

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO/2022)

CLASS: MSC/IMSC/PRE-PHD
BRANCH: CHEMISTRY

SEMESTER: III/IX
SESSION: MO/2022

SUBJECT: CH503 MOLECULAR SPECTROSCOPY

TIME: 03 Hours

FULL MARKS: 50

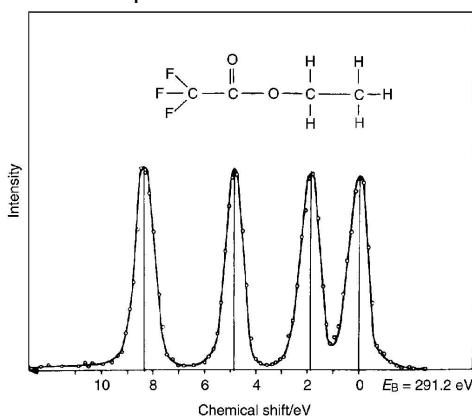
INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.

- Q.1(a) Describe 'Stark effect' in Rotational spectroscopy. [2] CO1 Remember
- Q.1(b) Compare and contrast with reason the role of quantum number 'k' in *rigid* and *non-rigid* symmetric top molecules. [3] CO1 Understand
- Q.1(c) Derive the complete expression of intensity of spectral lines in rotational spectroscopy. Also, derive J_{\max} i.e., the line with maximum intensity. [5] CO1 Remember
- Q.2(a) What are Stokes, anti-Stokes lines and Rayleigh scattering in Raman spectroscopy? [2] CO1 Remember
- Q.2(b) Depict the normal modes of vibration in carbon dioxide and identify the IR active and Raman active modes. [3] CO1 Remember
- Q.2(c) Explain the origin of P, Q and R branches in vibration-rotation spectroscopy. [5] CO1 **Remember**
- Q.3(a) Show the relationship between transition moment integral and the intensity of absorption. [2] CO1 Understand
- Q.3(b) How does the Franck-Condon factor govern the intensity of absorption? [3] CO1 Remember
- Q.3(c) Show that $n \rightarrow \pi^*$ transition is symmetry forbidden in formaldehyde (CH_2O). [5] CO1 Understand

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v'(yz)$		
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	-1	-1	R_z	xy
B_1	1	-1	1	-1	x, R_y	xz
B_2	1	-1	-1	1	y, R_x	yz

- Q.4(a) What is Koopman's theorem? [2] CO2 Remember
- Q.4(b) Explain the difference between UPS and XPS. What are the sources of ionizing radiation in UPS spectroscopy? [3] CO2 Remember
- Q.4(c) Photoelectron spectrum of C 1s is shown below for $\text{CF}_3\text{COOC}_2\text{H}_5$. Identify each carbon atom based on the XPS spectrum. [5] CO2 Understand



- Q.5(a) Discuss the two types of instruments used in Mossbauer spectroscopy. Which one has greater advantage? Why? [2] CO4 Remember
- Q.5(b) What are longitudinal and transverse relaxation time in NMR spectroscopy? [3] CO3 Remember
- Q.5(c) Explain the effect of NOE to modulate the signal strength in a coupled spin system. [5] CO3 Remember