

**Total number of printed pages – 7**      **B. Tech**  
**BSCC 2202**

**Fourth Semester Examination – 2008**

**MATERIAL SCIENCE**

**Full Marks – 70**

**Time : 3 Hours**

*Answer Question No. 1 which is compulsory  
and any **five** from the rest.*

*The figures in the right-hand margin  
indicate marks.*

( $h = 6.626 \times 10^{-34}$  Js, Mass of  $e = 9.1 \times 10^{-31}$  kg,  
 $e = 1.6 \times 10^{-19}$  C,  $c = 3 \times 10^8$  m/s,  $N = 6.023 \times 10^{23}$ ,  
 $R = 8.314$  JK<sup>-1</sup>/mol,  $k = 1.38 \times 10^{-23}$  J/K,  $\mu_0 = 4 \times 10^{-7}$ ,  
at.wt. : C = 12 amu, H = 1 amu)

1. Answer in brief : 2×10
- (a) Why can not visible light produce ionic polarization ?



- (b) Why does corrosion occur in oxygen lean area although oxygen accelerates corrosion ?
- (c) Discuss various factors that affect the drift velocity.
- (d) Why does conductivity of metal decrease at higher temperature ?
- (e) What is Meissner effect ?
- (f) A plane intercepts the crystal axes 'b' at 0.5b, 'c' at 0.25c. What are the miller indices if it is parallel to the third axis ?
- (g) Name two elements which when added to Germanium will create holes.
- (h) What is glass transition temperature ?
- (i) Why is BaTiO<sub>3</sub> ferroelectric below 120°C but not above it ?
- (j) What is meant by population inversion ?

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**Contd.**

2. (a) Deduce the mathematical expression for thermal conductivity of a conducting material. 4

(b) The density and atomic weight of a metal are  $7140 \text{ kg/m}^3$  and  $65.38 \text{ amu}$  respectively. The relaxation time is  $10^{-14} \text{ sec}$  at  $300 \text{ K}$ . Calculate 6

(i) resistivity

(ii) mobility of electrons and

(iii) the average drift velocity when an electric field of  $10 \text{ V/cm}$  is applied. (no of valence electrons = 2)

3. (a) What is Fermi energy ? What is the probability of finding the electron at the

Fermi energy level in a metal ? Will the probability be higher or smaller at Fermi energy level at a higher temperature ? 3

(b) Calculate the electron velocity at Fermi energy of sodium at  $0\text{K}$ . (density= $970 \text{ kg/m}^3$ , at.wt.= 23) 4

(c) Distinguish between conductor, semiconductor and insulator on the basis of band theory. 3

4. (a) There are  $10^{12}$  magnesium atoms, which replace an equal number of silicon atoms in a  $10 \text{ mm}^3$  wafer. Compare the conductivity with  $10^{12}$  aluminum atoms replacing equal number silicon atoms. 3

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(b) At an higher temperature, one of every  $10^{10}$  valence electrons in intrinsic silicon is in the conduction band.

(i) What is the conductivity ?

(ii) What is the temperature ?

( $a = 0.543 \text{ nm}$ ,  $\sigma_{20} = 5 \times 10^{-4} \text{ mho/m}^4$ ,  
no of atoms per unit cell = 8) 4

(c) In an n-type semiconductor, the Fermi energy level lies 0.3eV below the conduction band. Find the position of Fermi level if the temperature is increased to 350 K.

3

5. (a) Distinguish between hard and soft magnetic materials. 3

(b) A paramagnetic material has a magnetic field intensity of  $10^6 \text{ A/m}$ . Calculate the

magnetization and flux density if susceptibility is  $1.4 \times 10^{-3}$  at room temperature.

3

(c) Discuss the structure and applications of ferrites. 4

6. (a) Differentiate between type-I and type-II superconductors. 3

(b) Calculate the critical magnetic field for Tin at 1.5K and 2.5K. ( $T_c = 3.72\text{K}$ ,  $H_c(0) = 0.03 \text{ Tesla}$ ). 4

(c) The polarisability of argon is  $1.8 \times 10^{-40} \text{ Fm}^2$ . Calculate the dielectric constant at NTP. 3

7. (a) What are isotactic, syndiotactic and atactic polymers ? 3

(b) The weight average degree of polymerization for polypropylene is 15000. Calculate the weight average molecular weight. 3

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**Contd.**

- (c) Discuss about glass fibre reinforced polymer composite. 4
8. (a) Discuss the phenomenon of passivity. Why are chromium steels more corrosion resistant than carbon steel ? 5
- (b) What is LASER ? Discuss the mechanism of LASER action of He-Ne laser. 5

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