B.E. Instrumentation and Electronics Engineering

Second Year - First Semester EXAMINATION, 2019

Subject: Material science

Total Marks: 100 **Time: 3 hours**

Answer ALL the Four Modules
(All the sub questions are answered should be in one place.)

MODULE I

(Answer any one question)

1. (a) Calculate the atomic packing factor of face centred cubic (fcc) structure. (5)
   (b) Describe the three primary bonds in materials? Which is the strongest? (5)
   (c) What are Miller indices? Determine the miller indices of plane of intercepts on X, Y and Z axis are ½ a, 2a, -2a. (5)
   (d) Define Burger circuit, draw burger vector and slip plane for edge dislocation. (5)

2. (a) Describe different type of defects in crystal with appropriate diagram. (12)
   (b) With diagram showing X-ray diffraction, derive an expression for Bragg's law. (3)
   (c) Calculate the equilibrium number of vacancies per cubic meter for copper at 1000 °C. The energy for vacancy formation is 0.9 eV/atom; the atomic weight and density (at 1000 °C) for copper are 63.5 g/mol and 8.4 g/cm^3, respectively and k = 8.62×10^{-5} eV/K. (5)

MODULE II

(Answer any two questions)

3. (a) Derive the relation between the measureable quantity ε_r and atomic polorizability α_e for monoatomic gases. (5)
   (b) Derive Clausius- Mosotti relation for dielectrics subjected to static field. (5)
   (c) What is orientation polarization (P_o)? Consider a system of N permanent dipoles of magnitude μ_p at temperature T and by the application of electric field E along the x-axis, the $P_o = N \mu_p^2 E/3kT$. (10)

4. (a) Derive the relation for the frequency dependence of the electronic polorizability (α_e^*) and also graphically represent the frequency dependence of the real (α'_e) and imaginary (α''_e) parts of α_e^* for a single electron. (10)
   (b) Describe domain configuration in ferromagnetic materials. (4)
   (c) Classify ferroelectric materials on the basis of their chemical composition and structure with suitable examples (6)

5. (a) For a cylindrical piece of material subjected to a homogeneous field H produced by a solenoid, show that that $B = \mu_0 (H+M)$ (6)

(b) What is Bohr Magneton, show that orbital angular momentum is equal to (-e/2m) times the angular momentum for the case of a spherical charge cloud. (8)

(c) Describe antiferromagnetic materials and illustrate reciprocal of susceptibility as a function of temperature for a paramagnetic, ferromagnetic and anti-ferromagnetic materials. (6)

MODULE III

6. (a) What is high T_c superconductors, give two examples and briefly describe type I and type II superconductors. (10)

(b) What is polling in piezoelectric materials and write down the coupled equation to describe the direct and converse piezoelectric effect. (10)

(c) Define cooper pair and explain BCS theory on superconductivity. (10)

MODULE IV

7. (a) Illustrate motor and generator action in piezoelectricity. (10)