(b) Describe the three Einstein's Coefficients. How can these coefficients be determined from experimental quantities? (5)

(c) Write down the principle of Mossbauer spectroscopy. The Mossbauer spectrum of $[Fe(CN)_6]^{3-}$ is a singlet while that of $[Fe(CN)_5 NO]^{2-}$ is a doublet. Explain. (5)

5. (a) What is the significance of the Franck-Condon principle in electronic spectroscopy? (4)

(b) Explain how intensity of spectral lines would vary if excited electronic state (i) equally stable, (ii) more stable, (iii) less stable compared to ground state. (2,2,2)

(c) Although there is no quantum mechanical restrictions on the change in the vibrational quantum number during an electronic transition, the probabilities and intensities of such vibrational changes during electronic transitions are not the same. Explain. (5)

6. (a) Draw and explain the Jablonski Diagram in detail. (5)

(b) What is Stem-Volmer plot? Derive Stem-Volmer equation and explain the significance of this plot. (5)

(c) Which are the allowed transitions in UV-visible spectrum for cis-1,3-butadiene on the basis of symmetry principle. (5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 13332 **K**

Unique Paper Code : 2174000039

Name of the Paper : GE: Advanced Molecular Spectroscopy and Applications

Name of the Course : **B.Sc. (H)**

Semester : VII

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **All** questions carry equal marks
3. Attempt any **4** questions.
4. Use of non-programmable calculator is allowed.

1. (a) (i) A light bulb of 60 W emits at a wavelength of 0.5 pm. Calculate the number of photons emitted per second. (3)

(ii) Explain the principle involved in electronic spectroscopy? (2)

(b) (i) What is Heisenberg Uncertainty Principle and explain its importance in molecular spectroscopy. (3)

(ii) The mean lifetime of an electronically excited molecule is 10^{-8} s. If the emission of the radiation occurs at 610 nm, what are uncertainties in frequency (Av) and wavelength (AX)? (2)

OR

(ii) Explain the basic principle involved in Circular Dichroism (CD). (2)

(c) (i) State the Lambert-Beer's Law. Explain how it is related to the intensity of spectral lines and derive a relation between absorbance and transmittance. (3)

(ii) In which region of the electromagnetic spectrum do photons with the following wavenumbers lie? 10 cm^{-1}, 2000 cm^{-1}, 20000 cm^{-1}, 40000 cm^{-1}. (2)

2. (a) (i) What is Doppler broadening and how does the Doppler width of a transition depend on the temperature and mass of the molecule? (3)

(ii) Write a short note on Born- Oppenheimer approximation. (2)

(b) (i) Using the selection rule for the atomic spectra, state which of the following transitions are allowed : (3)

$^2P_{1/2} \rightarrow {}^2S_{1/2}$
$^2S_{1/2} \rightarrow {}^2D_{3/2}$
$^2D_{1/2} \rightarrow {}^2P_{3/2}$
$^2S_{1/2} \rightarrow {}^2D_{1/2}$
$^2S_{1/2} \rightarrow {}^2P_{3/2}$
$^2P_{1/2} \rightarrow {}^2S_{3/2}$

(ii) What do you understand by the mirror image symmetry rule. (2)

(c) What do you mean by quenching? Explain the mechanism of quenching for fluorescence and derive the expression for the quantum yield of the fluorescence quenching. (5)

3. (a) Plot the function $\sin^2(\omega t/2) / (\omega/2)^2$ versus a using time dependent perturbation theory. (5)

(b) Explain how it satisfies
(i) Bohr's condition and
(ii) Heisenberg Time-Energy Uncertainty Principle. (5,5)

4. (a) (i) What is meant by vibronic coupling in molecular spectroscopy? (2)

(ii) A 0.25M solution in a test tube with pathlength of 1 cm has an absorbance of 0.075 at 560 nm. What is the molar absorptivity coefficient of the solution? Calculate the absorbance if the concentration of solution is 0.65M. What is the concentration of the solution if absorbance is 0.445? (3)

P.T.O.