

**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) When the temperature of a solid metal increases
 - (a) strength of the metal decreases but ductility increases
 - (b) both strength and ductility of the metal decreases
 - (c) both strength and ductility of the metal increases
 - (d) strength of the metal increases but ductility decreases.
 - (ii) An allotropic material has
 - (a) fixed structure at all temperatures
 - (b) atoms distributed in random pattern
 - (c) different crystal structures at different temperatures
 - (d) fixed structure but random atom distribution.
 - (iii) An increase in the percentage of carbon in steel results into decrease in its

(a) hardness	(b) ductility
(c) ultimate strength	(d) corrosion resistance.
 - (iv) The heat treatment process used for softening hardened steel is

(a) carburizing	(b) tempering
(c) normalizing	(d) annealing.
 - (v) The cooling of eutectoid of carbon in iron (above lower critical temperature) results in

(a) ferrite and cementite	(b) ferrite and austenite
(c) cementite and austenite	(d) ferrite, cementite and austenite.
 - (vi) Cross-slip occurs in

(a) Edge dislocation	(b) Screw dislocation
(c) both edge and screw dislocation	(d) None of the above.

- (vii) The material having lowest value of linear coefficient of expansion is

(a) mild steel	(b) silver
(c) aluminium	(d) Invar.
- (viii) Which of the following is a thermosetting polymer?

(a) polystyrene	(b) polyolefins
(c) nylons	(d) phenolic resins.
- (ix) Gibbs phase rule for solid solution is (symbols are as per convention)

(a) $P + F = C + 1$	(b) $P + F = C + 3$
(c) $P = C + 4 - F$	(d) $P = F + 4$.
- (x) For steel the temperature beyond which the magnetic property is lost is called

(a) Curie temperature	(b) Recrystallization Temperature
(c) Debye Temperature	(d) Martensitic temperature.

Group – B

2. (a) What do you understand by the term "surface defects"? Name their types with the corresponding sketches.
 - (b) What is Berger vector? Show with sketch, Burger vector, dislocation line and slip plane in edge and screw dislocation.
 - (c) A hypothetical metal has the body centered cubic crystal structure. If its atomic weight is 70.5 g/mol and the atomic radius is 0.150 nm, compute its density.
- 4 + 6 + 2 = 12**
3. (a) What is lever rule for phase diagram?
 - (b) What are the different types of invariant reactions in binary phase solutions? Explain them with suitable examples.
 - (c) Two metals A (melting point 800C) and B (melting point 600C) form a binary isomorphous system. An alloy having 35% B has 75% solid and rest liquid whereas an alloy having 55%B has 25% solid at 700C. Estimate the composition of solidus and liquidus at the above temperature.
- 2+ 6 + 4 = 12**

Group – C

4. (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 (vi) Ledeburite.

- (b) Describe the transformation that occurs during equilibrium cooling of steel with 0.18 %C present from 1500°C to normal temperature.
- (c) Why non-ferrous metals are used in industry in spite of their higher cost in comparison with ferrous metals?

$$6 + 4 + 2 = 12$$

5. (a) What are the objectives of heat treatment of metals? What care one must take while heat treating to avoid defects?
- (b) What is tempering? Why is it done? Describe the various types of tempering.
- (c) What are low carbon steels? What are their applications?

$$(3 + 1) + (1 + 1 + 3) + (2 + 1) = 12$$

Group – D

6. (a) Deduce the expressions where true stress and true strain are related to engineering stress and engineering strain.
- (b) A long cylindrical rod is subjected to an axial fluctuating load of maximum +170 MN and minimum -170 MN (sinusoidal load). Find out the maximum stress, minimum stress, mean stress and stress amplitude in MPa unit for the specimen having diameter 50 mm.
- (c) Write 4 differences between Izod impact test and Charpy impact test.
- (d) Describe the strain offset method to find the yield strength of a material from engineering stress strain diagram. When is this method used?

$$3 + 3 + 3 + (2 + 1) = 12$$

7. (a) A rectangular block of material has the temperature distribution as $T = 14 - 6.5x$ where T is the temperature in Kelvin scale and x is the distance measured along the thickness measured in m. If the cross section area of the block is 850 cm² and heat transfer rate is 50 kJ/min, find out the thermal conductivity of the material in W/mK unit. Which one between pure metals and polymers has the more values of thermal conductivity and why?
- (b) Explain the term relative permeability of a material. Find out the permeability of a material having relative permeability 1.5. The permeability of vacuum is 12.57×10^{-7} H/m.

- (c) Define dielectric constant as the property of material and write down one application where the value of the property is required.

$$(3 + 2) + (2 + 2) + 3 = 12$$

Group – E

8. (a) Write a short note about metal matrix composites.
- (b) Write down some common abrasive materials and their use.
- (c) Describe the process by which the flexural stress can be measured for brittle ceramics.

$$5 + 3 + 4 = 12$$

9. (a) Define polymerization. Differentiate between the two different types of polymerization.
- (b) What is vulcanization? What is its effect on properties of rubber?

$$6 + 6 = 12$$