Registration No. :

Total number of printed pages – 2

B. Tech

PCMT 4301

Fifth Semester Regular Examination – 2014
PHASE TRANSFORMATION AND HEAT TREATMENT
BRANCH(S) : MM, MME
QUESTION CODE : H 138
Full Marks – 70

Time : 3 Hours

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

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1. Answer the following questions :   2×10

    (a) What is degree of freedom ? Calculate the maximum possible degrees of freedom in a binary system.

    (b) Explain the effect of supercooling on critical radius of nucleation and rate of nucleation.

    (c) What is Fick's first law of diffusion in steady state ?

    (d) How does temperature affect the diffusivity of atoms in a solution ?

    (e) What is temperature inversion and how it supports dendritic growth ?

    (f) What is particle coarsening ? What is its effect on strength of precipitation hardened alloy ?

    (g) Explain why case hardening methods improve the fatigue resistance of the steel ?

    (h) What is clustering or short range order parameter ?

    (i) Define the following terms : (i) Incubation period. (ii) critical cooling rate.

    (j) Compare flame and induction hardening.

2. (a) Explain briefly the different mechanisms of diffusion in crystalline solids. Compare the diffusivity of atoms in vacancy mechanism and in interstitial diffusion.   5

    (b) What is interface controlled growth and diffusion controlled growth ?   5

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3. Define Kirkendall effect. Derive the Darken's equation giving the relationship between the chemical interdiffusion coefficient of the solid solution and intrinsic diffusivities D_A and D_B of two elements A and B respectively considering the Kirkendall effect.   10

4. (a) What is heterogeneous nucleation ? Derive the expressions for Gibbs energy of formation of critical embryo and the rate of heterogeneous nucleation of β formed on planar surface of a foreign particle or inclusion. 5

   (b) In a binary eutectic system draw the free energy composition diagrams of the phases at temperatures T_1, T_2, T_3, T_E and T_4. Where T_A and T_B are melting temperatures of A and B, and T_E is the eutectic temperature and $T_1 > T_A > T_2 > T_B > T_3 > T_E > T_4$.   5

5. (a) What is tempering ? What is its aim ? What are the different stages of tempering of steel ?   5

   (b) Write down the differences between Lath Martensite and Plate Martensite. 5

6. (a) Draw and label the Iron - Iron carbide phase diagram with important temperatures, compositions and invariant reactions occurring in the system.   5

   (b) Calculate the fractions of pearlite, proeutectoid cementite, eutectoid cementite and ferrite in a 1% C steel that has been slow cooled to a temperature just below the eutectoid temperature.   5

7. (a) What is stress relieving annealing ? How are these stresses developed ? What are the aims of stress relieving annealing ?   5

   (b) Distinguish between Hardness and Hardenability. Also state the factors affecting the hardenability of steel.   5

8. Write short notes on any two of the following :   5×2

   (a) Martempering

   (b) Lower bainite and upper bainite

   (c) Martensitic transformations

   (d) Spinodal decomposition.

PCMT 4301   2   – C