ENGINEERING MATERIALS
(MECH 3103)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The atomic diameter of an FCC crystal (lattice parameter "a") is
(a) $a\sqrt{2}/2$ (b) $a\sqrt{2}/4$
(c) $a\sqrt{3}/4$ (d) $a/2$.

(ii) Atomic packing factor of a face centered cube is equal to
(a) 0.64 (b) 0.54
(c) 0.74 (d) 0.84.

(iii) The invariant reaction involving, austenite phase decomposing into two different solid phases, ferrite and cementite on cooling is known as _____
(a) Eutectoid (b) Eutectic
(c) Peritectic (d) Peritectoid.

(iv) Brass consists of
(a) Copper and Tin (b) Copper and Zinc
(c) Copper and Lead (d) Copper and Nickel.

(v) Eutectoid steel has C % of
(a) 0.25 (b) 0.54 (c) 0.76 (d) 1.20.

(vi) Paralite is a mixture of cementite and
(a) ferrite (b) austenite
(c) bainite (d) martensite.

(vii) The heat treatment process used for softening hardened steel is
(a) carburizing (b) tempering
(c) normalizing (d) annealing.

(viii) When eutectoid steel is isothermally cooled at a temperature above nose in TTT diagram, the microstructure obtained is
(a) Pearlite (b) Bainite
(c) Martensite (d) Austenite.

(ix) Which of the following carbides are used for cutting tools?
(a) Silicon carbide (b) Tungsten carbide
(c) Vanadium carbide (d) Chromium carbide.

(x) The process of heat softening, moulding and cooling to rigidness can be repeated for which plastics?
(a) Thermoplastics (b) Thermosetting polymers
(c) Both (a) and (b) (d) Neither (a) nor (b).

Fill in the blanks with the correct word

(xi) Two types of solid materials are crystalline and _____.

(xii) In edge dislocation burgers vector is _____ to dislocation line.

(xiii) Equilibrium cooling of eutectoid mixture of iron-carbon gives the microstructure called _____.

(xiv) The ratio of lateral strain and longitudinal strain is _____.

(xv) The property by which a material can sustain impact load is called _____.

Group - B

2. (a) Discuss the major differences between ionic bonding, covalent bonding & metallic bonding. *[(CO1)(Understand/LOCQ)]*
(b) What do you mean by recovery, recrystallization and grain growth? How do crystallization and grain growth affect different mechanical properties? *[(CO2)(Understand/LOCQ)]*

6 + (3 + 3) = 12

3. (a) What is the lever rule for a phase diagram? What are the different types of invariant reactions in binary phase solutions? *[(CO2)(Understand/LOCQ)]*
(b) Draw the phase diagram for the binary isomorphous alloy of Cu and Ni showing the regions of (i) liquid phase (ii) α-solid phase (iii) α-solid + liquid phase. The melting temperatures for pure Cu and Ni are 1085°C and 1453°C respectively. *[(CO2)(Apply/IOCQ)]*

(2 + 4) + 6 = 12

Group - C

4. (a) Draw iron carbon phase diagram. Show all the phases, temperatures and composition properly. *[(CO3)(Understand/LOCQ)]*
(b) Discuss the transformation that occurs and microstructures obtained during equilibrium cooling from liquid state of steel with 1.5% of carbon from liquid state to room temperature. *[(CO5)(Analyze/IOCQ)]*

(3 + 3) + 6 = 12

5. (a) With reference to Iron-Iron Carbide phase diagram discuss on the following:
(i) Austenite (ii) Alpha Ferrite (iii) Delta Ferrite (iv) Cementite (v) Pearlite.
[(CO3)(Understand/LOCQ)]

(b) What are the main characteristics of stainless steels? Name different types of stainless steels and their main application. *[(CO4)(Understand/LOCQ)]*

6 + (3 + 3) = 12

Group - D

6. (a) With the help of TTT diagram, explain the formation of coarse pearlite, fine pearlite, bainite and martensite. *[(CO5)(Understand/LOCQ)]*

(b) What are the different methods to measure hardness. Differentiate between hardness and toughness. *[(CO4)(Understand/LOCQ)]*

6 + (3 + 3) = 12

7. (a) A mild steel rod of 16 mm diameter was tested for tensile strength, with a gauge length of 60 mm. Following were the observations:
Final length = 70 mm
Final diameter = 12 mm
Yield load = 44 KN
Ultimate load = 65 KN
Calculate (i) Yield stress, (ii) Ultimate tensile stress, (iii) Percentage of elongation. *[(CO4)(Evaluate/HOCQ)]*

(b) Draw the microstructure of steel after quenching, normalizing and tempering operations. Also label different phases present in them. *[(CO5)(Understand/LOCQ)]*

6 + 6 = 12

Group - E

8. (a) Distinguish between thermoplastics & thermosetting polymer using any three of their characteristics. *[(CO6)(Analyse/IOCQ)]*

(b) What are ceramic materials? State the advantages of ceramic materials. *[(CO6)(Understand/LOCQ)]*

6 + (2 + 4) = 12

9. (a) Explain dry corrosion with chemical reaction. *[(CO6)(Understand/LOCQ)]*

(b) What is a composite? Identify various functions that a matrix phase performs in a composite material. *[(CO6)(Understand/LOCQ)]*

6 + (3 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	75	18.75	6.25