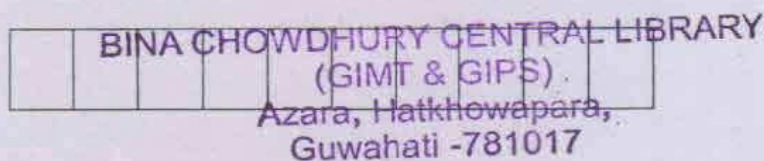


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EE 131303

Roll No. of candidate



2019

B.Tech. (EE) 3rd Semester End-Term Examination
MATERIAL SCIENCE
(New Regulation)
(w.e.f. 2017-2018)

Full Marks – 70

Time – Three hours

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

Answer question No. 1 and any *four* from the rest.

1. Fill in the blanks : (10 × 1 = 10)
- (i) In dielectric materials the spontaneous polarization vanishes above a certain temperature and the material becomes _____
 - (ii) A _____ material has negative magnetic susceptibility.
 - (iii) The relative permeability of a diamagnetic material always approaches _____.
 - (iv) The net magnetic moment is zero for _____ materials.
 - (v) _____ Rule indicates that the various contributions to the resistivity of metals are independently additive.

[Turn over

- (vi) The hysteresis loop of a ferroelectric material changes its shape with increase in _____.
 - (vii) The atomic packing fraction for B.C.C cubic crystal is _____.
 - (viii) A state of material in which it has zero resistivity is called _____.
 - (ix) The ferromagnetic materials show spontaneous magnetization below _____ temperature.
 - (x) The density of charge carriers in an extrinsic semiconductor can be found by measurement of the _____ of the material.
2. (a) What is crystal lattice? Calculate the packing fraction for Simple Cubic (SC), Body-Centred Cubic (BCC) and Face-Centred Cubic (FCC) crystal structures. (2 + 6 = 8)
- (b) State the Bragg's law. Gold with atomic radius 1.44 Å and face-centred cubic structure is used to determine the wavelength of X-rays. Calculate the wavelength of X-rays if the (111) plane diffracts the beam by 32.1° . Assume first order diffraction. (2+5=7)
3. (a) Define electronic polarization and orientational polarization in a dielectric material. Derive an expression for the static dielectric constant of a monoatomic gas. (2+5=7)
- (b) Assuming a Lorentz internal field, deduce Clausius-Mosotti relation for a solid containing N atoms/ m^3 , each atom having polarizability α . (5)
- (c) Find the total polarizability of CO_2 at 273 K and 1 atmospheric pressure if its susceptibility is 0.985×10^{-3} and $N = 27 \times 10^{25}$ atoms/ m^3 . (3)

4. (a) Define the terms Diamagnetism, Paramagnetism, Ferro-magnetism, Anti-ferromagnetism and Ferrimagnetism with reference to magnetic dipoles of the atoms. (5)
- (b) Derive an expression to show the relationship between susceptibility and temperature for Anti-ferromagnetic materials above the Neel temperature. (7)
- (c) Write a short note on Magnetic Anisotropy. (3)
5. (a) Explain the Meissner Effect in superconductors. (3)
- (b) Deduce an expression for the current density in a conductor with the help of the free electron theory of metals. (5)
- (c) A conducting wire has resistivity of 1.54×10^{-18} ohm-m at room temperature. There are 5.8×10^{28} conduction electrons per m^3 and the Fermi energy is 5.5 eV. Calculate the mobility and mean free path of the electrons. (4)
- (d) What are the factors affecting the resistivity of conductive materials? (3)
6. (a) What are n-type and p-type semiconductors? Derive an expression for the concentration of charge carriers in n-type and p-type semiconductors. (2 + 5 = 7)
- (b) Find the diffusion coefficients of electrons and holes of a silicon single crystal at 27°C , if the mobilities of electrons and holes are 0.17 and $0.025 \text{ m}^2 \text{ volt}^{-1} \text{ sec}^{-1}$ respectively at 27°C . (4)
- (c) Explain in brief the fabrication process of bipolar junction transistors. (4)

7. (a) Define piezoelectric, pyroelectric and ferroelectric materials. (3)
- (b) What is dielectric loss? Deduce an expression for the loss angle of a dielectric. (2 + 4 = 6)
- (c) What is crystal imperfection? Explain the various types of defects in solids. (6)
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