

**B.E. METALLURGICAL AND MATERIAL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2018****SUBJECT: ADVANCED CHARACTERISATION TECHNIQUES**

Time: Three Hours

Full Marks: 100

( Use separate Answer Script for each part )

**Part-1****(Answer question 1 and any three from the rest)**

1. Compare the mechanism of scattering of X-ray and electrons by matters. 10
2. (a) Write down the one-dimensional differential equation of running wave and discuss the D'Alembert solution 2+12  
(b) Outline the principle of Atomic Absorption Spectroscopy. 6
3. (a) Find the expression of the resultant amplitude of scattering from a pair of identical point scatterers and discuss its graphical representation 7+3  
(b) Find an expression of the wavelength of electrons and explain its relativistic corrections. 10
4. (a) For one dimensional; array of atoms having translational periodicity  $\vec{a}$ , so that Laue condition of diffraction is given by  $\vec{a} \cdot \vec{s} = h$ , where  $s$  is the scattering vector and  $h$  is an integer. 10  
(b) Define reciprocal lattice. Show that the magnitude of the reciprocal lattice vector ( $\vec{R}^*$ ) is given by, 4+6  

$$|\vec{R}^*| = |\vec{s}| = \frac{1}{d_{hkl}}$$

Where  $d_{hkl}$  is interplanar spacing.
5. (a) In reciprocal lattice diffraction from a crystal is never a point but a spot. Estimate the size of the diffraction spot. 10  
(b) Discuss the mechanism of image contrast in TEM 5  
(c) Discuss the concept of limiting sphere in TEM 5
6. (a) Define the term transmittance of UV-VIS spectroscopy. Explain how you could estimate the band gap of a semiconductor from its UV-VIS spectrum. 2+4  
(b) Discuss the mechanism of interaction of electromagnetic radiation with IR active molecules. Explain what you understand by energy of  $10\text{cm}^{-1}$  6+2  
(c) Explain why the line broadening of IR spectrum occurs. 6

[ Turn over

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**PART – II****(Use separate answerscript)**

Answer any two from the following:

Q1. (a) Discuss the principles for formation of images in a scanning electron microscope? How does SEI images differ from BSE images?

(b) How can SEM be used to know the local composition of a material?

10+5 = 15

Q2. (a) What are the advantages of AFM over SEM?

(b) Describe the principles for obtaining topographic images of a specimen in an AFM under contact, tapping and non-contact mode of operation.

3+12 = 15

Q3. (a) Describe the principle to obtain the phase transformation temperature a material and the nature of the transformation.

(b) Discuss the principle of the technique that can be used to know the austenite formation kinetics of a plain carbon eutectoid steel.

8+7 = 15