

2014  
B.E. (Mechanical Engineering)  
Second Semester  
ASP-X03: Physics of Materials

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

I. Attempt any five of the following:

- (a) Differentiate between primitive and non-primitive unit cells.
- (b) What information can be obtained from a crystallographic X-ray diffraction pattern?
- (c) What is the composition and uses of duralumin?
- (d) What do you understand by ductile to brittle transition of a material?
- (e) What is Gibb's Phase rule? Illustrate with an example.
- (f) What is temper embrittlement?

(2x5=10)

**Part A**

- II. (a) What are dislocations? Differentiate between edge and screw dislocations.  
(b) How atoms are arranged in a hexagonal unit cell. Determine the atomic packing efficiency of the hexagonal close packed unit cell. (4,6)
- III. (a) What is meant by carbon nanotube chirality? State how chirality affects the electrical properties of nanotubes.  
(b) State Fick's first and second laws of diffusion. How are concentration gradients related to the diffusion process according to Fick's laws? How is diffusion utilized in industrial processes or technological advancements? (4,6)
- IV. (a) Estimate the Young's modulus of a material, which has bonding characteristics as given by  $W = -\frac{A}{r^n} + \frac{B}{r^m}$  (where  $A, B, n$  and  $m$  are constants). Take that  $n = 1, m = 9$ , and  $A = 7.68 \times 10^{-29}$  J m. The equilibrium distance between bonding atoms is  $2.5 \text{ \AA}$ .  
(b) Sketch the time-strain curve for anelastic behaviour and compare it with the time-strain curve in the Voigt-Kelvin element. What do you deduce from this? (4,6)

**Part B**

- V. (a) Explain the driving force for: recovery, recrystallization and grain growth.  
(b) What are the characteristic microstructural features associated with the ductile and brittle fractures in a solid?  
(c) Define a slip system. Do all metals have the same slip system? Why or why not? (3,5,2)
- VI. (a) What do you understand by creep in a material? Discuss the effect of stress and temperature on creep.  
(b) Briefly cite the differences between pearlite, bainite and martensite relative to microstructures and mechanical properties. (5,5)
- VII. (a) Neatly sketch the Iron-Carbon phase diagram and explain the various invariant reactions and phases that are present in it?  
(b) Differentiate between TTT and CTT diagrams. (7,3)

x-x-x