Ref. No. : PG/NANO/T/112A/2024

Master of Technology in Nanoscience & Technology

1st Year, 1st Semester Examination – 2024

Characterization of Materials

Full Marks- 100

Use separate answer scripts for each part

Part I (50 marks)

Answer any **five** questions

1. Explain the followings:
   (a) Relativistic correction of mass of an electron is important for calculation of wave length of the wave associated with electron beam in high resolution TEM.
   (b) SEM is used to see the surface morphology of the specimen whereas, EBDS (Electron Back Scattered Diffraction) is used to get information much beneath the surface.
   (c) Lanthanum hexaboride gun is more preferred compared to tungsten hair pin gun as a thermoionic source of electrons in SEM.
   (d) More than one condenser lens are used in SEM. 10
2. Define reciprocal lattice. Using the concept of reciprocal lattice and Ewald construction derive the condition of diffraction of electron beam in TEM. 2 + 8
3. What are the different types of guns used in FESEM? Discuss the advantages and disadvantages the guns.
   Why do we get much better resolution in FESEM compared to SEM?
   With a schematic diagram discuss the operation of SEM. 2 + 3 + 2 + 3
4. Discuss with diagram the principle of dark field and bright field image contrast in TEM and the image contrast principles of SEM. 6 + 4
5. Define structure factor. Why structure analysis using TEM is less reliable? Why resolution of HRTEM is very high compared to other microscopes? 2 + 3 + 5
6. Calculate the wave length of the electron beam in HRTEM. How phase analysis of the sample specimen can be done in TEM? 5 + 5

Part II (30 marks)

Answer any **two** questions

1. Why will you characterize materials by X-ray? What is the importance of Bragg's law? Derive the law.
   How will you obtain particle size from X-ray diffraction pattern? 2 + 2 + 3 + 8

2. How various planes are indexed? Show that all planes don't contribute to the diffraction pattern. 3 + 12

3. What is the advantage of atomic force microscope? Briefly discuss the basic operational principle of atomic force microscope. How atomic force microscopes are classified? 3 + 10 + 2

Part III (20 marks)

Answer any **one** question

1. What is the wavelength range of the UV-Vis spectrum? Draw the instrumentation of UV-Vis spectroscopy. What are the red shift and blue shift? What are the limitations of Lambert-Beers law? What are the applications of UV visible spectroscopy? 2+7+4+4+3
2. What is the wavelength range of the FTIR spectroscopy? How does infrared spectroscopy work? What are the first Overtone, Fermi resonance and Hot bands in IR spectroscopy? What is the principle on which infrared spectroscopy works? What are the disadvantages of IR spectroscopy? 2+5+5+5+3