1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Geeta Sanon, R. Chand Publications, 2020.
3. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
4. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 1511,Kitab Mahal
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. Engineering Practical Physics, S. Panigrahi and B. Mallick, 1515, Cengage Learning.

240/PHYP/CC101

Semester-IV

Course ID - 240/PHYP/CC

QUANTUM MECHANICS

Max. Marks: 50 **Credit 3(45Hrs)**

Internal Assessment: 25 **Time: 3 hrs**

*Note: The paper setter is to set **Nine** questions. Question no. 1 (compulsory based on the entire syllabus) will consist of **five** short-answer type questions, each of two marks. The rest of the **eight** questions will be set uniformly, with two questions from each unit selected. A student is required to attempt **five** questions, selecting one from each unit, along with compulsory question no 1. The question paper shall contain 20 % numerical problems in the relevant papers.*

Course Objective: The course on waves and optics deals with basic concepts of optics like interference, diffraction and polarisation. It also discusses many of the applications of these concepts. An introductory-level discussion about waves is also included.	**Course Outcome:** The student will be able to understand the concepts of black body radiation, Planck's quantum theory, Photoelectric effect, Compton effect, wave function and its characteristics. He/she will get skills to apply Schrödinger wave equation for various one-dimensional problems and hydrogen-like atoms.

Unit-I

The origin of quantum theory: Failures of classical physics, black body radiation, Planck's quantum theory, Photoelectric effect, Compton effect, Atomic-spectra and Bohr model of atom, The Bohr correspondence principle, The Franck and Hertz experiment, Stern-Gerlach experiment, De Broglie's hypothesis: Wave properties of matter, Davisson-Germer experiment; Wave-particle duality, Double slit experiment, the Heisenberg uncertainty principle: stability of atoms, energy width and natural lifetime of excited states.

Unit-II

Wave function and the Schrödinger wave equation: Time dependent and time independent Schrodinger equation, dynamical evolution of a quantum state; properties of Wave Function, Interpretation of Wave Function, Condition for physical acceptability of Wave Functions. Eigenvalues and Eigen functions, Mathematical consideration of Schrodinger equation: Normalization, Orthogonality, Observables, Stationary states, Position, Linear momentum & Energy operators; commutator of position and linear

momentum operators; Postulates of quantum mechanics, Probability current density, Expectation values of position and linear momentum, Ehrenfest's theorem.

Unit-III

One-Dimensional problems: Eigen Functions and Eigenvalues for a Particle in a One-Dimensional Box, Potential step: reflectance and transmittance, Penetration of a barrier: reflectance, transmittance and tunnel effect, Application of barrier penetration, Tunnel diode and alpha decay (Qualitative description), One Dimensional Simple Harmonic Oscillator: Energy Levels and Wave Functions. Zero Point Energy.

Unit-IV

Quantum theory of hydrogen-like atoms: time independent Schrödinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d, shells, Pauli exclusion principle.

References:

1. A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
5. Quantum Mechanics, B. H. Bransden and C. J. Joachain, 2000, Pearson Education.
6. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
7. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education.

QUANTUM MECHANICS LAB

Marks (External): 20 **Credits: 1 (30Hrs)**
Marks (Internal Assessment): 05 **Time: 3 Hrs**

IV. Each student should perform at least five experiments.

V. The students are required to calculate the error involved in a particular experiment.

VI. List of experiments may vary.

List of Experiments:

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.

6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure
8. its intensity variation using Photosensor & compare with incoherent source – Na.
9. Photo-electric effect: photo current versus intensity and wavelength of light; maximum

10. energy of photo-electrons versus frequency of light.
11. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
12. To setup the Millikan oil drop apparatus and determine the charge of an electron.
13. Determination of Planck's constant using photocell.

References:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
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