Course: JT: 205: Quantum Mechanics
Instructors: Dr. Abhishek Kumar and Prof. Swapan K Pati

Syllabus

1. Waves & Particles, Basis sets, probability & superposition, wave equation Quantum Mechanical Postulates.
2. Uncertainty principle, minimum uncertainty, Ehrenfest's theorem.
3. Free particle, particle in a box, probability current, classical limits, stationary states.
4. Step potential, transmission and reflection coefficients, transfer matrix.
5. Quantum Harmonic oscillator
6. Delta-function potential, transmission and bound states.
7. Particle in a box revisited; Stationary states, Fermi Sea, Density of States and Quantum confinement.
8. Quantum Simple Harmomic Oscillator revsited; Operator arguments for constant energy separation and derivation of quantum classical correspondence. 2-dimensional simple Harmonic Oscillator - polar solutions, effect of magnetic field.
9. Angular momentum operators, commutation relations, separation of variables, symmetries, addition of angular momentum, 3J and 6J symbols, various theorems. Importance of angular momentum in single electron and many electrons systems, spin variables, spin-spin interactions and magnetic structures. Unitary operation and time evolution.
10. Hydrogen atom: spherical polar functions, functions without spherical symmetry, degeneracy. Bound states, tunneling and scattering. Various potentials and importance of Coulombic interactions in atoms.
11. Variational Principle and approaches for many-electron systems. Time-independent perturbation theory: non-degenerate and degenerate cases. Derivation of Operators corresponding to n'th order Perturbation Theory.
12. Application of perturbation theory and variation Principles to derive the ground state energy of He atom.

References:

1. E. Merzbacher, Quantum Mechanics, John Wiley & Sons, 3rd edition, 1998.

2. C. Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics Vol.1, John Wiley & Sons, 1977.

3. Arno Bohm, Quantum Mechanics: Foundations and Applications, Springer, 1993.