

B. MECHANICAL (EVENING) 4TH YEAR 1ST SEM. SUPPLE EXAMINATION, 2017

MATERIAL SC. AND ENGG.

Time: Three hours

Full Marks: 100

Answer any FIVE questions

1a) The potential energy of a system of two isolated atoms is given by the following expression:

$$U(r) = -\frac{A}{r^m} + \frac{B}{r^n}, \quad \text{where } r = \text{Interatomic distance; } A, B, m \text{ and } n \text{ are constants}$$

Derive the expressions for bond energy and bond length. (14)

b) Mention a few characteristics of covalent bond. (6)

2a) What is solid state diffusion ? Explain any one diffusion mechanism. (2+4)

b) For a carburization process, the carbon environment used has carbon content of 1.4%. The initial carbon content in steel is 0.3% and a carbon content of 0.8% is reached at a depth of 0.75 mm from the surface in 10 hours. Determine the carburization temperature. (14)

$$\text{Given: } D_0 = 20 \times 10^{-6} \frac{m^2}{s}; \quad Q = 142 \frac{KJ}{mol}; \quad R = 8.314 \frac{J}{mol K}$$

Z	0.45	0.50	0.55	0.60
erf(Z)	0.4755	0.5205	0.5633	0.6034

3a) Derive the expression for composite elastic modulus under iso-stress condition. Also mention the assumption made to derive the expression. (8+4)

b) For a fibre reinforced composite material, the fibre takes 95% of the applied longitudinal force. The cross sectional area of the fibre is 30%. Calculate the modulus ratio of the composite. (8)

4a) Explain the 'energy band structure' in solids. Differentiate among conductors, semiconductors and insulators in the light of energy band structure. (6+6)

b) The electrical resistivity of pure silicon is $2.3 \times 10^3 \Omega\text{-m}$ at 50°C . Calculate its electrical conductivity at 300°C . Assume that E_g of silicon is 1.106 eV.

$$\text{Boltzman constant} = 86.2 \times 10^{-6} \frac{eV}{K} \quad (8)$$

[Turn over

5a) What do you mean by 'Intrinsic' and 'Extrinsic' semiconductors ? (10)

b) For intrinsic semiconductors, prove that $\frac{n}{N} = e^{-\frac{E_g}{2kT}}$. The notations bears usual meanings.

What is p-type semiconductors ? (6+4)

6 a) Explain the Fermi-Dirac electron energy distribution function with the meanings of different notations used in the equation. (8)

b) Explain the terms 'piezoelectricity'. Mention three piezoelectric materials. (4+3)

c) A piezoelectric material has elastic modulus 85 GPa. Calculate the stress required to change its polarization from $850 \frac{C}{m^2}$ to $880 \frac{C}{m^2}$. (5)

7a) State Fick's laws of diffusion. (6)

b) Explain the Arrhenius equation for solid state diffusion. (4)

c) Explain the stress- strain diagram for a fiber reinforced composite material. (10)

8. Write short notes on the followings (any four): (4X5)

a) Co-ordination number

b) Diffusion and material property

c) Metallic bond

d) Diffusion flux

e) Bond length

f) Electrical conductivity

g) Composite material