M.Sc. S.Y. (Physics) (CBCS Pattern) Semester-IV

PSCPHYT15.3 - Core Elective E2.4 Paper-XV - Atomic and Molecular Physics-II

P. Pages : 2 **GUG/S/25/11417**

Time : Three Hours * 1 4 3 6 * Max. Marks : 80

Either:

1. a) Explain the concept of time dependence in quantum mechanics. How does the time evolution of a quantum state affect observables? **8**

b) Discuss re-orientational spectroscopy of liquids and its applications in molecular dynamics. **8**

OR

e) Derive the time-dependent perturbation theory and discuss its significance in quantum mechanics. **8**

f) Explain the fluctuation-dissipation theorem and its significance in quantum mechanics. **8**

Either:

2. a) Explain the principle of saturation spectroscopy. How is hole burning and detection performed in Doppler-broadened two-level systems? **8**

b) Describe the experimental methods used in saturation spectroscopy with lasers. How do they improve spectroscopic resolution? **8**

OR

e) Explain the concept of Ramsey fringes and their application in precision spectroscopy. **8**

f) What is Photoacoustic Spectroscopy (PAS)? Describe the Rosenzweig and Greshow theory for PAS in gaseous mediums. **8**

Either:

3. a) Explain the concept of stimulated Raman scattering (SRS). Derive its quantum mechanical treatment. **8**

b) Explain the electromagnetic theory of SRS and its implications for vibrational spectroscopy. **8**

OR

e) What is phase-sensitive detectors? Explain their working principles and applications in spectroscopy. **8**

f) What is time-resolved fluorescence? Describe how it is used to determine the lifetime of an excited state. **8**

Either:

4. a) What is matrix isolation spectroscopy? Explain its principle and applications in molecular studies. **8**

b) Describe the basic principles of Fourier transform spectroscopy. How does it improve spectral resolution? **8**

OR

e) Explain the matrix representation of symmetry elements for a point group. Also, differentiate between reducible and irreducible representations in group theory. **8**

f) Explain the concept of laser cooling and its application in atomic and molecular physics. **8**

5. Attempt all of the following:

a) Define the rotational correlation function and explain its role in pure rotational spectra. **4**

b) What is laser Optogalvanic spectroscopy? Explain its working principle and applications. **4**

c) Discuss non-radiative transitions in fluorescence. How do they affect emission efficiency? **4**

d) Explain normal coordinates and normal modes in molecular vibrations **4**

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