B.E. (MET) Part-II 4th Semester Examination, 2014

Introduction to Physical Metallurgy (MT-401)

Full Marks: 70 **Time: 3 Hours**

*Answer any **seven** questions.*
All questions carry equal marks

1 (a) Describe the various types of bonding in solids with examples of each.
(b) Define *polymorphism* and *allotropy* citing examples.
(c) What are *transition metals* and why are they called so?
(d) How is *atomic diameter* defined?

(4+2+2+2)

2 (a) Describe the process of solidification of metals elaborating the nature cooling curve, reason for undercooling, dendritic growth and formation of grains.
(b) Explain with sketches the difference in grain structure in a sand mould and a chill mould.
(c) How do *shrinkage cavities* form in an ingot?

(5+3+2)

3 (a) Explain how a binary *isomorphous* equilibrium diagram is constructed from cooling curves.
(b) Draw isomorphous solid solution systems showing maximum and minimum and a eutectic system involving an intermetallic compound.
(c) Describe the phenomenon of *coring* in an isomorphous system.

(3+3+4)

4 (a) Draw the equilibrium diagram of a binary eutectic system showing limited terminal solid solubilities and describe the solidification of a *hypoeutectic alloy* with corresponding microstructures at (i) the liquidus temperature, (ii) at a temperature intermediate of liquidus and eutectic temperatures and (iii) at the eutectic temperature.
(b) Apply phase rule to show that the eutectic point is invariant.

(8+2)

5 (a) Draw the Fe-Fe_3C equilibrium diagram labeling all the phase fields and indicating the reactions involved in the system with their temperatures and compositions.
(b) Indicate the critical temperatures and lines in the diagram and explain their implications.
(c) How do the eutectoid composition and eutectoid temperature respond to alloying additions?

(5+2+3)

6 (a) Describe the processes of annealing, normalizing and hardening of *hypoeutectoid* and *hypereutectoid* steels justifying the choice of temperature.
(b) Describe the *order-disorder transformation* in an alloy system with an example and its representation in the equilibrium diagram.
(c) Write down the *monotectic* and *syntectic* reactions and their graphical representations.

(6+2+2)

7. (a) Explain briefly the importance of chemistry-processing-structure-property relationship in developing metallic materials.
   (b) Calculate the fraction of pro-eutectoid ferrite, eutectoid ferrite and total ferrite in a 0.6 wt% C steel.
   (c) Determine the degrees of freedom for an isomorphous alloy system when both phases co-exist at equilibrium.

[6+3+1]

8. (a) Derive *Fick's* second law of diffusion.
   (b) Determine the diffusion co-efficient using the Grube solution.
   (c) Draw the isothermal section of A-B-C eutectic ternary diagram at (i) below the all eutectics (A+B), (A+C) and (B+C), but above (A+B+C) ternary eutectic temperature, (ii) below the ternary eutectic temperature.

[2+4+4]

9. (a) Differentiate between heat etching and heat tinting?
   (b) Explain the etching mechanisms of pure materials and duplex alloy.
   (c) Explain why diffusivity of carbon is higher in ferrite phase than that in austenite phase.
   (d) Explain why diffusion of interstitial element is much faster than substitutional element.

[3+3+2+2]

10 Write shorts notes on (any three): [10]
   (a) Optical Pyrometer
   (b) Uphill diffusion
   (c) Kirkendall effect
   (d) Hume Rothery's rules
   (e) Intermediate phase