Quantum Mechanics-II

Programme: M.Sc. (Physics) | Year: 1st year | Semester : 2nd semester
Course : Core Course | Credits : 4 | Hours (LTP): 40+12+0

Course Context and Overview:
The Quantum Mechanics-2 course is intended to take forward the students' understanding of the topics covered in Quantum Mechanics-1 in the previous semester, as well as add further knowledge on the mathematical tools involved in Quantum Mechanics. It covers advanced topics regarding wave functions, ket spaces, perturbation theory and angular momentum, and provides an overview of microscopic systems of identical particles and scattering theory. Relativistic quantum mechanics and the sem-classical theory of radiation are also introduced.

Prerequisite Courses: Quantum Physics-I, Mathematical Physics

Course outcomes(COs):

On completion of this course
CO1: The students will understand the methods of angular momentum algebra, including eigenstates and addition of angular momenta, and will learn the technique of time-dependent perturbation theory. They will learn about wavefunction representations and equations of motion.
CO2: Students will get familiar with identical particle systems, the concepts of bosons and fermions, the symmetry of wavefunctions, and second quantization.
CO3: Students will learn the techniques of particle scattering theory and scattering cross-section calculations.
CO4: Students will understand the basic concepts of relativistic quantum mechanics and the semi-classical theory of radiation.

Course Topics and contact hours allotment:

Topics	Contact Hours
Wavefunctions and Eqns of Motion: Stern-Gerlach experiment. Wave functions in position and momentum representations. Schrodinger and Heisenberg pictures. Heisenberg equation of motion. Interaction picture.	6
Time-dependent Perturbation theory: Time-dependent perturbation theory. Transition probabilities. Sudden and adiabatic approximations. Fermi golden rule. The variational method: simple	7

examples.	
Addition of Angular Momenta: Angular momentum algebra. Eigenstates and eigenvalues of angular momentum. Addition of angular momenta, Clebsch-Gordon coefficients.	7
Identical particle Systems: Systems of identical particles. Symmetric and antisymmetric wavefunctions. Bosons and Fermions. Pauli's exclusion principle. Second quantization, occupation number representation.	7
Particle Scattering: Non-relativistic scattering theory. Scattering amplitude and cross- section. The integral equation for scattering. Born approximation. Partial wave analysis. The optical theorem.	7
Relativistic Quantum Mechanics: Elements of relativistic quantum mechanics. The Klein-Gordon equation. The Dirac equation. Semi-classical theory of radiation.	6

Textbook references (IEEE format):

Text Books:

1. J.J. Sakurai *Modern Quantum Mechanics*, Benjamin / Cummings (1985).
2. P.A.M. Dirac, *The Principles of Quantum Mechanics*, Oxford University Press (1991).

Reference Books:

1. L.D.Landau and E.M. Lifshitz, *Quantum Mechanics -Nonrelativistic Theory*, 3rd Edition, Pergamon (1981).
2. P.M. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw-Hill (1977).
3. J. Bjorken and S. Drell, *Relativistic Quantum Mechanics*, McGraw-Hill (1965).
4. A. Messiah, *Quantum Mechanics*, Vols. 1 and 2, North Holland (1961).

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Information of relevant videos and web resources will be given during the course.