Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech

PCMT 4301

Fifth Semester Back Examination – 2014

PHASE TRANSFORMATION AND HEAT TREATMENT

BRANCH(S) : MM, MME

QUESTION CODE : L 223

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.

1. Answer the following questions : 2×10

   (a) Define a phase, a component, and degrees of freedom.

   (b) What is phase rule ? What can be the maximum number of phases coexisting in equilibrium in a binary system ?

   (c) Explain Kirkendall effect with a suitable example.

   (d) State the conditions for stable interface growth and cellular growth of nuclei.

   (e) What is invariant reaction ? State the invariant reactions in the Fe-Fe_3C phase diagram.

   (f) What is long range order and short range order in a solid solution ? What is the criteria for long range ordering ?

   (g) How sulphur produces hot shortness in steel and how this effect is removed ?

   (h) Define primary cementite, ledburite and transformed ledburite.

   (i) Why 'S' curve shifts towards left when the carbon content of steel increases beyond 0.77% ?

   (j) What is carburisung ? What is its effect on mechanical properties of steel ?

2. (a) Draw and label the binary phase diagram between A and B, if pure A melts at 1050°C and pure B melts at 1900°C. At 1250°C the solid solution α (50%B), the solid solution β (80%B) and the liquid (30%B) are in three phase equilibrium. At room temperature, the maximum solubility of B in A is 30% and the maximum solubility of A in B is 10%. Write the invariant reaction occurring in the phase diagram. 5

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(b) Give a classification of phase transformations in materials with characteristic features and examples of each type. Also with suitable sketch explain the condition of equilibrium in a heterogeneous system containing two phases. 5

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

(b) What is interstitial diffusion ? Derive the Fick's First law of diffusion in the steady state. 5

4. (a) Explain recrystalisation annealing. 5

(b) Explain and draw schematic diagrams to show how growth rate and nucleation rate vary with temperature for diffusion transformation that are induced by increase in temperature. 5

5. (a) 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 grian boundary of α. 5

(b) Explain martensitic transformation and how it is different from pearlitic transformation. 5

6. (a) What is retained austenite ? What are its advantages and disadvantages? How is retained austenite in steels eliminated ? 5

(b) Calculate the fractions of proeutectoid ferrite, eutectoid ferrite and pearlite in slowly cooled 0.4 wt% carbon steel. Draw the microstructure of the steel at room temperature. 5

7. (a) Draw the TTT diagram of eutectoid steel and explain the various regions of phase transformations in it. 5

(b) Explain the difference between normalizing and full annealing. 5

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

(a) Austempering

(b) Spinodal decomposition.

(c) Dendritic growth

(d) Bain model.