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**Third Semester B.E. Degree Examination, December 2011**  
**Materials Science and Metallurgy**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions, selecting at least TWO questions from each part.**

**PART – A**

- 1
  - a. Sketch the unit cell of a HCP crystal structure. Calculate the number of atoms per unit cell. Derive an expression for the density of atomic packing. (Given  $C = 1.633a$ ). (06 Marks)
  - b. Copper has an atomic radius of  $1.28 \times 10^{-8}$  cm, a FCC crystal structure and an atomic weight of 63.5. Calculate its density (Avogadro number =  $6.023 \times 10^{23}$ ). (05 Marks)
  - c. Explain the different types of surface imperfections, with neat sketches. (06 Marks)
  - d. State and explain the Fick's second law of diffusion. (03 Marks)
- 2
  - a. Draw the stress-strain diagram of mild steel and describe how the following properties can be obtained from the diagram:
    - i) Elastic modulus    ii) Ductility    iii) Toughness. (07 Marks)
  - b. A cylindrical specimen of steel having an original diameter of 12.8mm is tensile tested to fracture and found to have an engineering fracture strength  $\sigma_f$  of 460 MPa. If its cross-sectional diameter at the fracture is 10.7mm, determine
    - i) The ductility in terms of percent area reduction    ii) The true stress at fracture. (06 Marks)
  - c. Differentiate between the slip and twinning, with neat sketches. (07 Marks)
- 3
  - a. Explain with a sketch, the ductile to brittle transition in the materials. (04 Marks)
  - b. If the specific surface energy for  $Al_2O_3$  is  $0.9 \text{ J/m}^2$ , calculate the critical stress required for propagation of an internal crack of length 0.4mm. ( $E = 393 \text{ GPa}$  for  $Al_2O_3$ ). (05 Marks)
  - c. Draw and explain the S-N curve for steel and aluminium alloy. (05 Marks)
  - d. Define stress relaxation. Derive the corresponding expression. (06 Marks)
- 4
  - a. Explain the homogeneous nucleation. Discuss the significance of critical radius of the nuclei. (08 Marks)
  - b. Describe the different types of solid solution. (06 Marks)
  - c. State the Gibb's phase rule and explain with a simple example. (06 Marks)

**PART – B**

- 5
  - a. Construct a phase diagram for two metals completely soluble in the liquid state but partially soluble in solid state. (04 Marks)
  - b. Draw the iron-carbon equilibrium diagram and label all the parts. (08 Marks)
  - c. With the help of the diagram in 5(b), explain the cooling of steel with 0.6% carbon, showing the microstructure at different stages. (08 Marks)
- 6
  - a. Draw the TTT diagram for plain carbon eutectoid steel and explain the critical cooling rate. (07 Marks)
  - b. Explain any one type of surface hardening, with sketches. (06 Marks)
  - c. Differentiate between the normalizing and annealing, with sketches. (07 Marks)
- 7
  - a. Explain the different types of cast iron, with microstructures. (08 Marks)
  - b. Write a short note on the copper alloys. (08 Marks)
  - c. Explain the modification of Al - Si alloy. (04 Marks)
- 8
  - a. What is a composite material? How is it classified? (08 Marks)
  - b. With a neat sketch, explain any one method for production of fiber reinforced plastic. (06 Marks)
  - c. Briefly discuss the advantages & applications of metal matrix composites(MMCs). (06 Marks)

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.