ST.JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS), VISAKHAPATNAM

VII SEMESTER **PHYSICS** TIME:3Hrs/week
PH7402(4) **ATOMIC AND MOLECULAR SPECTROSCOPY** Max.Marks:100
w.e.f. 20AH Batch **SYLLABUS**

Objectives:

- *To provide students with a strong foundation in the principles and theories of*
- *atomic and molecular physics, and their industrial applications for material characterization.*

Course Outcomes:

Upon the successful completion of the course, students will be able to:

- *CO1: Discuss atomic structure using vector atom model, coupling schemes, and Absorption, emission and excitation spectra.*
- *CO2: Interpret experimental results related to Zeeman effect, Paschen-Back effect, and Stark effect and evaluate electron transitions and energy levels in atoms.*
- *CO3: Describe origin of X-ray radiations, measurements, reflection, refraction and diffraction of X-rays and their applications.*
- *CO4: Analyze the rotational, vibrational, and electronic spectra of molecules using spectroscopic techniques, energy levels and spectrum – PQR branches, Frank Condon principle and applications of vibrational spectroscopy.*
- *CO5: Explain the theory of Raman Scattering, rotational and vibrational Raman spectra and industrial applications of Raman spectroscopy.*

SYLLABUS

UNIT I: Atomic Spectra **14 Hrs**

Introduction: Vector atom model –Spectra of Alkali elements-fine structure- Spectral terms and term symbols, Ground states based on electron configuration - Coupling schemes - LS coupling - JJ coupling- Hund's rule of multiplicity - Equivalent and non-equivalent electronic systems. Spectral terms for equivalent and non-equivalent electrons - Width of spectral lines –Absorption, emission and excitation spectra- Spectrophotometer – Applications of atomic spectra – Photo Electron Spectroscopy- Atomic absorption spectroscopy.

UNIT II: Zeeman and Stark Effects **13 Hrs**

Introduction: Zeeman effect- Normal and anomalous Zeeman effects - Experimental details - Magnetic moment of atom and Lande's 'g'-factor - Zeeman effect in sodium atom - Lande g- formula for LS and JJ couplings - Paschen-Back effect - Splitting of sodium lines and selection rules - Stark effect - Experimental details - Weak and strong field effects – linear and quadratic Stark effects -Width of spectral lines.

UNIT III: X-ray Spectra **12 Hrs**

Production of X-rays-Origin of X-ray radiations-X-rays Light and electromagnetic spectrum- Measurement of X-radiations-polarization of X-radiations-Diffraction of X-radiations-Braggs law- Laue spots-Bragg's spectrometer-Reflection and Refraction of X-ray-X-ray scattering-Applications of X-rays

UNIT IV: Molecular Spectroscopy – Rotational – Vibrational Spectra **14Hrs**

Introduction – Rotational, vibrational and electronic spectra of diatomic molecules – Rotational spectra of a diatomic molecule as rigid rotator and non-rigid rotor – Intensity of rotational lines

- Rotational analysis of electronic spectra- Evaluation of rotational constants - Effect of isotopic substitution on rotational levels – Applications of rotational spectroscopy. Vibrational spectra of diatomic molecule – Diatomic molecule as a simple harmonic oscillator and anharmonic oscillator – Energy levels and spectrum – PQR branches – Progressions and sequences – Vibrational analysis of electronic spectra - DE slander's table – Evaluation of vibrational constants – Morse potential energy curve – Frank-Condon principle – Intensity distribution in absorption and emission spectra –IR and FTIR spectrometers - Applications of vibrational spectroscopy.

UNIT-V: Raman Spectroscopy **12 Hrs**

Introduction-Theory of Raman Scattering-Rotational and Vibrational Raman spectra-Mutual Exclusion Principle-Raman spectrometer-Fiber Coupled Raman Spectrometer-FT Raman Spectrometer- Structure determination using IR and Raman Spectroscopy-Industrial applications of Raman spectroscopy

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw - Hill Book company, Inc., (1962).

2. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt., New Delhi, (2005).

3. Elements of spectroscopy atomic, molecular and Laser physics, Gupta, Kumar, Sharma, Pragathi Prakashan, Meerut.

4. Atomic and Molecular Spectroscopy by Rita Kakkar, Cambridge University Press

Reference Books

1. Introduction to Atomic Spectra, H.E. White, McGraw-Hill Kogakusha. Ltd., New Delhi (1934).

2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, E.M. Mc Cash, Tata McGraw-Hill Pub.. (1994)

3. Spectroscopy, Vol. I & III, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York. (1976).