

**ENGINEERING MATERIALS**  
**(MEC2203)**

**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:

**$12 \times 1 = 12$**

*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) Cross-slip occurs in
  - (a) edge dislocation
  - (b) screw dislocation
  - (c) both edge and screw dislocation
  - (d) none of the above.
- (iii) Atomic packing factor of a face centered cube is equal to
  - (a) 0.64
  - (b) 0.54
  - (c) 0.74
  - (d) 0.84.
- (iv) Gibbs phase rule for gases is (symbols are as per convention)
  - (a)  $F+P = C+2$
  - (b)  $F+C = P+2$
  - (c)  $F+P = C+1$
  - (d)  $F+1 = C+P$ .
- (v) Eutectoid steel has C % of
  - (a) 0.25
  - (b) 0.54
  - (c) 0.76
  - (d) 1.20.
- (vi) Primary objective of annealing is to
  - (a) increase toughness and yield point
  - (b) reduce ductility and resilience
  - (c) remove foreign impurities and improve surface finish
  - (d) increase ductility and machinability.
- (vii) Major components of bronze are
  - (a) copper and zinc
  - (b) copper and tin
  - (c) copper and lead
  - (d) zinc and tin

(viii) An increase in the percentage of carbon in steel results into decrease in its  
 (a) hardness (b) ductility  
 (c) ultimate strength (d) corrosion resistance.

(ix) Which of the following is a property of ceramics?  
 (a) Low strength (b) Low melting point  
 (c) Resistant to corrosion (d) Bad insulation

(x) Polystyrene is an example of  
 (a) An addition polymer (b) A condensation polymer  
 (c) An elastomer (d) A monomer.

*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 temperature above which material loses magnetic property is called \_\_\_\_\_.

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

### **Group - B**

2. (a) Describe crystalline and amorphous structure. Write their effect on melting point and anisotropy of a material? *[(CO1, CO2) (Understand/LOCQ)]*  
 (b) Explain bonding between metallic elements in metals and its effect on the properties of metals. *[(CO1, CO2) (Understand/LOCQ)]*

**6 + 6 = 12**

3. (a) Explain with reason, the effect of grain size on yield strength and ductility of a metal. *[(CO1, CO2) (Analyse/LOCQ)]*  
 (b) Define Burger vector? Show with sketch, Burger vector, dislocation line and slip plane in edge and screw dislocations. *[(CO2) (Understand/LOCQ)]*

**6 + 6 = 12**

### **Group - C**

4. (a) Draw iron-carbon phase diagram showing phases at different temperature and carbon percentage. *[(CO3) (Understand/LOCQ)]*  
 (b) Explain with microstructure the transformation that occurs in a plain carbon steel with 1.5% of carbon during equilibrium cooling from the liquid state. *[(CO3) (Analyze/LOCQ)]*

**6 + 6 = 12**

5. (a) Draw the phase diagram for the binary isomorphous alloy of Cu and Ni showing the regions of (i) liquid phase (ii)  $\alpha$ -solid phase (iii)  $\alpha$ -solid + liquid phase. The melting temperatures for pure Cu and Ni are  $1085^{\circ}\text{C}$  and  $1453^{\circ}\text{C}$  respectively. *[(CO3) (Apply/LOCQ)]*

(b) Explain Full Annealing and Normalising processes with their effect on structure and property of steel. [(CO4) (Understand/LOCQ)]

**6 + 6 = 12**

### Group - D

6. (a) Write down the compositions, properties and applications of different plain carbon steel. [(CO5) (Understand/LOCQ)]

(b) A mild steel rod of 14 mm diameter was tested for tensile strength, with a gauge length of 50 mm. Following were the observations:

Final length = 68 mm

Final diameter = 9 mm

Yield load = 44 kN

Ultimate load = 65 kN

Calculate (i) Yield stress, (ii) Ultimate tensile stress, (iii) Percentage of elongation. [(CO5) (Analyse/IOCQ)]

**6 + 6 = 12**

7. (a) Why is alloying done? What are the effects of tungsten, chromium, tungsten and nickel alloying elements in steel? [(CO5) (Understand/LOCQ)]

(b) Define Young's modulus and Poisson's ratio. The Young's modulus and Poisson's ratio of a material are 210 GN/m<sup>2</sup> and 0.3 respectively. Determine the shear modulus of the material. [(CO5) (Apply/IOCQ)]

**6 + (4 + 2) = 12**

### Group - E

8. (a) Distinguish between thermoplastics & thermosetting plastics using any three of their characteristics. [(CO6) (Understand/LOCQ)]

(b) Describe in brief the properties and the importance of ceramic in Engineering Applications. [(CO6) (Understand/LOCQ)]

**6 + 6 = 12**

9. (a) Explain injection moulding method of polymer processing with neat sketch. [(CO6) (Understand/LOCQ)]

(b) What is composite? What are the characteristics of composite? Give any two example of composite materials. [(CO6) (Understand/LOCQ)]

**6 + (2 + 3 + 1) = 12**

| Cognition Level         | LOCQ  | IOCQ  | HOCQ |
|-------------------------|-------|-------|------|
| Percentage distribution | 68.75 | 31.25 | 0    |

