

2123

M. Tech. (Material Science and Technology)

Third Semester

MT-301: Advanced Material Characterization

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part.

x-x-x

I. Attempt any five parts of the following:

- (a) What is meant by surface reconstruction?
- (b) Discuss the importance of ion sources in the field of surface analysis.
- (c) Describe the typical energy range of electrons used in RHEED.
- (d) Define resolution and magnification in the context of electron microscopy.
- (e) Can STM be used to study non-conductive materials? Why or why not?
- (f) Why does ToF SIMS use a pulsed, not continuous, primary ion beam?

(2x5=10)

Part A

- II. (a) Explain the fundamental principles of Rutherford backscattering spectroscopy. Describe the key components of a Rutherford backscattering spectrometer.
(b) How is energy analysis used in RBS to determine the composition of a sample? Explain the significance of the energy of the backscattered particles in RBS. (5,5)
- III. (a) Describe the five principal types of meshes or nets and their unit meshes.
(b) Compare and contrast RHEED with LEED in terms of their applications and the type of information they provide about surfaces. (4,6)
- IV. Explain the concept of ellipsometric parameters Psi (Ψ) and Delta (Δ). How are these parameters related to the optical properties and thickness of thin films? Discuss the applications of ellipsometry in material science and industry. (10)

Part B

- V. (a) What is the basic principle of Scanning Tunneling Microscopy (STM)? How does the resolution of STM compare to other microscopy techniques? Discuss the factors that affect the image quality in STM.
(b) Compare the contact mode and non-contact mode in AFM. What is the significance of tapping mode in biological samples? (5,5)
- VI. (a) Explain how the image is formed in a TEM. Describe the role of electromagnetic lenses in a TEM. How do they focus and manipulate the electron beam?
(b) Identify the limitations of optical microscopy in terms of resolution and imaging capabilities. Highlight the advantages of electron microscopy over optical microscopy. (4,6)
- VII. (a) What is the operating principle UV photoelectron spectroscopy? How does the energy of emitted photoelectrons relate to the binding energy of electrons in a material?
(b) Explain the construction and working of hemispherical electron energy analyzer used in XPS. (6,4)

x-x-x