

**IV B.Tech. II Semester Supplementary Examinations, July -2005****X-RAY METALLOGRAPHY**  
**(Metallurgy & Material Technology)****Time: 3 hours****Max Marks: 80****Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. (a) What is electromagnetic radiation? Explain the properties of Electromagnetic radiation.  
(b) Write short notes on Stereographic projections.
2. (a) Mention various defects that occur in Crystal. Write in brief on each of them.  
(b) Nickel shows the diffraction maximum at  $2\theta = 101.502^\circ$ . The wavelength of X-rays is equal to  $1.541\text{\AA}$ . Calculate the lattice parameter of Nickel cell if the above reflection corresponds to (310) plane ( $n=1$ ).
3. (a) What is Absorption factor? Derive an expression for the absorption factor of a diffractometer specimen in the form of a flat plate of finite thickness.  
(b) Explain the factors to be considered in calculating the intensities of X-ray diffraction.
4. (a) Why should you use Monochromatic X-ray in the case of powder method? Explain.  
(b) Explain how cameras are classified in a Laue photograph. Explain any one of them.
5. What is the principle involved in X-ray spectrometer? With neat sketch, Explain the construction and working of X-ray spectrometer.
6. A Transmission Laue photograph is made of an Aluminum crystal with a crystal to film distance of 5 Cm. When viewed from the X-ray source, the Laue spots have the following x, y coordinates, measured (in Inches) from the center to the film.

X	Y
+0.66	+0.88
+0.94	+2.44
-0.10	+0.79
-0.45	+2.35
-0.77	+1.89

Plot these spots on a sheet of graph paper. By means of a Greninger chart, determine the orientation of the crystal, plot all poles of the form  $\{100\}$ ,  $\{110\}$  and  $\{111\}$ , and give the coordinates of the  $\{100\}$  poles in terms of latitude and longitude measured from the center of the projection.

7. Write notes on the following:

- (a) Phase diagram determination/ construction by X-ray diffraction method
- (b) Focussing Cameras.

8. Write notes on the following:

- (a) Focussing Cameras
- (b) Techniques used in stress measurements.

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1. (a) Explain with a neat sketch, the order of reflection.  
(b) The atomic radius of Molybdenum atom is 0.1363 nm. Compute the inter-atomic spacing for (111) set of planes in the molybdenum crystal. The crystal structure of molybdenum is bcc. What is the interplanar spacing for (220) set of planes?
2. Write short notes on the following:
  - (a) Thomson equation
  - (b) Polarisation factor
  - (c) Compton effect.
3. Write notes on the following:
  - (a) Absorption factor
  - (b) Temperature factor.
4. Discuss the principle, construction and working of a Debye-Scherrer camera.
5. If a count  $N_P$  of 30,000 is obtained in the peak of the diffraction line and ,in same time, a count  $N_B$  of 10,000 in background adjacent to the line, calculate the percent probable error in (a)  $N_P$  and (b)  $N_P - N_B$  .
6. What is the principle involved in Diffractometre method (The texture of Sheet). With neat sketch explain the working of Diffractometre method.
7. If the same (hkl) reflection from a given material is examined in a diffractometre with successively different wavelengths, how does the penetration depth  $x$  vary with  $\lambda$  ? Explain. (Assume the Wavelengths used lie on the same branch of the absorption curve of the material).
8. Derive the equation  
$$h = x_1 + C/2(3a+b/a+b)$$
  
(measurement of line position)

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1. With a neat sketch, describing the parts of X-ray tube, design a method for X-ray production.
2. (a) With sketches, explain the atomic scattering factor.  
(b) With a neat sketch, explain the effects produced by the passage of x-rays through matter.
3. (a) Derive an equation for the resolving power of a Debye-Scherrer camera.  
(b) A transmission Laue pattern is made of an Aluminum crystal with a specimen to film distance of 5 cm. The (111) planes of the crystal make an angle of  $3^\circ$  with the incident beam. What minimum voltage is required to produce a (111) reflection.
4. The powder pattern of Aluminium made with  $\text{Cu K}\alpha$  radiation contains ten lines, whose  $\text{Sin}^2\theta$  values are 0.1118, 0.1487, 0.294, 0.403, 0.439, 0.583, 0.691, 0.727, 0.872, and 0.981. Index these lines and calculate the lattice parameter.
5. What is the principle involved in X-ray spectrometer? With neat sketch, Explain the construction and working of X-ray spectrometer.
6. (a) Compare Diffractometre method and photographic methods.  
(b) Write notes on the following:  
(i) Inverse pole figures (ii) Amorphous and semi amorphous solids.
7. A transmission pinhole pattern is made with  $\text{Co K}\alpha$  radiation of an Iron wire having an almost perfect (110) fiber texture. The wire axis is vertical. How many high intensity maxima will appear on the lowest angle 110 Debye ring and what are their azimuthal angles on the film.
8. Compare and Contrast Coherent and Incoherent radiation.

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1. (a) Derive Bragg's law. Explain with neat sketches.  
(b) Determine at which (111), (200), (220), (311) planes of Nickel crystal will diffract X-rays ( $\lambda = 1.54\text{\AA}$ ). The crystal is an FCC crystal with a lattice parameter  $a = 3.52\text{\AA}$ . What are the values of interplanar distances?
2. (a) Draw the following planes and directions in a tetragonal unit cell (001), (011), (113), [110], [201], [101]. Show cell axes.  
(b) Rubidium is a BCC crystal. The angle of diffraction for (321) set of planes is at  $27^\circ$  for the first order reflection. The wavelength of X-rays used is  $0.0711\text{nm}$ . Calculate the interplanar distance of the planes. What is the atomic radius of Rubidium atom?
3. (a) Explain in detail the scattering of X-rays by an atom.  
(b) What is structure factor? Derive an expression for the structure factor. Calculate the structure factor for NaCl.
4. (a) How do you distinguish between BCC and FCC structures from powder pattern.  
(b) Write a note on Rotating crystal method.
5. (a) With a neat sketch explain back-reflection Lane method.  
(b) A Powder specimen in the form of a rectangular plate has a width of  $0.45\text{ in.}$ , measured in the plane of the diffractometre circle, which has a radius of  $4.37\text{ in.}$  If it is required that the specimen entirely fill the incident beam at all angles and that measurements must be made to angles as low as  $2\theta = 12^\circ$ , what is the maximum divergence angle that the incident beam may have?
6. What is the principle involved in Diffractometre method (The texture of Sheet). With neat sketch explain the working of Diffractometre method.
7. What is the basic principle involved in crystal structure determination? Explain various steps involved in determination of unknown structures.
8. Compare and Contrast Coherent and Incoherent radiation.

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