PHY-803 Quantum Mechanics

Credit Hours: 3-0

Prerequisite: None

Objectives and Goals: This course will provide a base for many subjects in physics such as

quantum information and computation, quantum optics, condensed matter theory and high energy physics.

Core Contents: Fundamental concepts of quantum theory, quantum dynamics, theory of angular momentum, group theoretic approach, approximation methods

Detailed Course Contents: The Stern-Gerlach experiment; kets, bras, and operators, base kets and matrix representations; measurements, observables, and the uncertainty relations, change of basis; position, momentum and translation, wave functions in position and momentum space; time evolution and the Schrodinger equation, the Schrodinger versus the Heisenberg picture; simple harmonic oscillator, Schrodinger's wave equation; rotations and angular momentum commutation relations, spin ½ systems and finite rotations; SO(3), SU(2), and Euler rotations; eigen values and eigenstates of angular momentum, orbital angular momentum; angular momenta as generators of SU(2), invariant subspaces; addition of angular momentum; time-independent perturbation theory: degenerate and non-degenerate case; hydrogen-like atoms: fine structure and the Zeeman effect; variational methods; time dependent perturbation theory

Course Outcomes: On successful completion of this course, students will know the basic formalism of quantum mechanics, the evolution, and dynamics of quantum systems like harmonic oscillators and hydrogen atom, the concept of angular momentum, associated algebra, and the approximation methods.

Textbook: J. J. Sakurai, Modern Quantum Mechanics, revised ed. Addison-Wesley Publishing Company 1994.

Reference books:

1. R. Shankar, Principles of Quantum Mechanics, 2nd ed. Plenum Press 1994.
2. D. H. McIntyre, Quantum Mechanics: A Paradigms Approach, Pearson 2012.

Weekly Breakdown		
Week	***Section***	***Topics***
1	Sec. 1.1	The Stern-Gerlach Experiment
2	Sec. 1.2-1.3	Kets, Bras, and Operators, Base Kets and Matrix Representations
3	Sec. 1.4-1.5	Measurements, Observables, and the Uncertainty Relations, Change of Basis
4	Sec. 1.6-1.7	Position, Momentum and Translation, Wave Functions in Position and Momentum Space
5	Sec. 2.1-2.2	Time Evolution and the Schrodinger Equation, The Schrodinger versus the Heisenberg Picture
6	Sec. 2.3	Simple Harmonic Oscillator
7	Sec. 2.4	Schrodinger's Wave Equation
8	Sec. 3.1-3.2	Rotations and Angular Momentum Commutation Relations, Spin ½ Systems and Finite Rotations
9	Sec. 3.3, 3.5	SO(3), SU(2), and Euler Rotations
10	Sec. 3.5-3.6	Eigen values and Eigenstates of Angular Momentum, Orbital Angular Momentum.
11	Shankar Chap 12	Angular Momenta as generators of SU(2), Invariant Subspaces.
12	Sec.3.7	Addition of Angular Momentum
13	Sec. 5.1-5.2	Time-Independent Perturbation Theory: Degenerate and Non-degenerate case
14	Sec. 5.3-5.4	Hydrogen-like Atoms: Fine Structure and the Zeeman Effect; Variational Methods (optional)
15	Sec. 5.6	Time Dependent Perturbation Theory