# Third Semester B.E. Degree Examination, June/July 2014
## Material Science and Metallurgy

Time: 3 hrs.                                                          Max. Marks:100

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

## PART – A

1  a. Define the following lattice:
      i)   Unit cell.
      ii)  Space lattice.
      iii) Atomic packing factor.
      iv)  Coordination number.                                      **(04 Marks)**

   b. Calculate the volume of the zinc crystal structure unit cell by using the following data: Pure
      zinc has the HCP crystal structure with lattice constants a = 0.2665nm and c = 0.4947nm.
                                                                      **(04 Marks)**
   c. State and explain Fick's first law of diffusion.               **(04 Marks)**
   d. What do you mean by crystalline imperfection? Explain briefly point and scalar/line defects.
                                                                      **(08 Marks)**

2  a. Compare the engineering stress and strain with the true stress and strain for the tensile test of
      a low carbon steel that has the following test values:         **(04 Marks)**

      | | |
      |---|---|
      | Load applied to specimen | = 75kN |
      | Initial diameter of specimen | = 12.5mm |
      | Diameter of specimen under 75kN load | = 12mm |

   b. Derive the expression for critically resolved shear stress (CRSS).   **(04 Marks)**
   c. Describe the dislocation mechanism that enables a metal to be plastically deformed without
      fracture.                                                       **(06 Marks)**
   d. What do you mean by linear and nonlinear elastic properties of a material? Explain any two
      properties briefly.                                             **(06 Marks)**

3  a. Define creep and explain a typical creep curve.                **(06 Marks)**
   b. What is fracture? State the differences between ductile and brittle fractures.   **(08 Marks)**
   c. State the factors that affect the fatigue strength of a metal. Explain them briefly.   **(06 Marks)**

4  a. State and explain Gibbs phase rule.                            **(04 Marks)**
   b. Explain homogeneous nucleation. Discuss the significance of critical radius of nuclei.
                                                                      **(08 Marks)**
   c. What is a solid solution? With suitable examples, explain the different types of solid
      solutions.                                                      **(08 Marks)**

## PART – B

5   a.   Define:
        i)    A phase in a material;
        ii)   A phase diagram.                                                                        **(02 Marks)**
     b.   Derive the lever rule for the binary phase diagram of two metals A and B completely soluble
          in each other.                                                                              **(04 Marks)**
     c.   Write equations for the following invariant reactions: entectic, peritectic, monotectic,
          entectoid and peritectoid. How many degrees of freedom exist at invariant reaction points in
          binary phase diagram?                                                                       **(06 Marks)**
     d.   Draw neatly Iron-carbon phase diagram and mark on it all salient temperatures,
          compositions, and phases.                                                                   **(08 Marks)**

6   a.   Explain the steps to construct TTT diagram. Draw a labeled sketch of TTT diagram for an
          eutectoid steel.                                                                            **(10 Marks)**
     b.   With neat diagrams, explain briefly austempering and martempering heat treatment process.
                                                                                                      **(10 Marks)**

7   a.   Discuss briefly about effects of alloying elements on properties of steel.                   **(10 Marks)**
     b.   Explain with phase diagram modification of Al-Si alloys.                                    **(05 Marks)**
     c.   Write a note on Spheroidal Graphite (SG) iron.                                              **(05 Marks)**

8   a.   Explain the following for production of FRP:
        i)    Spray lay-up process.
        ii)   Pultrusion process.                                                                     **(10 Marks)**
     b.   Explain with a neat sketch production of MMC by using powder metallurgy process.
                                                                                                      **(10 Marks)**

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