



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech(CT-OLD)/SEM-6/MS(CT)-601/2013
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 : $10 \times 1 = 10$

i) Which of the following is/are false statement(s) ?

- a) Line defects are thermodynamically stable
- b) Dislocations can end inside a crystal without forming loop
- c) ABC ABC ABC ... is stacking sequence for HCP crystal
- d) All of these.

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- ii) Which is *not* a characteristic property of a ceramic material ?
- a) High mechanical strength
 - b) Low hardness
 - c) Low elongation
 - d) High temperature stability.
- iii) Critical resolved shear stress would be zero in which of the following situations ?
- a) Tension axis being perpendicular to slip plane
 - b) Tension axis being parallel to slip plane
 - c) Both (a) and (b)
 - d) None of these.
- iv) Burger's vector changes with which of the following ?
- a) Kind of dislocation e.g. 'edge' or 'screw'
 - b) Length of dislocation
 - c) both (a) and (b)
 - d) none of these.

a) SiC

c) TiO_2

d) ZrO_2 .

a) *fcc* metals

b) *bcc* metals

c) *hcp* metals

d) intermetallic compounds.

a) $(123) < 111 >$

b) $(112) < 111 >$

c) $(110) < 111 >$

d) Only (a) and (b)

e) Only (b) and (c)

f) All of (a), (b) and (c).

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GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Discuss with sketches difference between 'slip' deformation and deformation by 'twinning'.
3. Discuss how a metal can be cathodically protected from corrosion.
4. Discuss primary recrystallization process. Why is primary recrystallization seldom accomplished in ceramic system ?
5. Neglecting the factors responsible for slip in pure metal single crystals, derive the relationship between uniaxial stress on a cylinder of a pure metal single crystal and the resolved shear stress on the slip system.
6. Narrate the fundamental postulates of Drude-Lorentz theory of metals. Discuss the successes and failures of free electron theory.

2 + 3

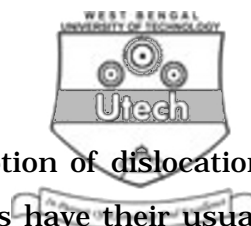
GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

7. a) Deduce a mathematical expression that would indicate the maximum stress to be applied for 'slip' to occur in a 'perfect' metallic lattice.



- b) Prove that $\dot{\gamma} = b \rho \bar{v}$ in respect of motion of dislocation through a crystal, where the notations have their usual meaning. 7 + 8
8. a) Assuming one dimensional periodic potential field, solve the Schrödinger's wave equation using 'Bloch function' and 'Kronig-Penney' models with necessary sketches and show how energy bands result from it.
- b) Discuss 'Brillouin zones'. State the condition for 'Bragg reflection' from a 2-D square lattice with a sketch.
- c) Discuss 'Density of states' of electron giving mathematical expression. 8 + 3 + 4
9. a) What do you understand by 'Crevice' ? Describe with sketches and electrochemical mechanism, the 'crevice corrosion' of a stainless steel in an aerated NaCl solution. 1 + 4
- b) What is 'Area effect' in respect of Galvanic corrosion ? Which of the following is more favourable from a corrosion prevention standpoint and why ?
- i) Copper plate-steel rivets
- ii) Steel plate-copper rivets. 3 + 3
- c) Discuss a mechanism for the dezincification of a 70-30 brass. What steps can you take to combat it ? 2 + 2



10. a) Discuss basic effects of 'cold working' of a metal and narrate the process of 'strain' or 'work hardening'.
- b) When a cold worked metal is heated to annealing temperature, show schematically how are mechanical properties affected at various stages of annealing.
- c) Discuss the process of precipitation and / or age hardening of metals with example. 3 + 3 + 4 + 5
11. a) Define and discuss the effect of Pething-Bedworth ratio and the other factors in respect of oxidation of metals if it is to form a protective oxide film ?
- b) Describe with sketches the anion and cation diffusion mechanisms of oxide formation on metals in detail.
- c) The density of Al is 2.7 g/cm^3 and that of Al_2O_3 is 4.0 g/cm^3 . Describe the characteristics of the Aluminium oxide film. Compare with the oxide film that forms on tungsten. The density of tungsten is 19.254 g/cm^3 and tungsten oxide (WO_3) is 7.3 g/cm^3 .

Given : M.O. of $\text{Al}_2\text{O}_3 = 101.96$, M.O. of Al = 26.981,

M.O. of $\text{WO}_3 = 231.85$, M.O. of W = 183.85

5 + 5 + 5

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12. a) Explain the principle of X-ray diffraction and determine the Bragg's equation.

b) For BCC iron, compute :

i) the interplanar spacing, and

ii) the diffraction angle for the (220) set of planes.

The lattice parameter for Fe is 0.2866 nm. Also assume that the monochromatic radiation having a wavelength of 0.1790 nm is used and the order of reflection is 1. 10 + 5

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