53 (IE 303) EEMD

2019

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.*

1. *(a)* What are crystals ? Explain how a given crystalline material can be classified into one of the 7-crystal systems. Differentiate between the lattice structure and crystal structure of a crystalline silicon. 10

   (b) Discuss how planes are specified in crystals. Explain how one can measure the inter-planar distance experimentally. Give an example of a planar defect. 10

Contd.

2. *(a)* What do you understand by polarization of a dielectric constant? Discuss how polarization in static electric field can be related to the dielectric constant of the material. Distinguish between electronic and ionic polarization. 10

(b) Define the term orientational polarization. Derive the expression for orientational polarization and show that at room temperatures its value is inversely proportional to absolute temperature. 10

3. *(a)* What is electrostriction? Discuss how purely electrostrictive materials is different from piezoelectric materials. 6

(b) Show that electronic polarizability is complex quantity when a dielectric material is subjected to alternating electric field. 8

(c) Evaluate the expression for dielectric loss if a material is characterized by a complex dielectric constant. 6

4. *(a)* What do you understand by Larmor frequency? Explain how it gives rise to magnetisation in diamagnetic materials. 6

(b) Derive the expression for magnetization in paramagnetic materials and show how it depends on the external magnetic field and the temperature of the material. 8

(c) What is spontaneous magnetization and explain how it is different in soft and hard magnetic materials? 6

5. *(a)* Derive the expression for dc electrical conductivity and thermal conductivity for conductors using Drude's model. 10

(b) In free electron gas model find the probability for successive collisions of a single particle separated by a time '*t*' seconds. Using this result, evaluate the expression for Joule's heating (ie power dissipated per unit volume). 10

6. *(a)* Explain the phenomena of superconductivity. What is Meissner effect and discuss how it differs in Type-I and Type-II superconductors ? Give *any two* practical applications of superconductors. 10

(b) Explain the phenomena of Hall effect with the help of a neat diagram. Derive the expression for Hall coefficient for a p-type semiconductor treating the carrier velocity as a vector. 10

7. *(a)* Write the dispersion relation (E *vs* k) for semiconductors. From it, derive the expression for density of electrons and holes in a semiconductor using Fermi-Dirac statistics. 8

(b) What is diffusion current ? Derive its expression for electrons and holes in the case of positive concentration gradient. 6

(c) Prove that the Fermi-level is continuous and doesn't bend across a p-n junction under open-circuited condition. Using it, derive Einstein's relation. 6