SEMESTER – V

BRANCH	Subject Title	Subject Code
B.Sc.(Physics–Major)	Quantum, Atomic and Molecular Physics	PYM1-151

Course Learning Outcomes(CLO)

On successful completion of this course, the students will be able to

1. Know the quantum mechanics and its applications.

2. Explain the atomic structures and X-rays

3. Analyse the molecular spectra such as electronic rotational and vibration

4. Identify the various maternaling Rama spectroscopic techniques.

CONTENT

Unit -1

Quantum Mechanics-1

1. Quantum technology in India: National Mission on Quantum Technologies & Applications (NM-QTA).

2. Particle nature of wave: Limitations of Classical Mechanics, Blackbody radiation; Photoelectric effect. Plank's radiation law; Compton effect.

3. Wave nature of particle De-Broglie hypothesis: experimental verification of De-Broglie hypothesis: concept of wave packet, concept of phase and group velocities

Unit -2

Quantum Mechanics-11

1.1 Operators in quantum mechanics: Eigenfunctions and Eigenvalues, Hermitian operator, Position and Momentum operator, Total energy (Hamiltonian) operator, Expectation value; Concept of parity: Parity operator, Ehrenfest Theorem.

2. Application of Schrödinger equation. Free particle Particle in one-dimensional box, Rectangular potential barrier, Tunnel effect. Applications of tunnel effect in barrier penetration (u-decay); One dimensional Harmonic Oscillator and concept of zero-point energy

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Unit-3

1. Atomic structure:

1. Brief review of Bohr and Summer field model of atom; Electron orbits, Energy levels and spectra, Vector atom model, Concepts of space quantization; Electron spin, Stern-Gerlach experiment, One and two valence electron systems; Pauli's exclusion principle and electron configuration, Spectroscopic notations of energy States, Multiplicity of energy level state.
2. Spin Orbit interaction, Selection rules, Spectra of alkaline atom, Fine structure of Sodium D line.

Unit :4

Zeeman effect and X-Ray Spectroscopy:

1. Zeeman effect: Early Discoveries and developments; Experimental arrangement; Normal and Anomalous Zeeman effect, Zeeman shift, Stark effect.

2. Nature and production of X-rays; Discrete and continuous X-ray spectra; Characteristics X-ray spectrum. Duane and Hants rule: X-ray emission spectra, Moseley's law and its application, Auger effect, Doublet structure of X-ray spectra; X-ray absorption spectra.

Unit-5

Molecular Physics:

1. Molecular Spectroscopy: Various types of spectra, Quantization of Vibration and Rotational energies: Pure Rotational Spectra Determination of intermolecular distance of Diatomic molecules, Pure vibrational Spectra of Diatomic molecule, Electronic Sestra of Diatoms

Raman Spectroscopy: Raman effect: Stokes and anti- stokes lines; Experimental setup of Raman effect; Classical theory of Raman effect: Quantum theory of Raman effect: Applications of Raman effect; Electronic spectrum; Born-Oppenheimer approximation: Franck Condon principle; Fluorescence and Phosphorescence

PRACTICAL

1. Determination of Rydberg's constant using hydrogen discharge tube.
2. Determination of Planck's constants using light emitting diode.
3. . Determination of specific charge e/m by Thomson's method.
4. Determination of Plank's constant using Photo cell
5. To determine the first excitation potential of gas (argon) by Franck Hertz experiment
6. To observe the Zeeman splitting of green mercury line using Fabry Parot Etalon for normal transverse and longitudinal configuration
7. Measurement of wavelength of mercury source spectrum by constant deviation spectrograph and calibration of drum.
8. Determination of wavelength of sodium light source with the help of plane transmission grating and spectrometer.
9. Verification of Fresnel's Law of reflection.
10. Verify Cauchy's formula using spectrometer.
11. Determination of wavelength of monochromatic light source by Fabry Parot interferometer.
12. Determination of electronic charge with the help of Millikan's oil drop method
13. Determination of Stefan's constant.
14. To count the number of particles emitting from radioactive source with the help of G. M. Counter
15. Determination of Lande's G-factor using Zeeman effect.
16. To study the absorption spectra of iodine vapour
17. To draw the characteristic curves of a Photo cell and determine stopping potential.
18. Determination of wavelength of monochromatic light source and thickness of mica sheet with the help of Michelson interferometer
19. Determination of thickness of mica sheet with the help of Bi-Prism.