

**BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) SECOND YEAR FIRST
SEMESTER EXAMINATION - 2025**

Subject: MATERIAL SCIENCE AND ENGINEERING Time : Three hours Full Marks: 100

(Answer any FIVE questions)

1(a) Briefly explain the various types of ferrous materials. (10)

1(b) Explain the HCP crystal structure and determine its atomic packing factor. (4+6)

2(a) Nickel has FCC crystal structure with atomic radius of 1.245 Å. Determine the followings:

(i) Atomic packing factor

(ii) Linear density along the direction [110]

(iii) Planar density along the plane (111). (12)

2(b) Draw the following crystallographic planes and directions:

(2 $\bar{1}$ 0), [102], (12 $\bar{1}$), [32 $\bar{1}$] (8)

3(a) State Fick's laws of diffusion. How will you determine activation energy for solid state diffusion ? (4+4)

3(b) For a carburization process, the carbon environment used has carbon content of 1.4%. The initial carbon content in steel is 0.3% and a carbon content of 0.8% is reached at a depth of 0.75 mm from the surface in 10 hours. Determine the carburization temperature. (12)

Given: $D_o = 20 \times 10^{-6} \frac{m^2}{s}$; $Q = 142 \frac{KJ}{mol}$; $R = 8.314 \frac{J}{mol K}$

Z	0.45	0.50	0.55	0.60
erf(Z)	0.4755	0.5205	0.5633	0.6034

4(a) Derive the expression for composite elastic modulus under iso-strain condition for a fibre reinforced composite material. Also mention the assumptions made to derive the expression. (6+3)

4(b) For a fibre reinforced composite material, the modulus ratio is 26 and the fibre takes 35% of the cross sectional area. What percentage of the longitudinal load is taken by the fibre ? (5)

4(c) Explain the stress-strain behaviour of a fibre reinforced composite under longitudinal loading. (6)

5(a) Draw the Iron-Carbon equilibrium phase diagram according to scale and explain the important features of the diagram. (8+6)

5(b) What do you mean by 'Eutectic', 'Eutectoid' and 'Peritectic' reactions? (6)

6(a) Draw and explain the Time Temperature and Transformation (TTT) diagram for eutectoid steel and explain the important features of this diagram? (14)

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6(b) How does the cooling rate influence the microstructure of eutectoid steel ? What is 'critical cooling rate' ?

(4+2)

7(a) An alloy of 40 kg of Pb-Sn contains 30% Sn by weight. Refer the Pb-Sn phase diagram given in Fig. 1 and determine the followings:

(i) Amounts of solid and liquid phases at 200 °C

(ii) Amounts of pro-eutectic solid and liquid phases

(iii) Amounts of α and β phases formed by eutectic reaction only.

(3+4+5)

7(b) Mention the objectives of heat treatment. Explain any one heat treatment process.

(4+4)

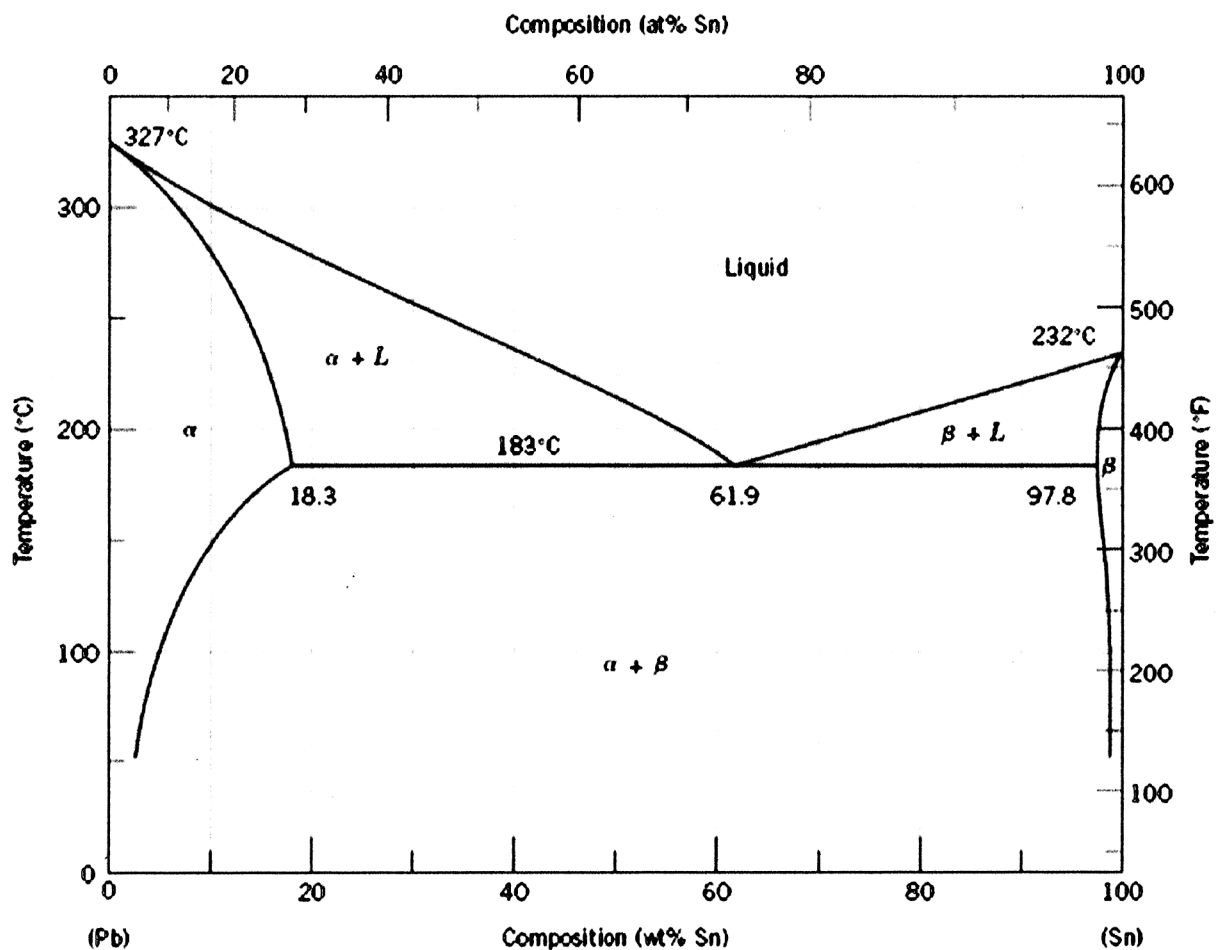


Fig. 1