PHYSICS- 11: QUANTUM MECHANICS AND APPLICATIONS-I

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Probability and probability current densities in three dimensions;Position, momentum& Energy operators; commutator of position and momentum operators; Expectation values of position and momentum; (3 Lectures)

Time independent Schrodinger equation- Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wave packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle; (10 Lectures)

General discussion of bound states in an arbitrary potential - continuity of wave function, boundary condition & emergence of discrete energy levels; application to one dimensional problems-square-well potential; Kronig-Penney model and appearance of energy bands in periodic potentials, like in crystal lattices; Elementary band theory of solids; effective mass of electrons; concept of holes; energy band diagrams; band-gap; conduction and valence bands; conductor, insulator and semiconductor; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle; (15 Lectures)

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground and the first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells; (10 Lectures)

Magnetic dipole moment and interaction energy in magnetic field; Stern-Gerlach experiment: electron spin & spin eigenvalues;Spin angular momentum;Pauli matrices(qualitative discussion) (10 Lectures)

Suggested study: (1) Bound states in a Delta function potential, (2) Zeeman effect - normal and anomalous, (3) Spin-orbit coupling in atoms - LS and jj couplings, (4) Understanding the diffraction due to a narrow slit as the spread of a wavepacket, (5) Why there is no classical limit of spin angular momentum while there is a classical limit for orbital angular momentum.

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews & K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Theory, David Bohm, 1951, Dover Publications
- Quantum Mechanics: Foundations and Applications, Arno Bohm, 3rd Edn., 1993, Springer.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

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PHYSICS PRACTICAL-V

(Students have to perform at least 5 experiments from the section VC. Additional experiments may be included with the approval of the committee of courses)

PHYSICS LAB.-VC

1. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 200 ^{o}C) and to determine its band gap.
2. To determine the Hall coefficient of a semiconductor sample.
3. To determine the Planck's constant using LEDs of at least 4 different colours.
4. To determine the wavelength of H-alpha emission line of Hydrogen atom.
5. To determine the absorption lines in the rotational spectrum of Iodine vapour.
6. To study V-I characteristics of PN diode, and Light emitting diode
7. To study the Characteristics of a Photo-diode.
8. To design a digital to analog converter (DAC) of given specifications.
9. To study the analog to digital convertor (ADC) IC.

Reference Books:

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill
- Electronic Devices and circuit Theory, R.L. Boylestad and L.D. Nashelsky, 2009, Pearson.
