

**Phase Transformation**  
**(MT 501)**

**Full Marks: 70**

**Time: 3 hrs**

*Use SINGLE answer script for answering of all questions.  
Answer any SEVEN questions*

1. (a) Outline the criteria for spinodal decomposition in a binary system.  
(b) Comment on the magnitude of wavelength of composition fluctuations in spinodal decomposition with derivation of relevant mathematical equation.  
(c) Differentiate between the following:
  - (i) Spinodal and nucleation-growth process
  - (ii) Coherent and chemical spinodal

[2+3+(3+2)]
  
2. (a) What are the prerequisites for an alloy to be age hardenable?  
(b) Discuss the role of the following on ageing characteristics of Al-Cu alloys:
  - (i) Amount of Cu
  - (ii) Temperature
  - (iii) Quenched-in vacancy

[3+(2+2+3)]
  
3. (a) Derive the expression of  $r^*$  and  $\Delta G^*$  from *free-energy* consideration for heterogeneous solidification.  
(b) Discuss the variation of  $\Delta G_{hetero}^*$  with (i) wetting angle and (ii) degree of supercooling.

[5+(3+2)]
  
4. Discuss the following with the help of schematic diagrams:
  - (a) Development of *constitutional supercooling*.
  - (b) Mechanism of *dendritic solidification*.
  - (c) Generation of typical *cast structure*.

[4+3+3]
  
5. Briefly discuss the following:
  - (a) Why *solidification requires some degree of supercooling to start but melting occurs without any superheating*?

- (b) What are the strategies in alloy design for minimization of particle coarsening?
- (c) Selection criteria of inoculants for solidification.

[3+4+3]

6. (a) Draw the T-T-T diagrams of a 0.3% carbon steel and 1.2% Carbon steel.
- (b) Why T-T-T- curve takes the C shape?
- (c) Discuss the effects of time and temperatures on production of homogenous austenite.

[4+3+3]

7. (a) Discuss the mechanism of formation of austenite in hypoeutectoid steel.
- (b) Discuss the Hull-Mehl model to illustrate the nucleation and growth of pearlite.
- (c) Define inter-lamellar spacing of pearlite. How does inter-lamellar spacing vary with transformation temperature?

[4+3+3]

8. (a) Discuss the variation of nucleation and growth of pearlite with temperature in eutectoid steel.
- (b) Distinguish between upper bainite and lower bainite.
- (c) Discuss the major characteristics of bainitic transformation.

[2+4+4]

9. (a) Why do strength and ductility parameter vary with increasing amount of cold-work?
- (b) Discuss the mechanism of recrystallization?
- (c) Explain with schematic diagram the microstructural and associated property changes that occur during recovery and recrystallization process.

[3+3+4]

10. (a) What is Bain distortion mechanism?
- (b) What is reversibility of martensitic transformation?
- (c) Illustrate the characteristics of isothermal martensite.

[5+2+3]