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

VIII SEMESTER **PHYSICS** TIME:3Hrs/week
PH 8402(4) **APPLIED SPECTROSCOPY** Max.Marks:100
w.e.f. 20AH Batch **SYLLABUS**

Course Objectives:

- *To provide students with knowledge of the principles and applications of the theoretical and practical aspects of various spectroscopic techniques in research fields.*

Course Outcomes:

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

- *CO1: Explain crystal and ligand fields, crystal field theory, energy level diagrams, and correlation diagrams for transition metal ions.*
- *CO2: Outline the properties of rare earth ions, Judd-Ofelt theory, radiative and non-radiative processes, and the applications of rare earth doped luminescent materials.*
- *CO3: Describe fluorescence and phosphorescence spectroscopy, normal and resonance fluorescence, non-radiative decay, and time-resolved emission spectroscopy.*
- *CO4: Discuss high-resolution spectroscopy techniques such as laser optogalvanic spectroscopy, matrix isolation spectroscopy, and laser cooling and their applications.*
- *CO5: Summarize the two-photon spectroscopy, selection rules, Photo acoustic spectroscopy and experimental methodology for applications in physics, chemistry, biology, and medicine.*

SYLLABUS

UNIT - I: Solid State Spectroscopy I – Transition Metal Ions 14 Hrs

Introduction – Crystal fields and ligand fields-Concept of ligand field – Scope of ligand field theory

– 'd' and other orbitals (s,p,f) – Quantitative basis of crystal fields – Crystal field theory – Octahedral crystal field potential on the d-wave functions – The evaluation of 10 Dq - Effect of weak field on S, P, D and F terms. Term energy level diagrams –

Correlation diagram for d2 configuration in octahedral coordination – Tanabe-Sugano diagrams for d2 configuration in octahedral field.

UNIT - II: Solid State Spectroscopy II – Rare Earth Ions 14Hrs

Introduction – Intensity of absorption and emission bands – Oscillator strengths – Intra- configurational f-f transitions –Selection rules – Electric and Magnetic dipole transitions – Judd- Ofelt theory and evaluation of Judd-Ofelt parameters – Radiative transition probabilities of excited states of rare earth ions – branching ratios, stimulated emission cross-sections – Non-radiative process – Energy transfer – Possible mechanisms of energy transfer – Resonance energy transfer – Process of IR to visible up-conversion – Applications of rare earth doped luminescent materials.

UNIT-III: Fluorescence and Phosphorescence Spectroscopy 13Hrs

Introduction – Normal and Resonance Fluorescence – Intensities of Transitions – Non-radiative decay of fluorescent molecules – Phosphorescence and the nature of the triplet state – Population of the triplet state–Delayed Fluorescence – Excitation spectra – Experimental methods –Emission life time measurements – Time resolved emission spectroscopy – Applications of Fluorescence and Phosphorescence.

UNIT – IV: High Resolution Spectroscopy 12Hrs

Introduction – Light detectors – Single photon counting technique – Phase sensitive detectors – Laser optogalvanic spectroscopy – Matrix isolation spectroscopy – Laser cooling and its applications.

UNIT- V: Two Photon Spectroscopy 12Hr

Introduction – two-photon absorption spectroscopy – Selection rules – Expression for the two- photon absorption cross section – Photo acoustic spectroscopy – Experimental methodology and applications to Physics, Chemistry, Biology and Medicine.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Molecular spectra and Molecular Structure Vol.I, G. Herzberg, 2ndEd, Van. Nostrand(1950).

2. Molecular Structure and Spectroscopy G. Aruldhas, Printice-Hall Pvt. Ltd.(2001).

3. Instrumental Methods of Analysis Willard, Merritt, Dean & Settle, CBS Pub, (2001).

4. Spectro chemical Analysis, L.H. Ahrens and S.R.Taylor, Addison Wesley,London,Pergamon,1961.

5. Elements of Spectroscopy, Gupta, Kumar and Sharma Pragati Prakasan, New Delhi (2012).

6. Elements of Diatomic Molecular Spectra, H. Dunford, Addison WeslyPublishingcompany,1965.

Reference Books

1. Principles of Fluorescence Spectroscopy, Joseph R. Lakowicz – Plenum Press, (1983).

2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata Mc Graw-Hill,(1983).

3. Spectroscopy Straughan and Walker (Vol.2 &3),John Wiley&Sons, (1976).