Dr Ray Bahadar Singh 62 2/12/2022

National Institute of Technology Hamirpur
Department of Material Science and Engineering
End-Term Examination Nov-Dec 2022-23 (Odd Semester)

Sub: Phase Transformation   **Course Code: MS-211**
Time: 3hrs   **Max. Marks: 50**

Note: Answer all questions. Draw neat sketch wherever needed.

Q. 1. Discuss the metallurgical aspect of design of an automobile gear (5)

Q. 2. Answer the followings (10)
(a) Give the example of each (i) Closed packed structure (ii) Open structure
(b) Bainite
(c) Lists the nucleation sites in the materials with their energy hierarchy
(d) Give an example of single component system with multiphase at different physical states
(e) Coherent interfaces

Q. 3. Draw CCT diagram for eutectoid steel and superimpose the different cooling curves to obtain different phases. (5)

Q. 4. Explain the martensitic transformation in steels. How the variation of carbon affect the properties of martensite and why? (5)

Q. 5. For a Fe-0.4wt% C alloy at 900°C and 600°C: (i) Plot the constitution points on the phase diagram; (ii) Identify the phases present, and find their compositions in wt%; (iii) If the temperature is slowly reduced from 900°C to 600°C, at what temperatures are phase boundaries crossed? Identify the phases present after each boundary is crossed. How does slow cooling from 900°C to 600°C differ for a Fe-0.8wt% C alloy? (5)

Q. 6. Explain the precipitation hardening in duralumin alloy; also explain the effect of temperature on the precipitation hardening. (5)

Q. 7. What are the industrial importances of the phase transformations (5)

Q. 8. Calculate the homogeneous nucleation rate in liquid copper at under-cooling of 180, 200 and 200 K, using the following data: $L = 1.88 \times 10^9\ Jm^{-3}$, $T_m = 1356\ K$, $\gamma_{sl} = 0.177\ Jm^{-2}$, $f_0 = 10^{11}\ s^{-1}$, $C_0 = 6 \times 10^{28}$ atoms m^{-3}, $k = 1.38$. (10)