53 (IE 303) EEMD

2018

ELECTRICAL ENGINEERING MATERIALS AND DEVICES

Paper : IE 303

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **seven**.*

1. *(a)* Explain the seven crystal systems. Give their names, specifications and the types of lattice structures in each class. 10

   (b) Differentiate between the lattice structure and crystal structure of the materials Silicon and *GaAs*. 5

   (c) What do you understand by Bragg's law? Discuss *any one* application of Bragg's law with the help of necessary equation. 5

2. *(a)* List the assumptions in Drude model. 4

(b) Derive the expression for AC conductivity of a material using Drude model. 6

(c) Using Drude model, derive the probability for successive collisions by a single electron to be separated by a time 't'. Employing this result, derive the expression for heat generated per unit volume in a conductor due to the flow of electric current. 10

3. *(a)* Explain the various phenomena associated with superconductivity. Differentiate between Type-I and Type-II superconductors. Give an example of high T_C superconductor, and discuss its applications. 10

(b) Derive the expression for thermal conductivity of a material using Drude's model. 5

(c) Discuss the corrosion properties of Aluminium and Copper conductors. 5

4. *(a)* The electrons in conduction band of a semiconductor material can be represented using the effective mass equation, $-\frac{\hbar^2}{2m_e^*}\nabla^2\psi(x, y, z) = E\psi(x, y, z)$ where $\hbar$ is the Planck's constant and m_e^* is the electron effective mass. Derive the expression for density of states using periodic boundary conditions. 10

(b) Explain how Fermi-Dirac distribution function determines the number of electrons in conduction band. Derive the expression for this number in terms of effective density of states. 10

5. *(a)* Draw the energy band diagram of n-type and p-type semiconductors. Explain how Fermi level vary as a function of doping concentration. 5

(b) Show that the product of electron and hole concentration is a constant and it is equal to the square of intrinsic carrier concentration, n_i. 5

(c) Derive the expression for diffusion current in a semiconductor which is non-uniformly doped with donor impurity. 5

(d) Show that the Fermi level is a constant along the length of a semiconductor at equilibrium conditions. 5

6. (a) Show that $\frac{D_n}{\mu_u} = \frac{K_B T}{|q|}$

where D_n is the electron diffusion constant and μ_u is electron mobility. K_B is the Boltzman's constant, T is the temperature in °K and q is the charge of electron. 5

(b) Explain how n-type and p-type semiconductors can be distinguished using Hall effect. 5

(c) Using schematic diagram, explain how dielectric materials can be polarized. 5

(d) Define the term permittivity and discuss the case when it becomes a complex quantity. 5

7. (a) Write short notes on the following types of magnetic materials —
(i) dia, (ii) para, (iii) ferro and (iv) antiferro magnetic materials. 10

(b) Distinguish between :

(i) Piezo-electric Effect and Magnetostriction

(ii) Soft and Hard Magnetic Materials. 10
