This question paper contains 7 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **6442**

Unique Paper Code : **251102** **D**

Name of the Paper : **ELHT-102 : Engineering Materials**

Name of the Course : **B.Sc. (Hons.) Electronics**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question No. **1** is compulsory.

Use of non-programmable scientific calculator is allowed.

1. (*a*) Define : 3×5=15

(*i*) Unit Cell

(*ii*) Packing Factor

(*iii*) Miller Indices.

(*b*) At 300 K, Aluminium has FCC structure with a = 3.9 Å. What would be the Bragg angle for (111) reflection (1st order) when CuKα(λ = 1.54 Å) radiation is used.

(*c*) Compute the electrical conductivity of a 5.1 mm diameter cylindrical silicon specimen 51 mm long in which a current of 0.1 A passes in an axial direction. A voltage of 12.5 V is measured across two probes that are separated by 38 mm. Also compute the resistance over the entire 51 mm of the specimen.

P.T.O.

(*d*) Estimate the energy required to raise the temperature of 2 kg of the following materials from 20 to 100°C :

(*i*) aluminum (specific heat is 900 J/kg-K)

(*ii*) soda-lime glass (specific heat is 840 J/kg-K)

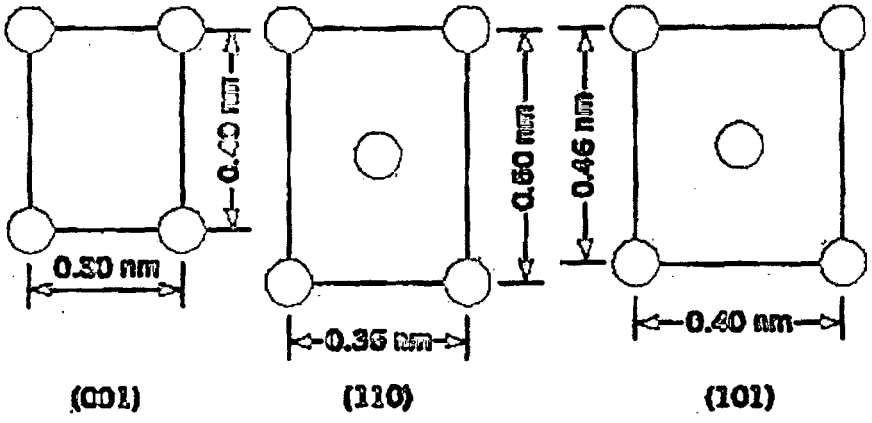
(*iii*) high-density polyethylene (specific heat is 1850 J/kg-K).

(*e*) A coil of wire 0.25 m long and having 400 turns carries a current of 15 A :

(*i*) What is the magnitude of the magnetic field strength H and magnetic flux density if the coil is in vacuum ?

(*ii*) Compute the flux density inside a bar of Chromium that is positioned within the coil. The susceptibility of Chromium is 3.13×10^{-4}.

2. (*a*) Below are shown three different crystallographic planes for a unit cell of some hypothetical metal. The circles represent atoms : 6

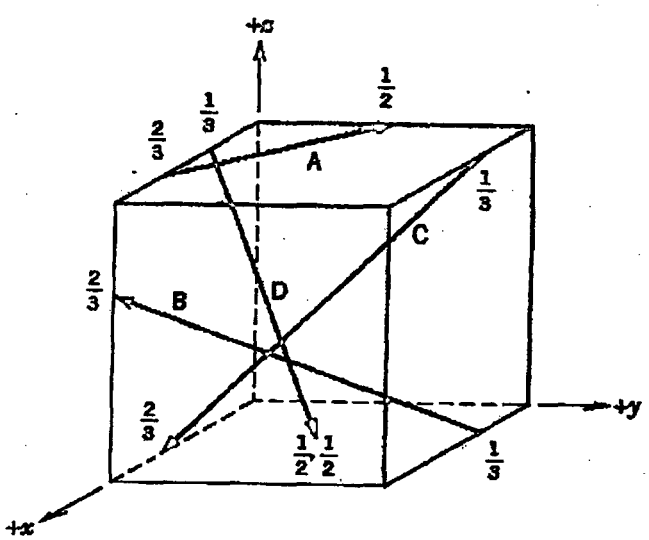


(*i*) To what crystal system does the unit cell belong ?

(*ii*) What would this crystal structure be called ?

(*iii*) If the density of this metal is 8.95 g/cm^3, determine its atomic weight.

(*b*) Determine the indices for the directions (A, B, C and D) shown in the following cubic unit cell. 4



(*c*). Explain various types of point defects in a crystal. What is the influence of point defects on the properties of the material ? Are defects always undesirable ? 5

P.T.O.

3. (*a*) The fatigue data for a ductile cast iron is given as follows : 6

Stress Amplitude [MPa]	Cycles to Failure
248	1×10^5
236	3×10^5
224	1×10^6
213	3×10^6
201	1×10^7
193	3×10^7
193	1×10^8
193	3×10^8

(*i*) Make an S—N plot (stress amplitude versus logarithm cycles to failure) using these data.

(*ii*) What is the fatigue limit for this alloy ?

(*iii*) Determine fatigue lifetimes at stress amplitudes of 230 MPa and 175 MPa.

(*iv*) Estimate fatigue strengths at 2×10^5 and 6×10^6 cycles.

(*b*) What is true stress and true strain ? Discuss the significance of true stress. Derive an expression to relate true stress to engineering stress. 4

(*c*) Differentiate between brittle and ductile materials graphically. On this basis, define yield strength and ductility. Give an expression for percentage elongation in trems of length and area. Why ductility is considered as an important design parameter in drawing of wires ? 5

4. (*a*) Explain variation of electrical conductivity in metals with low and high temperature and hence explain Matthiessen's rule. What is the distinction between electronic and ionic conduction ? 5

(*b*) The intrinsic carrier density of germanium at 300 K is 1.7×10^{19} m^{-3}. It is doped with a pentavalent impurity of concentration 1 ppm (parts in million). Assuming that all the impurity atoms are ionized, calculate :

(*i*) the factor by which the majority concentration is more than the intrinsic carrier concentration

(*ii*) hole concentration

(*iii*) conductivity.

Given that density of germanium is 5.32×10^3 kg/m^3, atomic weight = 72.59 mobility of electron is 0.36 m^2/V-s and that of hole is 0.18 m^2/V-s. 6

(*c*) Explain Hall Effect. Discuss its importance and derive the expression for Hall coefficient. 4

5. (*a*) Derive an expression for the specific heat of solids on the basis of Debye model and discuss the variation of Debye specific heat with temperature. 6

(*b*) For each of the following pairs of materials, decide which has the larger thermal conductivity. Justify your choices : 3

(*i*) Pure copper; aluminum bronze (95 wt% Cu-5 wt%Al)

(*ii*) Fused silica; quartz.

(*c*) What do you mean by thermoelectricity ? Explain the Seeback, Thomson and Peltier effect. 6

6. (*a*) What is meant by local field in a solid dielectric ? Deduce an expression for the local field in a solid dielectric and hence obtain Clausius-Mossotti equation. 6

(*b*) Define spontaneous polarization. How does it vary with temperature ? Explain ferroelectric and paraelectric transition on its basis. 4

P.T.O.

(*c*) Ammonium chloride gas has dielectric constant of $\in_r = 1.0083$ at 0°C and $\in_r = 1.0049$ at 100°C. The number of molecules per unit volume = 2.7×10^{25} m^{-3} at 0°C. Calculate the permanent dipole moment of ammonium chloride. 5

7. (*a*) What are hard and soft ferromagnetic materials ? What are their chief characteristics ? Also mention their one application each. 6

(*b*) Nickel is FCC and its lattice parameter is 3.52 Å. The magnetic moment of nickel atom is 0.6 Bohr magneton. Calculate the saturation magnetization of Nickel. 4

(*c*) What are ferrites ? Compare their properties with ferromagnetic materials on the basis of their structure and magnetic moment. Why they are preferred over ferromagnetic materials in high frequency applications ? 5