MATERIAL SCIENCE AND TECHNOLOGY
(AEIE 2111)

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) Which one of the following is **NOT** a strong bond?
(a) van der Waals bond (b) Covalent bond
(c) Metallic bond (d) Ionic bond.

(ii) Coordination number in simple cubic crystal structure
(a) 2 (b) 4 (c) 6 (d) 8

(iii) Visible light's wavelength range:
(a) 0.39 – 0.77 mm (b) 0.39 – 0.77 μm
(c) 0.39 – 0.77 nm (d) 0.39 – 0.77 cm.

(iv) Example for strengthening mechanism in single-phase material
(a) Strain hardening (b) Precipitation hardening
(c) Fiber strengthening (d) dispersion strengthening

(v) Above the following line, liquid phase exist for all compositions in a phase diagram
(a) Tie-line (b) Solvus
(c) Solidus (d) Liquidus

(vi) Engineering stress-strain curve and True stress-strain curve are equal up to
(a) Proportional limit (b) Elastic limit
(c) Yeild point (d) Tensile strength point

(vii) The degree of freedom at triple point in unary diagram for water _____.
(a) 0 (b) 1 (c) 2 (d) 3

(viii) Fracture stress (σf) is proportional to
(a) crack length (b) 1/crack length
(c) (crack length)$^{1/2}$ (d) (crack length)$^{-1/2}$.

(ix) Usually _____ is the initial stage of a component manufacturing.
(a) Design (b) Conception
(c) Material selection (d) Testing

(x) One of characteristic properties of polymer material _____.
(a) High temperature stability (b) High mechanical strength
(c) High elongation (d) Low hardness

Group- B

2. (a) Compare among diamagnetic, paramagnetic and ferromagnetic materials with specific examples ofeach type. [(CO6) (Analyse/IOCQ)]
(b) Describe thermal expansion and define co-efficient of thermal expansion. [(CO1) (Understand/LOCQ)]/ [(CO1) (Remember/LOCQ)]
(c) List the applications of advanced materials. [(CO1) (Remember/LOCQ)]

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

3. (a) Three materials with uniform cross-sectional area of 2 m^2 are exposed to heat energy of 600W. The temperature gradients of the three materials are given as 1, 20 and 1000 K/m respectively. Estimate the thermal conductivities of the above materials and categorise them based on that. [(CO1) (Analyse/IOCQ)]
(b) List the applications of LED, LASERs and optical fibers. [(CO1) (Remember/LOCQ)]
(c) Examine the dielectric constant of a barium titanate crystal, which, when inserted in a parallel plate condenser of area 10 mm × 10 mm and distance of separation of 2 mm, gives a capacitance of 10^{-9} F. [(CO1) (Analyse/IOCQ)]

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

Group - C

4. (a) Define Burger' svector. Draw neat sketches illustrating the arrangement of atoms around an edge dislocation and displayBurger'svector on the sketch of aforesaid edge dislocation. [(CO2)(Remember/LOCQ)]/[(CO2)(Apply/IOCQ)]
(b) Estimate the line energy of dislocation in BCC iron. The burgers vector iniron is of the ½<111> type. The shear modulus of iron is 80.2 GN/m^2. (The lattice parameter of BCC iron is 2.87 Å). [(CO2)(Analyse/IOCQ)]

(2 + 7) + 3 = 12

5. (a) The dislocation density in a Cu sample is increased by cold working from 10^9 m/m^3 to 10^{13} m/m^3. Examine the free energy change during recrystallization. [(CO2) (Analyse/IOCQ)]
(b) Differentiate between slip and twining. [(CO2) (Analyse/IOCQ)]
(c) Discuss the restoration process in materials. [(CO2) (Understand/LOCQ)]

3 + 3 + 6 = 12

Group - D

6. (a) Compare between ductile and brittle fracture based on fracture parameters. [(CO2) (Analyse/IOCQ)]
   (b) Explain the stages of brittle fracture. [(CO2) (Analyse/IOCQ)]

6 + 6 = 12

7. (a) The Young's modulus of a certain material is 200 GN/m^2 and its true surfaceenergy is 1.5 J/m^2.Thecrack length is 5 μm. Calculate its fracture strength. If the actual fracture strength is 1 GN/m^2, then provide justification in support of the result. [(CO2) (Analyse/IOCQ)]/ [(CO2) (Evaluate/HOCQ)]
   (b) Comment on the usefulness of phase diagram. [(CO3) (Evaluate/HOCQ)]

(4 + 2) + 6 = 12

Group - E

8. (a) How steels are classified based on carbon content? Categorize stainless steels based on constituents of the microstructure. [(CO6) (Understand/LOCQ)]/[(CO6) (Analyse/IOCQ)]
   (b) Criticize the role of noble metals in engineering applications. [(CO5) (Evaluate/HOCQ)]
   (c) Classify ceramics based on their compositions**.** [(CO4)(Understand/LOCQ)]

(3 + 3) + 4 + 2 = 12

9. (a) Compare between thermoplastic and thermosetting materials. List moulding techniques employed in fabrication of polymers. [(CO6) (Analyse/IOCQ)]/[(CO4) (Remember/LOCQ)]
   (b) Classify the corrosion in metals. [(CO5) (Understand/LOCQ)]
   (c) Appraise the material recycling process. [(CO5) (Evaluate/HOCQ)]

(3 + 3) + 4 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.50%	43.75%	18.75%

Course Outcome (CO):

After the completion of the course students will be able to:

1. Explain the properties and structure of engineering materials.
2. Analyze defects in materials and their effect on engineering properties as well as limit their use in service.
3. Make use of phase diagrams to predict microstructures and also to understand precipitation hardening.
4. Compare & Evaluate the processing of engineering materials.

5. Choose the proper engineering material for defined field of applications with economic, environmental and societal considerations.
6. Determine the importance of material properties in engineering design.

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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/NDA1MzM5NTM4NzYz/a/NDY4MjQ3ODUzODcw/details