3-1.5	Matrix mechanics, General Quantum systems, Postulates
3	Mc 2.1-2.3	Matrix representation of operators, Measurements
4	Mc 2.4-2.8	Commuting observables, Uncertainty principle, spin-1 system, general quantum system
5	Mc 3.1-3.2, 3.4-3.4.1	Schrodinger equation, Spin precession, Time dependent Hamiltonian, Magnetic resonance
6	Mc 5.1-5.5	Particle in a box, Infinite square well, finite square well
7	Mc 5.6-5.7	Analysis, superposition states and time dependence
8	Mc 6.1-6.5	Unbounded states: Free particle states, scattering, tunneling
		Midterm Exam
9	Mc 7.1-7.3	Angular momentum: Energy eigen value equation
10	Mc 7.4-7.6	Angular momentum, spherical coordinates, motion of a particle on a ring and sphere
11	Mc 8.1-8.3	Hydrogen atom: Radial eigen value equation and its solution, Hydrogen energies and its solutions .
12	Mc 8.4-8.6	Hydrogen atom: The radial wave function, The full hydrogen wave function, Superposition states
13	Mc 9.1-9.4	Harmonic oscillator: Wave functions, Dirac notation
14	Mc 9.5-9.8	Harmonic oscillator: Momentum space wave function, the uncertainty principle, time dependence
15	RS	Raising Lowering operator treatment of Harmonic Oscillator