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
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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)   Gibbs phase rule for condensed state reaction under constant pressure is
       (a) F+P = C+2   (b) F+C = P+2
       (c) F+P = C+1   (d) F+1 = C+P.

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

(iii) Delta iron occurs at temperature of
       (a) room temperature   (b) above melting point
       (c) between 1400°C to1539°C   (d) between 910°C to 1400°C.

(iv)   Cross-slip occurs in
       (a) edge dislocation   (b) screw dislocation
       (c) both edge and screw dislocation   (d) none of the above.

(v)   Number of atoms present per unit cell of a HCP crystal is
       (a) 1   (b) 6   (c) 4   (d) 2.

(vi)   Which of the following constituents of steel is softest and least strong?
       (a) Austenite   (b) Perlite
       (c) Ferrite   (d) Cementite.

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

(viii) 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.

(ix) Which one of the following materials has maximum elasticity?
(a) Rubber   (b) Glass   (c) Steel   (d) Silver.

(x) During normalizing process of steel, the specimen is heated
(a) above upper critical temperature and cooled in furnace
(b) above upper critical temperature and cooled in air
(c) above lower critical temperature and cooled in air
(d) below upper critical temperature and cooled in furnace.

Fill in the blanks with the correct word

(xi) Hypereutectoid steel contains carbon percentage more than _____.

(xii) Hooke's law states that within elastic limit _____ is proportional to strain.

(xiii) The ability of the material by virtue of which it can be drawn into a wire is known as _____.

(xiv) The _____ polymers are those in which repetitive molecular units are joined together end to end in single chains.

(xv) Low-carbon steel consists of less than _____% carbon.

Group - B

2. (a) A hypothetical metal has the face centered cubic crystal structure. If its atomic weight is 60 g/mol and the atomic radius is 0.150 nm, calculate its density. Why is there a discrepancy between actual and theoretical density of material?
[(CO1)(Apply/IOCQ)]
(b) What is the atomic packing factor? Calculate the atomic packing factor of Face Centered Cubic (FCC) structure.   *[(CO1)(Understand/LOCQ)]*
6 + 6 = 12

3. (a) Write three differences between edge and screw dislocations.
[(CO2)(Understand/LOCQ)]
(b) What do you mean by equilibrium phase? Explain with Gibb's phase rule why alloys have a range of melting points, whereas pure materials have one distinct melting point if pressure is kept constant.   *[(CO2)(Understand/LOCQ)]*
6 + 6 = 12

Group - C

4. (a) Discuss about crystal structure, composition range and temperature range for stability of any three equilibrium phases of iron carbon alloy.
[(CO3)(Understand/LOCQ)]
(b) Name any two ferrous alloys mentioning their compositions, microstructures, properties and applications.   *[(CO4)(Understand/LOCQ)]*
6 + 6 = 12

5. (a) What is stainless steel? What are ferritic, austenitic and martensitic stainless steels?   *[(CO4)(Understand/LOCQ)]*

(b)   Discuss about any three non-ferrous alloys mentioning their compositions, properties and applications. *[(CO4)(Understand/LOCQ)]*

6 + 6 = 12

Group - D

6. (a)   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. *[(CO4)(Create/HOCQ)]*

  (b)   Explain the following properties.
(i) Resilience (ii) Hardness (iii) Toughness. *[(CO4)(Understand/LOCQ)]*

6 + 6 = 12

7. (a)   Justify the purpose of Annealing and Normalizing process. *[(CO5)(Evaluate/HOCQ)]*

  (b)   Explain the method of Quenching. Name any two quenching medium. *[(CO5)(Understand/LOCQ)]*

6 + (4 + 2) = 12

Group - E

8. (a)   Explain any three types of polymer molecular structure with suitable sketch. *[(CO6)(Understand/LOCQ)]*

  (b)   Write down the properties and application of refractory and abrasive material. *[(CO6)(Remember/LOCQ)]*

6 + 6 = 12

9. (a)   Differentiate between metal matrix and polymer matrix composite with example. *[(CO6)(Analyse/IOCQ)]*

  (b)   Differentiate uniform and pitting corrosion with suitable sketch. *[(CO6)(Analyse/IOCQ)]*

6 + (2 + 2 + 2) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	68.75	18.75	12.5

Course Outcome (CO):

After the completion of the course students will be able to
1. Classify different materials like metals, polymers, ceramics, composites and advanced materials and analyze different crystal structure of materials.
2. Identify different types of defects in the material structure and construct the phase diagram of a multi-phase system of alloy.

3. Analyze the Iron –Iron Carbide equilibrium diagram and discuss the composition, properties and applications of ferrous and nonferrous alloy.
4. Explain mechanical, thermal, electrical and magnetic properties of material and implement the concept in mechanical components design.
5. Explain different heat treatment processes for ferrous material.
6. Discuss the properties, applications and making processes of different polymers, ceramics, composites and nanomaterials.

LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.