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BRAINWARE UNIVERSITY

Term End Examination 2025-2026

Programme – B.Tech.(ME)-2024

Course Name – Engineering Materials and Metallurgy

Course Code - BTM40105

(Semester IV)

Full Marks : 60

Time : 2:30 Hours

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question)

1 x 15=15

1. Choose the correct alternative from the following :

- (i) Identify the crystal structure of martensite formed in steel.
 - a) Face-centered cubic (FCC)
 - b) Body-centered cubic (BCC)
 - c) Body-centered tetragonal (BCT)
 - d) Hexagonal close-packed (HCP)
- (ii) A steel with 0.8% carbon and 100% pearlite is recognized as
 - a) Eutectoid steel
 - b) Hypo-eutectoid steel
 - c) Hyper-eutectoid steel
 - d) pro-eutectoid steel
- (iii) Recall the Gibbs phase rule for a general system as
 - a) $P + F = C - 1$
 - b) $P + F = C + 1$
 - c) $P + F = C - 1$
 - d) $P + F = C + 2$
- (iv) The coordination number of the FCC crystal structure is enumerated as
 - a) 4
 - b) 8
 - c) 12
 - d) 16
- (v) Select from the following materials that exhibit non-linear elastic behaviour
 - a) Mild steel
 - b) Aluminium
 - c) Cast iron
 - d) Rubber
- (vi) Identify the material commonly used for manufacturing a lathe bed.
 - a) Mild steel
 - b) Cast iron
 - c) Stainless steel
 - d) Aluminium alloy
- (vii) HSLA steels are primarily used in _____.
 - a) Textile manufacturing
 - b) Automotive and structural applications
 - c) Food processing
 - d) Paper industry
- (viii) The first letter code for high-speed steel is
 - a) XT
 - b) T
 - c) X
 - d) TT

- (ix) The correct sequence of the given materials in ascending order of their weldability is
 a) MS, Cu, Cl, Al
 b) Cl, MS, Al, Cu
 c) Cu, Cl, MS, Al
 d) Al, Cu, Cl, MS
- (x) Fick's Second Law is mainly applicable to diffusion under
 a) Steady-state conditions
 b) Non-steady-state conditions
 c) Vacuum conditions
 d) Elastic deformation
- (xi) The two-stage heating schedule up to hardening temperature is employed for high-speed steel (18-4-1 type) to ensure
 a) check on grain growth
 b) minimum possible oxidation risk
 c) both options
 d) none of these
- (xii) In general, all alloying elements increase hardenability of steels except
 a) Si and Co
 b) Co and Al
 c) Si and Al
 d) B and Si
- (xiii) Recall the precipitate responsible for precipitation hardening in an Al-4%Cu alloy. Which of the following precipitates causes the strengthening?
 a) Cu_2Al
 b) CuAl
 c) CuAl_2
 d) None of these
- (xiv) Choose the correct reason why XRD cannot be used to analyze amorphous materials effectively.
 a) Low beam intensity
 b) Large crystal size
 c) Absence of long-range order (LRO)
 d) High absorption coefficient
- (xv) A researcher needs to confirm whether nanoscale crystallites are embedded within an amorphous matrix. Select the most suitable approach.
 a) XRD only
 b) Raman spectroscopy
 c) TEM imaging combined with SAED
 d) DSC

Group-B

(Short Answer Type Questions)

3 x 5=15

2. Write down the difference between Frenkel and Schottky defect. (3)
3. Define coordination number. Write the coordination number for the BCC and FCC lattices. (3)
4. Explain the Gibbs' phase rule with usual notations. (3)
5. State the purpose of the Jominy end-quench test. (3)
6. Justify the reason behind melting of ice from the edges before the interior on the basis of metallurgical principle. (3)

OR

The specific heat of solid copper above 300 K is given by (3)

$$C_p = 22.64 \times 10^{-3} T \text{ Jmol}^{-1}\text{K}^{-1}$$

By how much does the entropy of copper increase on heating from 300 to 1358 K?

Group-C

(Long Answer Type Questions)

5 x 6=30

7. Write a short note on "Martempering". (5)

8. For three hypothetical materials A, B and C, the atomic weight, density and atomic radius are listed below. Determine whether its crystal structure is FCC, BCC or HCP and justify your determination for each. (5)

Material	Atomic Weight (g/mol)	Density (g/cc)	Atomic Radius (nm)
A	24.31	1.74	0.160
B	107.87	10.49	0.144
C	22.99	0.971	0.186

9. Distinguish between downhill diffusion and uphill diffusion in solids. (5)
10. Sketch iron-cementite phase diagram and label the phase fields. Discuss in brief the different invariant reactions that take place in this system. (5)
11. The Bravais lattice system includes an end-centred orthorhombic lattice but excludes an end-centred tetragonal lattice. Explain with the help of a sketch. (5)
12. Explain the construction of TTT diagram according to the first principle. Why it is called S-curve? (5)

OR

- Explain why martensite is hard? What is the crystal structure of martensite? (5)

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