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No. of Printed Pages—3

EE-403

B. TECH.

FOURTH SEMESTER EXAMINATION, 2003-2004

ELECTRICAL ENGINEERING MATERIAL

Time : 2 Hours

Total Marks : 50

Note : Attempt ALL questions.

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1. Attempt any FOUR :—

- (a) The potential energy W of a system of two atoms varies as a function of their distance of separation r as follows :—

$$V = -\frac{\alpha}{r^n} + \frac{\beta}{r^m}$$

Determine an expression for their bond energy at equilibrium involving only the constants α , n and m .

- (b) Draw a (110) and $(\bar{1}\bar{1}1)$ plane inside a cubic unit cell. Determine the Miller indices of the direction that is common to both these planes.
- (c) Calculate the percentage ionic character of the compound semiconductor, Ga As and In As by using Pauling's equation. Electronegativity of Ga, As and In are 1.8, 2.2 and 1.5 respectively.
- (d) In a crystal whose primitives are 1.2 \AA , 1.8 \AA and 2 \AA , along whose Miller indices are $(2,3,1)$ cuts intercept 1.2 \AA along X axis. What will be the length of intercepts along Y and Z axes ?

135

- (e) Calculate the c/a ratio for an ideally close packed HCP crystal.
- (f) Write short notes on :
 - (i) Crystal Growth
 - (ii) Screw Dislocation
 - (iii) Bragg's Law

2. Attempt any *FOUR* :—

- (a) State and prove Wiedemann-Franz-Lorentz relation.
- (b) Find the probability for an electronic state to be occupied at room temperature, if the energy of this state lies 0.5 eV above the Fermi level. Do the same for a state which lies below the fermi level.

$$K_{\beta} = 1.38 \times 10^{-23} \text{ J/atom-K,}$$

$$\text{Room Temperature} = 300 \text{ K.}$$

- (c) As the concentration of electrons in a semiconductor is changed by changing the impurity level, the conductivity also changes. Show that it passes through a minimum,

$$\text{when } n_e = n_i \sqrt{\frac{\mu_h}{\mu_e}} \text{ and find the minimum}$$

value. n_i is the intrinsic concentration.

- (d) Prove the London equation $\nabla^2 \vec{B} = -\frac{1}{\lambda^2} \vec{B}$,

where λ is the penetration depth.

- (e) Using drift and diffusion current in a semiconductor, find an expression of continuity equation.

(f) Define reverse saturation current and explain its temperature dependence.

3. Attempt any TWO :—

(a) Derive units of α_e from that of electric field strength E and dipole moment (α_e : electronic polarisability).

• Discuss atomic mechanism of polarisation.

(b) Derive Clausius-Mossotti Relation.

The atomic weight and density of sulphur are 32 and 2.08 gm/cm³ respectively. α_e of the atom is 3.28×10^{-40} F-m². If sulphur solid has cubical symmetry, what will be its relative dielectric constant ?

(c) Prove that the energy dissipated in dielectric material as dielectric loss per unit volume is given by —

$$p = \frac{W}{2} \epsilon_o \epsilon_r' E_0^2$$

4. Attempt any TWO :—

(a) Does a large magnetic moment per atom mean a high curie temperature ? Explain. Discuss Langevin's theory of paramagnetism and derive an expression for paramagnetic susceptibility.

(b) Iron has a curie temperature 1041 K, but it is not magnetic in the absence of magnetic field. Explain. Discuss phenomenon of domain theory.

(c) Differentiate between :

(i) Diamagnetism and paramagnetism, and

(ii) Soft and hard magnetic materials.

