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

Total Number of Pages: 02 **B.TECH**
PCMT4301

5TH Semester Regular / Back Examination 2015-16
PHASE TRANSFORMATIONS AND HEAT TREATMENT
BRANCH: MM, MME
Time: 3 Hours
Max marks: 70
Q.CODE: T169

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) An alloy A-B contains 40 wt% B. Calculate at% B in this alloy. Given atomic weights of A = 30, B = 63.

b) Distinguish between austempering and martempering.

c) Explain how the presence of inclusions, voids and second phase particles influence grain growth.

d) What is the homogeneous nucleation barrier, ΔG^* for a spherical particle of radius, r, of a new phase and what is the critical radius, r^* of the nucleus?

e) Give the Matano-Boltzman analysis of diffusion in one – dimensional diffusion couples with variable D and determine diffusion coefficient as a function of composition.

f) What is Kirkendall effect?

g) Compare the structure and properties of a spherodised steel and a quenched and tempered steel.

h) In pearlitic transformation how does the temperature of transformation influence the interlamellar spacing?

i) How is spinodal decomposition different from nucleation and growth?

j) Distinguish through suitable sketches between an annealed structure and a quenched and aged structure of an age hardenable alloy.

Q2 **a)** Explain the Bain distortion model of martensitic transformation. Explain the athermal, isothermal, and burst type of martensitic transformations. **(5)**

b) What is interface controlled growth and diffusion controlled growth? Derive the general expression for the growth rate of precipitate particles and explain how the growth rate varies with time in growth of spherical particles. **(5)**

Q3 **a)** Explain and determine the Gibbs energy of formation of a critical embryo, ΔG^*, radius of critical embryo, r^*, and rate of nucleation for homogeneous nucleation of spherical particles and heterogeneous nucleation at impurity surfaces **(5)**

b) The melting point of copper is 1083˚C. Calculate the critical radius of the copper nucleus during solidification of liquid copper at 983˚C. The enthalpy of fusion of copper is 1.88 x 10^9 Jm^{-3}. The liquid solid interfacial energy is 0.144 Jm^{-3}. **(5)**

Q4 **a)** Through suitable diagrams explain the difference between the T-T-T curves and C-C-T curves of a eutectoid steel. Give the cooling paths during continuous cooling of a eutectoid steel to obtain the following microstructures: (i) Pearlite, (ii) Martensite and Pearlite, (iii) Martensite. **(5)**

b) Show and explain the variation of the molar Gibbs energy of mixing, ΔG_m, as a function of composition (i) of an ideal binary solution, and (ii) of a regular binary solution at different temperatures when the enthalpy of mixing (A parameter) is positive with the help of suitable diagrams. **(5)**

Q5 **a)** Draw the three-dimensional view of a ternary phase diagram between three components, which pair up as simple binary eutectic systems such that there are four phases in the system, corresponding to the liquid and the three terminal solid solutions α, β and γ. **(5)**

Draw isothermal sections:

(i) at a temperature below the three binary eutectic temperatures and above the ternary eutectic temperature.

(ii) at a temperature below the ternary eutectic temperature.

b) In a binary simple eutectic system having terminal solid solutions draw free energy composition diagrams of the α, β and liquid phases at temperatures T_1, T_A, T_2, T_3, T_E, T_4. Where T_A and T_B are melting temperatures of A and B and $T_1 > T_A > T_2 > T_3 > T_E > T_4$. **(5)**

Q6 **a)** Explain briefly the different mechanisms of diffusion in crystalline solids. Compare the diffusion coefficient of atoms in diffusion by vacancy mechanism and in interstitial diffusion. What are high diffusivity paths in crystalline solids and how is the dominant diffusion path determined? **(5)**

b) What is heterogeneous nucleation? Derive the expressions for Gibbs energy of formation of critical embryo and the rate of heterogeneous nucleation β formed at a planar grain boundary of α. **(5)**

Q7 **a)** Explain the mechanism and kinetics of pearlite growth. **(5)**

b) The ratio of diffusion rate of silver in silicon at 1350˚C to that at 1100˚C was found to be 8 in a doping process. Calculate the activation energy Q for silver diffusion in silicon. R= 8.314 $Jmol^{-1}K^{-1}$. **(5)**

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

a) Hardening and Tempering

b) Order disorder transformations

c) Spinodal decomposition

d) Age hardening