

Subject: Analytical Instrumentation

PAPER : XIII (T - 303)

Time : Four hours

Full Marks : 100

Separate answer script is be used for each group
Group-A

Section-I

Answer question No.1 and two more questions from the rest.

1. Answer any six ;

1X6

- (a) NMR is the study of absorption of by nuclei in a magnetic field.
- (b) Give a list of main parts of a CW NMR instrument.
- (c) What is speed of an electron at 300kV acceleration Voltage?
- (d) What is resolving power of a light microscope?
- (e) Write four components of a modern TEM.
- (f) For viewing which of the following would a TEM not be a good choice? (a) RBC
- (b) Fracture surface (c) 3D external surface of mitochondria (d) Ribosome
- (g) Write names of two material normally used to construct tips of AFM.

2. (a) Write down the principle of electron microscope. What types of electron sources are used in electron microscope ? Compare their advantages and disadvantages.

2+3

(b) If a focused beam of electron hits a sample in a SEM what will be the outcomes from it. Why and when metal coating is necessary for SEM samples? How coating thickness on a sample is controlled?

2+2+1

3. (a) What is SPM ? Write on constant height and constant current mode of STM with diagram. What information of a sample we can get from LFM study?

2+2+1

(b) Explain the principle of work of an atomic force microscope. Describe it with signal flow chart for contact mode with diagram.

2+3

4. Write notes on any two of the following:

5X2

(a) ESEM (b) Cryo-electron microscope. (c) EPMA (d) Sample preparation for SEM

[Turn over

Section - IIAnswer *any four* questions :

1 x6

5. What is the role of electrodes in the construction of a pH meter ? Give a diagram and explain. 1 ml of 0.1 normal HCl is mixed with 1 ml of 0.00000001 normal NaOH. Calculate the pH of the resultant solution.
6. Why molecular spectra are band spectra , while atomic spectra are line spectra ? Give the basic principles of molecular spectroscopy.
7. How many vibrational modes a CH₂ group may have in a compound like CH₂XY ? Alkane CH bond executes stretching and contraction at a rate of 9.3×10^{13} times per second. Calculate IR stretching frequency of the bond. What is Fermi resonance ?
8. Explain basic principles of Raman spectroscopy. How does it differ from IR spectroscopy?
9. What is " finger print zone " in IR spectroscopy ? How does Hydrogen bonding affect OH stretch in a compound? Illustrate.
10. What are bathochromic and hypsochromic shifts ? Explain what is called an extended chromophore .Discuss the effect of solvent in uv-vis spectroscopy.

M. Sc (Instrumentation) Examination, 2019
(2nd Year, 1st Semester)

Group-B

Answer any five:

1. How Cu K_{α} X-ray generates? Why we choose Cu as target of X-ray source? Comparison of structural features among poly-crystalline, single crystalline and amorphous materials. What are the difference in XRD pattern of above materials? 2+2+3+3
2. What are the factors that modify the intensity of the scattered electrons in XRD. Derive an expression of structure factor of any crystal having Millar indices (h,k,l). Find the selection rule for SC lattice. 3+5+2
3. Calculate the Atomic Packing Factor for FCC lattice. Describe how the planes are determined by powder X-ray diffraction method with Debye-Scherrer geometry. What are the origins of XRD peak broadening? 2+6+2
4. What are pseudo-capacitor and double layer super-capacitor? Describe the charge storage mechanism of both process. What is specific capacitance? 2+6+2
5. What is galvanometric charge discharge (GCD) curve? Discuss the nature of GCD curve of a capacitor and super-capacitor. How specific capacitance (C_{sp}) can be obtained from galvanometric charge discharge (GCD) curve of a given material at a fixed current. What is electro-chemical impedance of a super-capacitor? 2 + 3 +3+ 2
6. Explain how the Cylindrical Mirror Analyzer (CMA) work in Auger spectroscopy? How CMA of XPS & Auger spectroscopy differ? What is the maximum depth of XPS? In Auger spectroscopy what is KLL transition? 4+3+1+2
7. How does paper chromatography work in separation process? What do you mean by retention factor (R_f) in paper chromatography? What is its significance? 5+2+3