

Course 12: Advanced Quantum Mechanics

Course code: MSCPH-512

Credit: 3

BLOCK 1 Scattering and Perturbation Theory

Unit –1: **Scattering Theory:** Formulation of scattering theory, scattering amplitude, cross section, Partial wave analysis, optical theorem

Unit –2: **Born approximation:** Phase shifts, scattering length and effective range, Low energy scattering Born approximation and its validity.

Unit –3: **Perturbation Theory I:** Time dependent perturbation theory, Transition probability Constant Perturbation and Fermi's-Golden rule, Harmonic Perturbation, Selection rules for electric dipole radiation.

Unit –4: **Perturbation Theory II:** Adiabatic approximation, Sudden approximation, semi classical treatment of an atom with electromagnetic radiation.

BLOCK 2: Relativistic Quantum Mechanics

Unit –5: **Relativistic Quantum Mechanics:** Klein-Gordon equation and its failure, Dirac equation, Plane wave solutions, Interpretation of negative energy states.

Unit –6: **Spin Theory:** Antiparticles, Spin of electron, Magnetic moment of an electron due to spin, Energy values in a coulomb potential

BLOCK 3 Identical Particles and Quantisation of Fields

Unit –7: **Identical particles:** Identical particles, exchange degeneracy, symmetric and anti symmetric functions for many particles system, Classical Fields, Schwinger's action principle, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the concept of particle.

Unit –8: **Quantisation of Fields:** Quantization relations, Quantization of non-relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators, Second quantization.

Reference Books:

1. Satya Prakash, *Advanced Quantum mechanics*, Ramnath Kedarnath Publication, Delhi
2. P.M. Mathews and K. Venkatesan, *A Text book of Quantum Mechanics*, Tata Mc Graw-Hill, New Delhi.
3. L.I. Schiff, *Quantum Mechanics*, McGraw-Hill
4. David J. Griffiths, *Introduction to Quantum mechanics*, Pearson.
5. V. Devanathan, *Quantum Mechanics*, Narosa Publishing House, New Delhi.
6. P.A.M. Dirac, *The Principles of Quantum Mechanics*, Oxford University Press, London.
7. B.K. Agarwal, *Quantum Mechanics and Field Theory*, Lokbharti Publications, India.