

- (b) Describe with a flow sheet the extraction alumina by Bayer Process indicating various factors involved. Explain the chemistry underlying the electrolytic production of aluminium.

4 + 8 = 12

9. (a) Describe KROLL's process for extraction of titanium metal by reduction of TiCl_4
- (b) Depict the principle for the extraction of gold by cyanidation process followed by gold recovery through cementation process.
- (c) What is the purpose of zone refining?

4 + 6 + 2 = 12

**MATERIAL SCIENCE & ENGINEERING
(CHEN 3133)**

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) For hexagonal crystal structure, the relation between the lattice constants a , b , c and angles α , β & γ is
 (a) $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$
 (b) $a = b = c$ and $\alpha = \beta = \gamma \neq 90^\circ$
 (c) $a = b \neq c$ and $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$
 (d) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$.
- (ii) Packing efficiency of a crystal depends on
 (a) Nature of bonding (b) Coordination number
 (c) crystal system (d) Valency.
- (iii) Time dependent recoverable deformation is called
 (a) elastic deformation (b) plastic deformation
 (c) anelastic deformation (c) permanent deformation.
- (iv) The presence of Schottky defects in crystals leads to
 (a) increase in density
 (b) decrease in density
 (c) no change in density
 (d) sometimes an increase or sometimes a decrease.
- (v) Medium carbon steel contains carbon in the range of
 (a) 0.15-0.35% (b) upto 0.15%
 (c) 0.35%-0.65% (d) 0.65%- 1.2%.
- (vi) The process of zone refining is utilised for ultra-purification of
 (a) Si (b) Ge (c) Ga (d) all of these.

- (vii) Alloy steel is potentially produced in
 (a) Open Hearth furnace (b) LD converter
 (c) Electric arc furnace (d) Bessemer converter.
- (viii) Uncommon impurity in gold ore is
 (a) Ag (b) Cu (c) Zn (d) Pb.
- (ix) The existence of Frenkel defects in crystal causes
 (a) increase in density
 (b) decrease in density
 (c) no in density
 (d) sometimes an increase or sometimes a decrease.
- (x) The hearth and side walls of electric arc furnace is lined with refractories of
 (a) silica (b) magnesite
 (c) 60% alumina (d) silicon carbide.

Group - B

2. (a) Mention the different crystal systems and corresponding crystal structures with their usual characteristic lattice parameters for a unit cell (drawing of figures is not necessary).
 (b) Explain how Bragg's law can be used to determine the crystal structure.
 (c) What do you understand by Miller indices of crystal plane? Narrate the systematic procedure for the determination of Miller indices of crystal plane.
- 4 + 4 + 4 = 12**
3. (a) Prove that atomic packing factor of the FCC crystals structure is greater than that of the BCC crystal structure.
 (b) A KCl crystal which has FCC structure has a density of $1.98 \times 10^3 \text{ kg/cm}^3$. Its molecular weight is 74.55. Find the distance between the adjacent atoms.
 (c) Define the terms
 (i) Flexural strength
 (ii) Toughness
 (iii) hardness
 (iv) anelastic deformation of engineering materials.
- 4 + 4 + 4 = 12**

Group - C

4. (a) What are the different types of dislocation found in crystals? Narrate the difference between screw and edge dislocations with the help of Burger's vector circuit.
 (b) Derive an expression for the equilibrium concentration of Frenkel defects with the help of enthalpy of formation of such defects in the crystal.
- (2 + 3) + 7 = 12**
5. (a) Draw Fe-C phase diagram indicating specially the eutectic and eutectoid regions and explain its immense importance in the production of various types of steel.
 (b) Explain microstructural changes that happened in hyper-eutectoid steel during cooling below 900°C.
 (c) What is martensite steel?

6 + 4 + 2 = 12**Group - D**

6. (a) Describe the basic principle and process of steel making using LDAC converter.
 (b) Summarise the essential activities in a steel melting shop.
 (c) What is the purpose of vacuum treatment of molten steel?
- 6 + 3 + 3 = 12**
7. (a) Mention the advantages of continuous casting system over ingot casting system for teeming of molten steel?
 (b) Describe schematically the vertical mould- bend discharge type continuous casting assembly practiced for steel stating the function of each.

4 + 8 = 12**Group - E**

8. (a) What are the essential features of hydrometallurgical process? Under what conditions it would be preferred to pyrometallurgical process?