Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS / B.TECH(EEE / ICE)OLD / SEM-3 / MS-301 / 2012-13

2012

MATERIAL 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) Fick's first law describes diffusion process when

      a) concentration depends on time and space

      b) concentration varies with time

      c) concentration is independent of space

      d) concentration depends on space but independent of time.

   ii) In Hume-Rothery rules of extensive solid solubility, the atomic diameter of the solute and solvent atoms should not differ by more than

      a) 50% b) 15%

      c) 2% d) 0%.

iii) The term 'phonon' is related to
   a) light wave
   b) gas molecules
   c) lattice vibration
   d) positively charged ions.

iv) Which of the following elements is added to iron to improve its corrosion resistance ?
   a) Zn b) Cr
   c) Mg d) Al.

v) Curie-Weiss law is obeyed by
   a) paramagnetic materials
   b) ferromagnetic materials below Curie temperature
   c) antiferromagnetic materials
   d) ferromagnetic materials above Curie temperature.

vi) At the equilibrium separation distance for an ion pair interionic force will be
   a) zero b) minimum
   c) maximum d) any value.

vii) With the increase in temperature the orientation polarization in general
   a) increases b) decreases
   c) remains constant d) sharply increases.

viii) Dislocations are sometimes called
   a) point imperfection b) line imperfection
   c) surface imperfection d) volume imperfection.

ix) APF of regular HCP crystal structure is
   a) 0·68 b) 0·74
   c) 0·22 d) zero.

x) A cation vacancy and an anion vacancy in a crystal of the type *AB* is called
   a) Schottky defect b) Frenkel defect
   c) pair of vacancies d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What is meant by plastic behaviour of a material ? Explain with necessary stress-strain curve. What are engineering stress and engineering strain of a material ?
3. Define atomic packing factor. Prove that atomic packing factor for the FCC crystal structure is greater than the BCC crystal structure.
4. What is meant by polarization ? Explain different types of polarization mechanism involved in dielectric material.
5. What is creep ? Describe the mechanism of creep with a suitable graph.
6. State and explain Hume-Rothery rules of alloying. Hence explain the Cu-Ni solution.

GROUP – C

(Long Answer Type Questions)

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

7. a) What are ferroelectricity and piezoelectricity ? Give examples for ferroelectric and piezoelectric materials. 3 + 2

   b) What is meant by local field in a solid dielectric ? Deduce an expression for the local field in a solid dielectric and hence obtain Clausius-Mosotti relation. 2 + 4

   c) Calculate the electronic polarisability of an isolated Se atom. The atomic radius of a Se atom is 0·12 nm. 4

8. a) State some drawbacks of Drude-Lorentz theory.

   b) Explain why conductivity of a conductor decreases with temperature.

   c) If a copper wire of commercial purity is to conduct 10 A with a maximum voltage drop of 0·4 V/m, what would be its minimum diameter ?
   Given : Conductivity = $5{\cdot}85 \times 10^{7}\ \Omega^{-1}\ m^{-1}$.

d) A uniform Ag-wire has a resistivity of $1{\cdot}54 \times 10^{-8}$ Ω-m at room temperature. For an electric field along the wire of 1 V/cm, compute the average drift velocity and mobility of electron.

Given : No. of electrons = $5{\cdot}8 \times 10^{28}$ / m^3, $e = 1{\cdot}602 \times 10^{-19}$ C.

9. a) What are Schottky and Frenkel defects ? 2 + 2

b) What do you mean by dislocation in the material ? Explain different types of dislocations that may be present in the material. 1 + 4

c) With the help of a representative sketch explain briefly the salient points of the metastable iron-carbon equilibrium diagram. 6

10. a) Explain the solubility limits of Pb-Sn alloy from its phase diagram. What is the eutectic point for such an alloy ? 5 + 2

b) Define the term APF of a crystal lattice. Calculate the APF of an HCP crystal.

Given : $\frac{c}{a} = \sqrt{\frac{8}{3}}$. 5

c) Explain why *X*-rays are used in determination of crystal structures. 3