Ref. No. : Ex/ME/T/324/2017(Old)

B. E. MECHANICAL. ENGG 3RD YR. 2ND SEM.(OLD) -2017
MATERIAL SCIENCE & ENGINEERING

Time: Three hours | ***Answer any FIVE questions*** | Full Marks: 100

Answer should be brief and to the point

Q1 (a). Deduce Fick's second law of diffusion.

(b). A 0.85% Carbon Steel component has been decarburized at 900 °C for a duration of 5 hours in an atmosphere equivalent of 0.2% Carbon at the surface of the component.

Calculate the percentage concentration of carbon at a depth of 0.25 mm. from the surface of the component.

Given: Do = 0.7×10^{-4} m^2/s, Q = 157 KJ/mol, R = 8.314 J/mol.K.

Z	0.25	0.30	0.35	0.40	0.45
Erf(z)	0.2763	0.3286	0.3794	0.4284	0.4755

5+15 = 20

Q2 (a). Derive the expression for composite elastic modulus under iso-strain condition for a fibre reinforced composite material. Also mention the assumptions made to derive the expression. 6+4=10

(b). For a fibre reinforced composite material, the modulus ratio is 26 & the fibre takes 35 % of the cross sectional area. What percentage of the longitudinal load is taken by the fibre? 5

(c) Explain the stress-strain behavior of a fibre reinforced composite under longitudinal loading. 5

[Turn over]

Q3 (a). Explain, using an energy-band diagram, how electrons and electron holes are created in pairs in intrinsic silicon.\

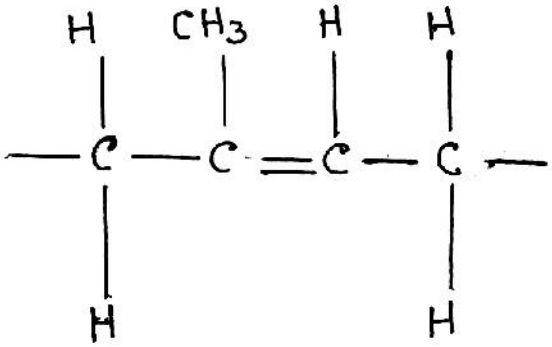
(b). The electrical resistivity of pure silicon is $2.3X10^{3}\Omega m$ at 300 K. Calculate its electrical conductivity at 300°C. Assume that the Eg of silicon is 1.1 ev; K = $8.62X10^{-5}$ Ev/K.

(c). Define n-type and p-type extrinsic silicon semiconductors. 7+7+6=20

Q4 (a). Define the degree of polymerization for a polymer chain.

Write a general chemical reaction for the chain polymerization of ethylene monomer into the linear polymer polyethylene.

(b). How many kilograms of sulphur are needed to cross-link 20% of the cross-link sites in 300kg of polyisoprene rubber?



(Poly-isoprene Rubber)

(c). Define the degree of polymerization for a polymer chain. 7+7+6=20

Q5 (a). Calculate the density of zinc blends (ZnS). Assume the structure to consist of ions and that the ionic radius of Zn^{2+} = 0.060 nm and that of S^{2-} = 0.174 nm.

(b). Define coordination number and critical radius ratio for the packing of ions in ionic solids.

(c). How does the specific volume vs temperature plot for a glass differ from that for a crystalline material when these materials are cooled from the liquid states. Name two glass forming oxides. 7+6+7 = 20

Q6(a). Define a thermosetting plastic. Describe the atomic structural arrangement of thermoplastics.

(b). Write structural formulas for the mers of the following vinyl polymers:

(i) PTFE (ii) PS (iii) PVC (iv) PE

(c). Describe the vulcanization process of rubber.

7+6+7 = 20

Q7 (a). Explain why the electrical conductivity of intrinsic silicon and germanium increases with increase in temperature.

(b). Why must one consider the average degree of polymerization and the average molecular weight of a thermoplastic material.

(c). What are plasticizers? How do plasticizers usually affect the strength and flexibility of polymeric materials?

(d). What are glass network modifiers? How do they affect the silica- glass network? Why are they added to silica glass? 5+5+5+5 = 20

[Turn over

Q8 (a). Write short notes on the following (any four): 5X4=20

i) Ionic bond

ii)Visco-elastic property of polymers

iii) Pizoelectric materials

iv) Degree of polymerization

v) Electrical insulator

vi) Engineering ceramics & traditional ceramics

vii) Elastomers

viii) Difusion flux