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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.

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 Å, 1·8 Å and 2 Å, along whose Miller indices are (2,3,1) cuts intercept 1·2 Å along X axis. What will be the length of intercepts along Y and Z axes ?

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(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.

$K_\beta = 1{\cdot}38 \times 10^{-23}$ J/atom-K,
Room Temperature = 300 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, when $n_e = n_i \sqrt{\frac{\mu_h}{\mu_e}}$ 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.

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(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/cm^3 respectively. α_e of the atom is $3{\cdot}28\times10^{-40}$ F-m^2. 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 —

$$p = \frac{W}{2} \in_o \in_r' E_0^{\,2}$$

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.

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