VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
SESSION 2015 - 16 (Supplementary June ~ July 2016)

Total Pages—5

(Set-Q_2)

B.Tech - 3rd(M & M)

Introduction to Physical Metallurgy

Full Marks : 70

Time : 3 hours

Answer Q. No. 1 which is compulsory and any five out of seven questions

The figures in the right-hand margin indicate marks

1. Answer the following in short : 2 × 10

   (*a*) Define coordination number and atomic packing factor.

   (*b*) Calculate the atomic packing factor for FCC crystal.

   (*c*) Titanium undergoes a change in phase BCC to HCP at 880°C on cooling. Calculate the percentage volume change. Given the lattice parameters $a_{BCC} = 3{\cdot}32$ Å and aHCP = 2·956 Å and C = 4·683 Å.

(*Turn Over*)

(*d*) Show schematically the (112), (0 –1 0) planes and [–2 1 –1], [–1 –1 –1] directions in cubic crystal.

(*e*) Distinguish between crystalline and non -crystalline solids.

(*f*) Define burgers vector and show schematically for edge and screw dislocation.

(*g*) What are the angles between the following directions of cubic crystal [001] and [111]; [011] and [101] ?

(*h*) Draw the phase diagram of pure iron from room temperature on wards.

(*i*) Differentiate between single crystal and polycrystalline material.

(*j*) Define solid solution, Gibb's phase rule, phase diagram and lever rule.

2. (*a*) State Hume-Rothery rules that favors substitutional solid solutions. 5

(*b*) Explain with a neat sketch the solidification of 70Ni30Cu alloy from the phase diagram. 5

3. (*a*) Sketch iron-cementite phase diagram and explain the invariant reactions. 8

(*b*) Check whether the reaction is energetically feasible

$$b_1 + b_2 \rightarrow b_3$$

where burgers vector $b_1 = a/2[\,0\ 1\ -1]$; $b_2 = a/2[-1\ 0\ 1]$; $b_3 = a/2[-1\ 1\ 0]$. 2

4. (*a*) What are the different types of crystal defects ? Explain with atomic scale models. 5

(*b*) A binary eutectic freezes at a fixed temperature in a binary system, whereas a binary eutectic in ternary system with three phase equilibrium freezes over a range of temperature. Explain why ? 5

5. (*a*) What are the deformation mechanisms in metals at room temperature ? Show schematically. 5

(*b*) Superimpose the stress-strain curves of brittle and ductile materials. Explain the different elastic and plastic properties that are obtained from the stress-strain curves. 5

6. (*a*) Explain the difference between resolved shear stress and critical resolved shear stress. Derive the expression for critical resolved shear stress. 5

(*b*) The critical resolved shear stress of perfect crystal of copper is 5 MPa. Determine the amount of stress to be applied in tension along [1 −1 0] axis of copper crystal to make it slip on (1 1 −1) [0 −1 1] slip system. 5

7. (*a*) Draw the TTT curve for eutectoid steel and indicate the phases in different regions. 5

(*b*) Discuss the martensite characteristics and morphology of martensite. 5

8. (*a*) Define hardenability. What is the common criterion of hardenability of steels and why ?

Enumerate the five factors affecting the hardenability of the steel. 5

(*b*) Differentiate between hot working and cold working. 2

(*c*) What is the composition, properties and applications of phosphor bronzes ? 3
