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Total number of printed pages – 2

B. Tech  
PCMT 4301

**Fifth Semester Back Examination – 2014**

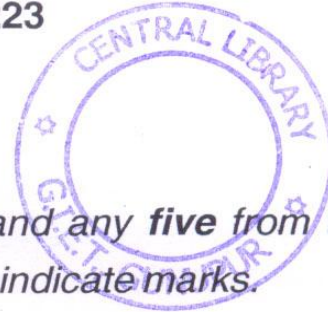
**PHASE TRANSFORMATION AND HEAT TREATMENT**

**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<sub>3</sub>C 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 carburising ? 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  $\alpha$  (50%B), the solid solution  $\beta$  (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 recrystallisation 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  $\beta$  formed at a planar grain boundary of  $\alpha$ . 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.