



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (CT)/SEM-6/MS(CT)-601/2011

2011

ENGINEERING MATERIALS SCIENCE

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

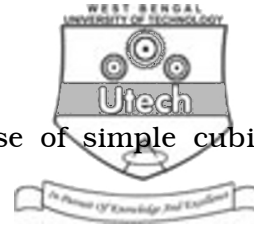
10 × 1 = 10

i) The no. of lattice points in a primitive cell are

- | | |
|------|------------------|
| a) 1 | b) $\frac{1}{2}$ |
| c) 2 | d) $\frac{3}{2}$ |

ii) The packing factor of cubic crystal is

- a) 60%
- b) 56%
- c) 90%
- d) none of these.



iii) The coordination number in the case of simple cubic crystal structure is

- a) 12 b) 6
- c) 2 d) 1.

iv) Miller indices of the plane parallel to the x and y -axes are

- a) (1, 0, 0) b) (0, 1, 0)
- c) (0, 0, 1) d) (1, 1, 1).

v) X-rays are produced when an element of high atomic weight is bombarded by high energy

- a) protons
- b) photons
- c) neutrons
- d) electrons.

vi) The number of Bravais lattices are

- a) 14 b) 7
- c) 21 d) 28.



vii) Driving force for recrystallization process is

- a) grain boundary energy
- b) stacking fault energy
- c) stored energy for cold work
- d) none of these.

viii) Example for strengthening mechanism in single phase material is

- a) precipitation hardening
- b) strain hardening
- c) fiber strengthening
- d) dispersion strengthening.

ix) Main form of ceramic degradation is

- a) Corrosion
- b) Dissolution
- c) Weathering
- d) Swelling.



- GROUP – B**
(Short Answer Type Questions)

2. Distinguish between Seebeck and Peltier effects.
3. Define atomic radius in crystals and hence calculate the atomic radii in the case of bcc and fcc lattices.
4. What do you understand by polymorphism ? Explain it with example in connection with iron.
5. Find the distance d_{hkl} between adjacent plane of side a crystal lattice.
6. Discuss the diffusion mechanisms of oxide formation on metals.
7. Derive the critical resolved shear stress for slip.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

8. Show that the number of Frenkel defects in equilibrium at a given temperature is proportional to $(N N_i)^{\frac{1}{2}}$, where N be the number of atoms and N_i be the interstitial atoms. 15
9. Derive Bragg's laws of X-rays diffraction in crystals. By using Bragg's X-ray spectrometer, show that NaCl crystal has a fcc structure. 6 + 9
10. Sketch the time-strain curve for anelastic behaviour and compare it with the time-strain curve in the Voigt-Kelvin element. What do you deduce from it ? 6 + 6 + 3
11. a) Why real crystals are found to be weaker than what might be theoretically possible ?
- b) What is slip system ? State the principal slip planes and directions in bcc, fcc and hcp crystals. Why are fcc metals more plastic than bcc and hcp ?



- c) Calculate the macroscopic shear strain resulting from the motion of dislocations.
- d) A relatively large plate of a glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m^2 and 69 GPa, respectively, determine the maximum length of a surface flaw that is possible without fracture. 2 + 4 + 6 + 3
12. a) Discuss the quantum force electron theory of metals pointing out the shortcomings thereof.
- b) Discuss 'Density of States' of electron giving mathematical expression. 12 + 3
13. a) What are the important factors that affect corrosion of materials ? Why corrosion is considered as the reverse process of extractive metallurgy ?
- b) Narrate the different ways to express the rates of corrosion. State the Nernst equation.
- c) What is intergranular corrosion ? Discuss the metallurgical condition leading to intergranular corrosion in an austenitic stainless steel.
- d) Discuss how can you cathodically protect a metal from corroding. 3 + 4 + 3 + 5



14. Discuss briefly any *three* of the following :

3 × 5

- a) Griffith's criterion of brittle fracture.
 - b) Theoretical cohesive strength of metals.
 - c) Distinction between slip & twinning deformation.
 - d) Slip in a perfect lattice.
 - e) Recrystallization of metals.
 - f) Passivation.
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