2054
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. I which is compulsory and
selecting two questions from each Part.

x-x-x

I.   **Attempt any five parts (2 x 5=10)**

(a) Sketch $(11\bar{2})$ plane within a cubic unit cell.

(b) Differentiate between zig-zag and armchair carbon nanotubes.

(c) What do you understand by viscoelasticity?

(d) How do factors such as temperature and stress affect the creep strain?

(e) Define eutectoid transformation and provide an example of a material system
where it occurs.

(f) Under what conditions we get coarse pearlite and fine pearlite from austenite?

Part-A

II.   (a) What are ionic crystals? Derive an expression for the cohesive energy for an ionic
crystal.

(b) Describe a hexagonal close pack structure and calculate its packing fraction.
(5,5)

III.   (a) What are point defects in crystal lattice? How are they caused?

(b) Give a brief account of phenomenon of diffusion. How is diffusion employed for
doping in semiconductors?   (3,7)

IV.   (a) Discuss the atomistic basis of elastic behaviour.

(b) A tensile load of 100 N is applied to an aluminium-boron
composite of 1 mm^2 cross-sectional area. The volume of the parallel fibres is
30%. What is the stress in the fibres, when the load axis is (i) parallel to the fibres,
and (ii) perpendicular to the fibres? (Given, $Y_{Aluminium}=71GN/m^2$ and
$Y_{Boron}=440GN/m^2$)   (6,4)

Part-B

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

(b) Describe the mechanisms responsible for the ductile to brittle transition in metals
Discuss the factors that influence the ductile to brittle transition temperature.   (6,4)

VI.   Consider the binary isomorphous solution of copper and nickel. Draw its phase
diagram and discuss the various microstructures developed during its equilibrium and
non-equilibrium cooling.   (10)

VII.   (a) Find free energy change associated with homogeneous nucleation of a sphere
of radius r. Find the critical nucleus radius r* for homogeneous nucleation.

(b) Briefly cite the differences between pearlite, bainite and spheroidite relative to
microstructure and mechanical properties.   (6,4)

x-x-x