Total No. of printed pages = 6

EE 131303

Roll No. of candidate | | | | | | | | | | |

2017

B.Tech. 3rd Semester End-Term Examination

Electrical

MATERIAL SCIENCE

Full Marks – 100 Time – Three hours

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

Answer Question No. 1 and any *six* from the rest.

1. Answer the following questions : (10 × 1 = 10)

   (a) Coordination number in simple cubic crystal structure

   (i) 2

   (ii) 3

   (iii) 4

   (iv) 6

   (b) Identify a good dielectric.

   (i) Iron

   (ii) Ceramics

   (iii) Plastic

   (iv) Magnesium

[Turn over

(c) Dielectric loss is a function of

(i) Frequency

(ii) Temperature

(iii) Both

(iv) None

(d) Edge dislocation Imperfection is a sub type of

(i) Point Imperfections

(ii) Line Imperfections

(iii) Volume Imperfection

(iv) Surface Imperfection

(e) Materials which can store electrical energy are

(i) Magnetic material

(ii) Semiconductor

(iii) Dielectric material

(iv) Super conductors

(f) Drift Current in semiconductor is due to

(i) Electric field

(ii) Gradient of carrier concentration

(iii) Magnetic field

(iv) Holes

(g) Identify the ferroelectric material

(i) Rochelle salt

(ii) Quartz

(iii) Zinc oxide

(iv) Lead zirconate

(h) The materials having low coercive force are suitable for making

(i) Weak magnets

(ii) Soft magnets

(iii) Hard/Permanent magnets

(iv) None of the above

(i) The ratio of intensity of magnetization to magnetization force is

(i) Flux density

(ii) Susceptibility

(iii) Permeability

(iv) None of the above

(j) The material which has negative value of susceptibility is

(i) Ferromagnetic

(ii) Paramagnetic

(iii) Diamagnetic

(iv) Ceramic

2. (a) For a BCC crystal, find out the relation between atomic radius (r) and lattice constant (a) and also the atomic packing factor for BCC crystal structure. (2 + 3 = 5)

(b) Find out the Miller Indices for the following intercepts: (1 + 1 + 1 = 3)

(i) a, b/2, 3c

(ii) a, 2b, -3c/2

(iii) a, 2b, ∞.

(c) Explain the Bragg's law with a suitable diagram. (3)

(d) A beam of X-rays of $\lambda = 0.842\mathring{A}$ is incident on a crystal at a glancing angle of 18°, when the 1st Bragg's reflection occurs. Calculate the glancing angle for 3rd order reflection. (4)

3. (a) What is polarization in dielectric materials? Explain its types in brief. (4)

(b) The dielectric constant of helium, measured at 0°C and 1 atmosphere is $\varepsilon_r = 1.0000684$. Under these conditions the gas contains 2.7×10^{25} atoms per m^3. Calculate the radius of electron cloud (atomic radius). Also calculate the displacement 'x' when a Helium atom is subjected to a field of 10^6 V/m. (5)

(c) What is a dipole moment? With reference to a 2-D Cartesian coordinate system (x,y) four point charges are located as follows: a charge of Q coulomb at the point (0,0); -Q at (1,0); 3Q at (1,1) and -3Q at (0,1); the numbers refer to meters. Find the magnitude and direction of net dipole moment of the system. (2 + 4 = 6)

4. (a) Derive the expression for internal field in solid and liquid dielectrics. (5)

(b) Define polarizability. The susceptibilty of Argon at 273 K and 1 atmosphere is 4.35×10^{-4}. Find the atomic polarizability of argon when $N = 2.7 \times 10^{25}$ atoms per m^3. (2 + 3 = 5)

(c) Derive the Debye's generalization Clausius-Mosotti relation for a solid containing N atoms/m^3, each atom having polarizability α Farad m^2. (5)

5. (a) Write short notes on

(i) Ferromagnetic Domains.

(ii) Magnetostriction. (4)

(b) Derive expression for relation between susceptibility and temperature for ferromagnetic materials above Curie temperature. (5)

(c) What are soft and hard magnetic materials with applications? (3)

(d) Explain the method of classifying magnetic materials. (3)

6. (a) Describe the phenomenon of superconductivity and its behavior in magnetic field. Give some applications. (3 + 3 + 3 = 9)

(b) Why is carbon preferred for brushes in electrical machines? (3)

(c) Define relaxation time, collision time, mean free path. (3)

7. (a) The Hall Effect of a p-type semiconductor is positive. What is its significance? (2)

(b) What do you understand by drift and diffusion currents in case of transistor? Deduce the Einstein Relation relating to these currents. (2 + 5 =7)

(c) Explain the behavior of p-n junction under forward and reverse bias conditions. (3)

(d) The resistivity of intrinsic germanium at 300 K is 0.47 ohm-m. If the electron hole motilities are 0.38 and 0.18 m^2 $volt^{-1}$ s^{-1}, calculate the intrinsic carrier density at 300K. (3)

8. (a) Derive Joules law. (5)

(b) The following data for copper

Density= 8.92 g/cc

Resistivity = 1.73×10^{-8} ohm-m

Atomic weight = 63.5

Calculate mobility and average time of collision of electrons in copper. (6)

(c) A solenoid of 0.3 m length and 2 cm in diameter is required to develop magnetic field of 10 kA/m in vacuum when powered with 1 A.

(i) Determine the number of turns of wire.

(ii) What is the DC voltage required to power if the solenoid is wound with 0.5 mm diameter copper wire. The resistivity of copper is 17.2×10^{-6} Ohm-m. (4)

9. (a) Classify the bonds and also give their properties. (5)

(b) Explain briefly about the various crystal defects. (5)

(c) Write about piezoelectricity and dipolar relaxation. (5)