

**ENGINEERING MATERIALS
(MECH 2104)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
 - (i) If 'a' is the lattice parameter of a Body Centered Cubic (BCC) crystal, then the distance between two nearest neighbours are
(a) $(\sqrt{3}/2)a$ (b) 2a (c) $\sqrt{(2a)}/3$ (d) $\sqrt{3}$.
 - (ii) Which of the following bond is the weakest?
(a) Ionic bond (b) Covalent bond
(c) Metallic bond (d) Secondary dipole bond.
 - (iii) Pearlite is a mixture of cementite and
(a) ferrite (b) austenite
(c) bainite (d) martensite.
 - (iv) Austenite has a maximum solubility of carbon in iron of
(a) 0.76% at 727°C (b) 1.41% at 923°C
(c) 2.14% at 1147°C (d) 4.3% at 1229°C.
 - (v) Austenite in steel when rapidly cooled (quenched) from recrystallisation temperature forms
(a) pearlite (b) bainite
(c) martensite (d) ledeburite.
 - (vi) Which of the following is magnetic allotrope of iron?
(a) α -iron (b) β -iron
(c) γ -iron (d) δ -iron.
 - (vii) The ability of the material by virtue of which it can be drawn into a wire is known as
(a) malleability (b) ductility
(c) fatigue (d) creep.

- (viii) How does the Vicker's hardness test differ from Brinell's?
(a) Duration of indentation (b) Load applied
(c) Materials to be tested (d) Type of indenter.
- (ix) Which of the following is a thermosetting polymer?
(a) Polystyrene (b) Polyolefins
(c) Nylons (d) Phenolic resins.
- (x) Metal Matrix Composites are mostly made up of
(a) metal matrix with metallic wires as reinforcement
(b) metal matrix with ceramic fibres as reinforcement
(c) metal matrix with polymeric fibres as reinforcement
(d) all these are applicable.

Group – B

2. (a) What do you understand by solid solution? How many types of such solutions are there?
(b) Explain with neat sketches the mechanism for 'dislocation' and 'twinning' as related to plastic deformation.
(c) Give the comparison between ionic bond and covalent bond.
(2 + 2) + 4 + 4 = 12
3. (a) With a proper sketch, explain schottky defect & frenkel defect in a lattice. State two reasons for increase of vacancies with respect to their equilibrium concentration in a metal.
(b) Explain Atomic packing factor and also calculate the atomic packing factor of Face Centered Cubic (FCC) structure.
(4 + 2) + (2 + 4) = 12

Group – C

4. (a) Draw an Iron carbon phase diagram showing eutectoid, eutectic and peritectic points with all the temperatures and carbon percentages.
(b) Why heat treatment is necessary for ferrous metals and alloys? What are the different case hardening methods that are used in heat treatment process? Explain any one case hardening method.
6 + (2 + 2 + 2) = 12
5. (a) Name any three non-ferrous alloys mentioning their compositions, properties and applications.
(b) State the differences between Annealing and Normalizing processes.

- (c) Write Gibb's phase rule and explain all the terms used in this equation.

$$6 + 4 + 2 = 12$$

Group – D

6. (a) What do you mean by toughness and malleability of steel? What is Resilience of a metal?
- (b) Differentiate between true strain and engineering strain. The engineering stress and strain at fracture were found to be 450 MPa and 0.63 respectively. Determine true stress and true strain.

$$(4 + 2) + (2 + 4) = 12$$

7. (a) In order to evaluate various mechanical properties of a steel specimen of 12.5 mm diameter and 62.5 mm gauge length was tested in a standard tension test. Yield load = 40.0 KN; Maximum load = 71.5 KN; Fracture load = 50.5 KN; Gauge length at fracture = 79.5mm; strain at load of 20 KN = 7.75×10^{-4} Determine: (i) modulus of elasticity, (ii) Modulus of resilience, (iii) Modulus of toughness.
- (b) Define Brinell hardness number and from the definition, show that Brinell hardness number N is given by: $N = 191 / 10 \sqrt{(100 - d^2)}$ for a load of 3000 kgf, where D is the diameter of steel ball and d is the diameter of impression. What would be the corresponding formula for 10 mm diameter ball and 500 kgf load?

$$6 + 6 = 12$$

Group – E

8. (a) Define corrosion. What are the factors that affect the corrosion of a metal? What are the methods to prevent corrosion on the surface of the metal?
- (b) Differentiate between thermoplastics and thermosetting plastics. Why plastics are considered as modern engineering materials?
9. (a) What are ceramic materials? State the advantages and applications of ceramic materials in engineering?
- (b) What is a composite? List the various functions that a matrix phase performs in a composite material.

$$(2 + 2 + 2) + (2 + 4) = 12$$