M. Tech. (Material Science and Technology)
First Semester
MST-101: Materials and their Properties

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt _five_ questions in all, including Question No. 1 which is compulsory and selecting two questions from each Part.

x-x-x

Q.1. Attempt the following:-

Q. 1 (a) Sketch the following in a hexagonal unit cell. $(000\bar{1})$, $[10\bar{1}0]$.

(b) Which of the two atomic mechanisms of diffusion is faster and why? **(2)**

(c) What is the difference between the process of slip in a single crystal and a polycrystalline sample? **(2)**

(d) Discuss various surface treatments to improve the fatigue life of a material. **(2)**

(e) Explain thermal expansion of materials from atomic perspective. **(2)**

(2)

Part A

Q. 2 (a) The attractive force between ions with unlike charges is $\frac{e^2}{4\pi\epsilon_0 r^2}$, while the repulsive force is $\frac{ce^2}{r^n}$, c and n are constants. Obtain an expression for the equilibrium distance r_0 between the ions in terms of c and n. Also show that the energy required to separate the ions to an infinite distance apart is

$$E = \frac{e^2}{4\pi\epsilon_0 r_0}\left(1 - \frac{1}{n-1}\right)$$

r is the distance between the ions. **(4)**

(b) Derive planar density expressions for FCC (100) and (111) planes, and linear density expressions for BCC [100] and [111] directions, in terms of atomic radius R. **(4)**

(c) What is the difference between a Bravais lattice and a non-Bravais lattice? **(2)**

Q. 3 (a) What are interfacial defects? Discuss various interfacial defects in a crystal. **(5)**

(b) Carbon is allowed to diffuse through a steel plate 10 mm thick. The concentrations of carbon at the two faces are 0.85 and 0.40 kg/m^3, which are maintained constant. If the preexponential and activation energy are 6.2×10^{-7} and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is 6.3×10^{-10} $Kg/m^2 s$. **(5)**

Q. 4 (a) What are elastomers? How is their elastic response different from normal elastic materials? **(3)**

(b) Differentiate between resilience and toughness. **(3)**

(c) A tensile stress is to be applied along the long axis of a cylindrical brass rod that has a diameter of 10 mm. Determine the magnitude of the load required to produce a 2.5×10^{-3} mm change in diameter if the deformation is entirely elastic. The Poisson's ratio and the modulus of elasticity for brass are 0.34 and 97 GPa respectively. **(4)**

Part B

Q. 5 (a) What do you understand by slip system? Describe the mechanism of slip in a single crystal. **(5)**

(b) Describe various methods to increase the strength of a metal. **(5)**

Q. 6 (a) Differentiate between (i)stable and unstable crack (ii) intergranular and transgranular fracture. **(4)**

(b) Discuss the creep behaviour of a metal w.r.t. time. **(3)**

(c) What do you understand by thermal conductivity of a metal? Explain the mechanism of thermal conduction. **(3)**

Q. 7 (a) What do you understand by Thermal Shock Resistance? On what factors does it depend? **(3)**

(b) Briefly explain what determines the characteristic color of (a) a metal and (b) a transparent non-metal. **(4)**

(c) Describe the phenomenon of photoconductivity. **(3)**

x-x-x