Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH (EEE-O)/ICE (O)/SEM-3/MS-301/2011-12

2011

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
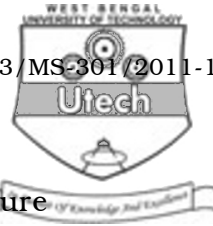
   i)   The surface crack causing fracture in a brittle material is made twice as deep, the fracture strength will

        a) decrease by $\sqrt{2}$ factor   b) decrease by factor 2

        c) decrease by factor 4   d) not change.

   ii) The average drift velocity v_x of electrons in a metal is related to the electric field E and collision time τ, as

        a) $\sqrt{\dfrac{m}{eE\tau}}$ b) $\dfrac{m}{eE\tau}$

        c) $\dfrac{eE\tau}{m}$ d) $\sqrt{\dfrac{eE\tau}{m}}$.

iii) The mobility of charge carriers in an intrinsic semiconductor is proportional to

a) $T^{3/2}$
b) T^{-2}

c) $T^{1/2}$
d) $T^{-3/2}$.

iv) The minimum number of ions in the unit cell of an ionic crystal with BCC space lattice is

a) 4
b) 8

c) 1
d) 2.

v) According to the Debey's theory, specific heat of a solid depends on temperature as

a) $\dfrac{1}{T}$
b) T^2

c) T^3
d) $\dfrac{1}{T^2}$.

vi) With insertion of a dielectric, the capacity of a capacitor

a) increases
b) decreases

c) does not change
d) changes arbitrary.

vii) In a dielecric, the polarization is

a) linear function of applied field

b) square function of applied field

c) exponential function of applied field

d) logarithimic function of applied field.

viii) Thermal conductivity of superconductor

    a)   increases with increase in temperature

    b)   increases with decrease in temperature

    c)   independent of temperature

    d)   increase initially and then decrease with increase in temperature.

ix) Ferrites are

    a)   ferromagnetic materials

    b)   anti-ferromagnetic materials

    c)   paramagnetic materials

    d)   diamagnetic materials.

x) Spontaneous magnetization is shown by the

    a)   paramagnetic components

    b)   ferromagnetic components

    c)   anti-ferromagnetic compounds

    d)   ferromagnetic compounds.

xi) The term 'phonon' is related to

    a)   light wave   b)   gas molecule

    c)   lattice vibration   d) $+ve$ charged ions.

xii) Which of the following materials is used to increase the corrosion resistance of an alloy ?

    a)   Nickel   b)   Chromium

    c)   Molybdenum   d)   Lead.

GROUP – B

(Short Answer Type Questions)

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

2. Show in the presence of dielectric, electric polarization P is related with Electric Field E and flux density D by,

$$P = \varepsilon_0 \, E \, (\varepsilon_r - 1)$$

3. a) What do you mean by strengthening mechanism of material ?

   b) What is the difference between ductile fracture and brittle fracture ? $2 + 3$

4. Write down working principle of semiconductor laser.

5. a) Define phase. In a binary phase diagram (pressure omitted), what is the maximum number of phases that can co-exist for at least one degree of freedom ?

   b) Water vapour, ice and water are in equilibrium at $0 \cdot 01°C$ and at a pressure of 613 Pa. Which of these phases would disappear, when the temperature is decreased and when the pressure is increased ?

   $1 + 2 + 2$

6. a) Explain with suitable diagram direct band gap and indirect band gap semiconductors.

   b) What is the need of optical resonator for production of LASER ? $3 + 2$
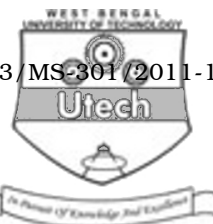
GROUP – C

(Long Answer Type Questions)

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

7. a) Explain 'internal field' in a solid dielectric. Obtain Clausius-Mosotti equation relating macroscopic dielectric constant with microscopic polarizabilities.

2 + 8

b) What is dielectric loss ? Explain the frequency dependence of dielectric properties. 2 + 3

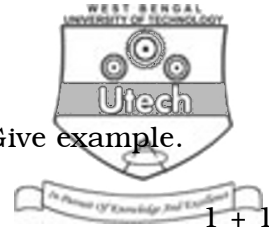8. a) What is superconductivity ? Name two superconductive material. 2 + 1

b) State Dulong-Petit Law and describe how the departure from this law at lower temperature has been explained by Einstein theory. Describe Debye's modificiation.

1 + 5 + 1

c) What are the different types of point defects ? How are they caused ? 2 + 3

9. a) What is compound semiconductor ? Give example.

$1 + 1$

b) What is the significance of band gap ? What is Fermi level ? $2 + 2$

c) Explain when intrinsic semiconductors behave as a perfect insulator. Explain when an extrinsic semiconductor behaves as an intrinsic one. $2 + 2$

d) As the concentration of electrons in a semiconductor is changed by changing impurity level, the conductivity also changes. Show that it has a minimum value when,

$$n_e = n_i \sqrt{\frac{\mu_h}{\mu_e}},$$ where n_e is the concentration of electron, n_i the intrinsic concentration, μ_e and μ_h are the mobility of electrons and holes respectively. And find the minimum value. 5

10. a) What is the difference between Elastic and Anelastic deformations ? Explain the Viscoelastic behaviour for polymers. Show and explain the different regions between the relaxation modulus and temperature plotting. $2 + 3 + 5$

b) What is the difference between ductile and brittle fractures ? Explain the mechanism for fracture propagation in materials. $2 + 3$

11. Write short notes on any *three* of the following :   3 × 5

   a)   Diamagnetism and Antiferromagnetism

   b)   Fick's laws of diffusion

   c)   The phase rule

   d)   Superconductivity

   e)   van der Waals bonding.

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