

**III Semester M.Sc. Degree Examination, April/May 2022**  
**INDUSTRIAL CHEMISTRY**  
**Spectroscopic Techniques**

Time : 3 Hours

Max. Marks : 70

- Note :** a) Answer **any five** subdivisions from Part-A and **any five full** questions from Part-B.  
b) Figures to the **right** indicate marks.

PART - A

1. Answer **any five** sub-divisions.**(5×2=10)**

- a) Mention any two applications of Raman Spectroscopy.
- b) What is Stark effect ?
- c) State Beer Lambert law.
- d) Give any two differences between proton and carbon NMR.
- e) Mass spectrometry is the correct terminology but not Mass spectroscopy. Justify the same.
- f) In NMR spectroscopy, what is meant by spin-spin coupling ?
- g) With any one suitable example. Write McLafferty rearrangement.
- h) In vibrational spectroscopy. What is meant by zero point energy ?

PART - B

Answer **any five** of the following.

2. a) The fundamental vibrational frequency of HCl is  $86.63 \times 10^{12}$  Hz. Calculate zero point energy and force constant for HCl.
- b) Explain the factors influencing width and intensity of spectral lines.
- c) Obtain the expression for moment of inertia for rigid diatomic molecule.

**(4+4+4=12)**

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3. a) What are Nuclear and Electron spin interaction ? Explain.  
b) How does IR spectroscopy differ from Raman spectroscopy ?  
c) Explain the activity of the following molecules with respect to IR and microwave spectrum  $H_2$ ,  $HCl$ ,  $CO_2$  and  $CH_4$ . (4+4+4=12)
4. a) Write a short note on factors affecting the positions of UV bands.  
b) How do you distinguish following pair of compounds by IR spectroscopy ?  
i) Acetanilide                      ii) Acetic acid  
iii) Phenol                              iv) Ethyl benzoate  
c) Discuss the applications of UV spectroscopy in the structural study of organic molecules. (4+4+4=12)
5. a) With a neat labelled diagram, explain the working principle of IR spectroscopy.  
b) Describe the factors affecting band positions and intensities hydrogen bonding phase and solvent. (6+6=12)
6. a) Why is it necessary to use deuterated solvents for NMR experiments ?  
b) Briefly explain spin-spin coupling and spin decoupling.  
c) Write a short note on double resonance techniques used in NMR spectroscopy. (4+4+4=12)
7. a) With neat labelled diagram, explain the working principle of Nuclear Magnetic Resonance spectroscopy.  
b) Briefly explain the terms  
i) Coupling constant  
ii) Shielding and deshielding.  
c) A compound (molecular formula  $C_9H_{10}O_2$ ) gives the following spectral data.  
IR :  $1720\text{ cm}^{-1}$   
 $^1H$ NMR :  $\delta$ 1.29(3H,t)  
              4.35 (2H, g)  
              7.40 (3H, m)  
              8.81 (2H, m)  
Determine the structure of compound. (4+4+4)



8. a) Predict the fragmentation in the following compounds from their molecular ion

- i) Benzyl acetate
- ii) 1-Phenyl ethanol

b) How do you distinguish aromatic ester and alcohol by using mass spectroscopy technique ?

c) An organic compound A (Molecular Formula  $C_5H_{10}O$ ) exhibits the following spectral data

UV ( $\lambda_{max}$ ) : 280 nm

IRV<sub>max</sub><sup>(cm<sup>-1</sup>)</sup> : 17.5

<sup>1</sup>HNMR( $\delta$ ppm) : 0.9 (3H, t)

1.60 (2H, m)

2.20 (3H, s)

2.40 (2H, t)

Mass (m/z) : 86, 71, 43 (100%)

Deduce the structure of compound. (4+4+4)

9. a) Write a short note on double McLafferty rearrangement and Nitrogen rule.

b) Discuss fragmentation pattern for following compounds

- i) Acetanilide
- ii) P-Nitrobenzene.

c) How does a mass spectrometer detect isotopes ? Explain with example.

(4+4+4=12)