

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech/CT(NEW)/SEM-6/CT-602/2013

2013

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 the following :

10 × 1 = 10

i) The atomic packing fraction of diamond cubic structure is

- | | |
|---------|----------|
| a) 0.34 | b) 0.35 |
| c) 0.52 | d) 0.74. |

ii) The radius ratio of NaCl crystal falls into which of the following ranges ?

- | | |
|------------------|------------------|
| a) 0.155 – 0.225 | b) 0.225 – 0.414 |
| c) 0.414 – 0.732 | d) 0.732 – 1.00. |



WEST BENGAL
UNIVERSITY OF TECHNOLOGY

Utech

In Pursuit of Knowledge and Excellence

- 
- WEST BENGAL
UNIVERSITY OF TECHNOLOGY
- Utech
- In Pursuit of Knowledge and Excellence



vi) Unit of surface energy is

- a) dynes/cm b) dynes/cm²
c) ergs/cm d) ergs/cm² .

vii) Fracture stress (σ_f) is inversely proportional to

- a) crack length b) $\frac{1}{\text{crack length}}$
c) (crack length)^{1/2} d) (crack length)^{- 1/2} .

viii) Which of the following is/are slip system(s) of a *bcc* lattice ?

- a) { 111 } < 110 > b) { 110 } < 111 >
c) { 112 } < 110 > d) { 123 } < 110 > .

ix) Least tendency of formation of deformation twinning is observed in case of

- a) intermetallic compounds
b) *fcc* metals
c) *bcc* metals
d) *hcp* metals.

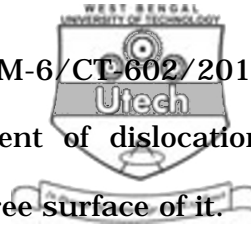


- x) Ti and its alloys are commonly used in
- a) oxidising conditions
 - b) strongly oxidising conditions
 - c) reducing conditions
 - d) airfree acids and aqueous solutions environment.

GROUP - B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Write appropriate defect reaction for incorporation of CaO in ZrO_2 crystal using the Kröger-Vink notation and show how the rules of substitution have been complied with.
3. a) A diffracted X-ray beam is observed from the $(2\ 2\ 0)$ plane of iron at a 2θ angle of 99.1° where X-rays of 0.15418 nm wavelength are used. Calculate the lattice parameter of iron crystal.
- b) Calculate the density of NaCl that has rock salt crystal structure. Given : The ionic radii of Na^+ is 0.102 nm and Cl^- is 0.181 nm . Atomic masses of $\text{Na} = 22.99\text{ gm/mol}$ and $\text{Cl} = 35.45\text{ gm/mol}$. $2\frac{1}{2} + 2\frac{1}{2}$



4. Briefly discuss with sketch how movement of dislocation through a crystal produces a step at the free surface of it.
5. Defining Pilling-Bedworth ratio, state the important factors of consideration if a metal is to form a protective oxide.
6. Briefly discuss intrinsic and extrinsic semiconductor with supporting energy band diagrams.
7. Enumerate the differences between Slip and Twinning mechanisms of deformation.

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. a) State Bragg's law of X-ray diffraction. Give the mathematical derivation of the law using relevant schematic diagram. 2 + 5
- b) In a crystal, whose primitives are 1.2 Å, 1.8 Å and 2.0 Å, a plane (2 3 1) cuts an intercept of 1.2 Å along the X-axis. Find the length of intercept along Y-axis and Z-axis. 4
- c) Show that, in a simple cubic lattice, the separation between successive lattice planes (1 0 0), (1 1 0) and (1 1 1) are in the ratio of 1 : 0.71 : 0.58. 4



9. a) Give the mathematical derivation for the equilibrium concentration of point defect in an ionic crystal. Consider the point defect as 'Frenkel' defect. 7

- b) Deduce Griffith's criterion of brittle fracture of solids with suggested modifications of it. 8

10. a) Draw the nominal stress-strain curve for mild steel and explain the principal features of it. What do you understand by 0.2% Yield strength and how is it obtained from the stress-strain diagram of the above curve ?

4 + 2

- b) Define 'engineering' stress and 'true' stress. Compare the engineering stress and strain with the true stress and strain for the tensile test of a low-C steel having the following test values : 2 + 4

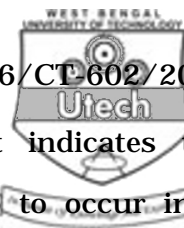
Load applied to specimen = 17,000 lbf

Initial specimen diameter = 0.500 inch

Diameter of specimen

under 17,000 lbf load = 0.472 inch.

- c) Amongst *fcc*, *bcc* and *hcp* metals, which is the most plastic and why ? 3

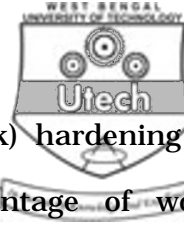


11. a) Deduce a mathematical relation that indicates the maximum stress to be applied for slip to occur in a perfect metallic lattice.
- b) Derive a relation between a uniaxial stress acting on a cylinder of a pure metal single crystal and the resolved stress.
- c) Prove that $\gamma = b\rho\bar{v}$, in respect of motion of dislocation through a crystal, where the notations have their usual meanings.
12. a) What are 'Crevice' and 'Pitting' corrosions ? Describe with sketch an eletrochemical mechanism for the crevice corrosion of a stainless steel in an aerated NaCl solution.
- b) Define corrosion 'polarization' and 'overvoltage'. Explain with sketches corrosion rate from polarization data :
- i) where both oxidation and reduction reactions are rate limited by activation polarization.
- ii) where reduction reaction is under combined activation-concentration polarization control.

5 + 5 + 5

2 + 3

2 + 4 + 4



13. a) Explain the mechanism of strain (work) hardening of metals. Point out the major disadvantage of work hardening as a method of increasing strength of a metal or alloy. 4 + 1
- b) Draw a polarization curve for a metal that displays an active-passive transition. Illustrate how an active-passive metal can exhibit both active and passive corrosion behaviours. 3 + 4
- c) Explain why conductivity of a semiconductor increases with temperature while that decreases for a metal as we move from absolute zero of temperature. 3
- =====