2023
M. Tech. (Material Science and Technology)
First Semester
MT-101: Introduction to Material Science

Time allowed: 3 Hours   Max. Marks: 50

NOTE: *Attempt* <u>*five*</u> *questions in all, including Question No. I which is compulsory and selecting two questions from each Part.*

x-x-x

1 (a) Draw a $(\bar{1}010)$ plane and $[11\bar{2}0]$ direction in a hexagonal lattice. **(2)**

(b) Explain why the properties of polycrystalline materials are most often isotropic. **(2)**

(c) Why external surfaces are considered as a defect in a solid material? **(2)**

(d) What is the difference between true stress and engineering stress? **(2)**

(e) Briefly explain why metals are better thermal conductors than ceramic materials. **(2)**

Part A

2 (a) Discuss the structure of diamond and also determine its atomic packing fraction. **(4)**

(b) Discuss the elements of reflection symmetry in a cubic crystal? **(3)**

(c) Demonstrate that the minimum cation-to-anion radius ratio for a coordination number of 3 comes out to be 0.155. **(3)**

3 (a) Niobium has an atomic radius of 0.1430 nm and a density of 8.57 g/cm^3. Determine whether it has an FCC or BCC structure. Atomic weight of niobium is 92.9 amu. **(4)**

(b) What do you understand by point defects in a metal? How point defects in a ceramic affect its stoichiometry? **(4)**

(c) Which diffusion mechanism is faster and why: Interstitial diffusion or vacancy diffusion?. **(2)**

4 (a) 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 $6.3 \times 10^{-10} Kg/m^2 s$. **(4)**

(b) What are viscoelastic materials? Explain with an example. **(3)**

(c) A cylindrical specimen of some metal alloy 10 mm in diameter is stressed elastically in tension. A force of 15,000 N produces a reduction in specimen diameter of $7 \times 10^{-3} mm$. Compute Poisson's ratio for this material if its elastic modulus is 100GPa. **(3)**

Part B

5 (a) Describe various methods to increase the strength of a metal. **(4)**

(b) Discuss characteristics of dislocations, which are important with regard to the mechanical properties of the metals. **(3)**

(c) What do you understand by slip system? Give an example. **(3)**

6 (a) Differentiate between (i) ductile and brittle fracture (ii) fatigue and creep failure. **(4)**

(b) Discuss the significance of impact fracture testing. What are the main testing techniques? **(4)**

(c) What do you understand by the heat capacity of a material? How do you explain it at the atomic level? **(2)**

7 (a) Briefly explain thermal expansion using the potential energy versus interatomic spacing curve **(4)**

(b) Discuss various phenomena through which light interacts with matter. **(3)**

(c) What determines the characteristic color of a (i) a metal (ii) a transparent non-metal? **(3)**

x-x-x