Registration no: | | | | | | | | | | |

Total Number of Pages: 02

B.Tech
PCMT4301

5th Semester Regular / Back Examination 2016-17
PHASE TRANSFORMATIONS AND HEAT TREATMENT

BRANCH(S):METTA, MME

Time: 3 Hours

Max Marks: 70

Q.CODE: Y447

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** **(2 x 10)**

a) What is an intermediate phase? Give an example.

b) In a single-component condensed system what is the maximum number of phases that can co-exist?

c) During homogeneous nucleation, what is the effect of undercooling on the critical size of a particle?

d) Show through a suitable diagram and explain briefly how the overall transformation rate changes with temperature.

e) How do the alloying elementsinfluence the eutectoid temperature in the Fe-Fe_3C system?

f) Briefly explain how the common alloying elements influence the position of the C curve in the T-T-T diagram of a eutectoid steel.

g) What is the purpose of tempering a quenched steel?

h) What is secondary hardening?

i) What is the difference between an ordered CuZn (β' phase) structure and random CuZn (β phase) structure. Draw the unit cells and explain briefly.

j) How does the austenitic grain size influence the pearlitic transformation?

Q2 **a)** Derive a general expression for the free energy change on mixing a regular solution by using the quasichemical approach.And through suitable diagrams show the effect of ΔH_{mix} and temperature, T on ΔG_{mix} i.e. for exothermic solutions and endothermic solutions at high and low temperatures. **(5)**

b) Draw the Fe-Fe_3C phase diagram and label the important phase fields, temperatures and compositions. Give the invariant reactions occurring in the system. **(5)**

Q3 **a)** Derive the expressions for diffusion coefficient of atoms, D, as a function of temperature for (i) substitutional diffusion of solute atoms by vacancy mechanism and (ii) interstitial diffusion of interstitially dissolved solutes. Compare the activation energies for the two types of diffusion. **(5)**

b) In a binary isomorphous system of A and B draw free energy composition curves of α and liquid phases at temperatures T_1, T_A, T_2, T_B, and T_3, Where T_A and T_B are melting temperatures of A and B and $T_1 > T_A > T_2 > T_B > T_3$. **(5)**

Q4 **a)** In a Pb-Sn binary system the melting temperature of pure Pb is 327°C and that of pure Sn is 232°C. At 183°C α solid solution of 18.3 wt% Sn, liquid solution of 61.9 wt%Sn and β solid solution of 97.8 wt% Sn are in three phase equilibrium.The solubility of Sn in αat room temperature is 2 wt% and that Pb in β is 1wt%. **(5)**

(i) Draw the phase diagram and label the phase fields, temperatures and compositions.

(ii) What is the invariant reaction at 183°C?

(iii) For a 60 wt% Pb-40 wt% Sn alloy calculate the phases present at a temperature just above 183°C and at a temperature just below 183°C.

b) Referring to the above Pb-Sn phase diagram draw and explain briefly the changes in microstructure when the following alloys are cooled slowly from liquid state to room temperature: **(5)**
(i) Pb-1wt% Sn, (ii) Pb-10wt% Sn, (iii) Pb-40wt% Sn, (iv) Pb-61.9wt% Sn and (v) Pb-80wt% Sn.

Q5 **a)** Show and explain the variation of the total free energy change, Δf, accompanying the formation of a spherical new phase particle as a function of the radius, r, of the particle during homogeneous nucleation. Determine the expressions for the critical radius, r*, and the critical free energy of nucleation, Δf^*, and through suitable diagram explain the effect of transformation temperature on r* and Δf^*. **(5)**

b) Derive the expression for the total free energy change, Δf_{het}, accompanying the formation of a heterogeneous nucleus on the planar surface of a foreign inclusion. Determine the expression for the critical free energy of heterogeneous nucleation, Δf^*_{het} and explain how it is influenced by the contact angle, θ. **(5)**

Q6 **a)** Draw the T-T-T diagram of a eutectoid steel and label it. Show the time temperature paths on the T-T-T diagram to obtain the following microstructures: (i) 100% pearlite, (ii) 100% Bainite, (iii) 50% pearlite and 50% Bainite (iv) 100% Martensite. **(5)**

b) Explain the Jominy end quench test for determining the hardenability of steels. **(5)**

Q7 Explain in detail the essential characteristics of the different stages of annealing and the microstructural and property changes that take place on heating a cold worked metal. **(10)**

Q8 **Write short notes on any TWO:** **(5 x 2)**

a) Pack carburizing and post carburizing heat treatments.

b) Martensitic transformations.

c) Particle coarsening.

d) Age hardening of Al-Cu alloys.