Course: JTL 205: Quantum Mechanics

Syllabus

1. Waves & Particles, Basis sets, probability & superposition, wave equation.

2. Matrix formulation, various operators and their properties, wave-particle duality, commutation relations, Heisenberg uncertainty.

3. Free particle, particle in a box, probability current, classical limits, stationary states, Fermi Sea, Density of States and Quantum confinement.

4. Harmonic oscillator - solution from various approaches; Operator arguments for constant energy separation and derivation of quantum classical correspondence. 2-dimensional simple Harmonic Oscillator - polar solutions, effect of magnetic field.

5. 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.

6. Hydrogen atom: spherical polar functions, functions without spherical symmetry, degeneracy. Bound states, tunneling and scattering. Various potentials and importance of Coulombic interactions in atoms.

7. 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.

8. 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.