Integrated Dual Degree (B.Tech and M.Tech)
Sub_Code: RME4C003/RCI4G001

4th Semester Regular/Back Examination: 2023-24
SUBJECT: Introduction To Physical Metallurgy and Engineering Materials
BRANCH(S): MECH, MMEAM, C&EE, CIVIL, CE, ME
Time: 3 Hours
Max Marks: 100
Q.Code: P591
Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1   Answer the following questions: (2 x 10)

a) Draw [1$\bar{2}$0] and ($\bar{2}\bar{1}\bar{1}$) in cubic crystal system.

b) Distinguish between unit cell and primitive cell.

c) At 910℃ the γ-Fe transforms to α-Fe. What is the percentage of volume expansion?

d) Derive Gibb's phase rule. What is the minimum and maximum number of phases which could exist in a pure metal?

e) Why are grain boundaries favorable sites for nucleation or growth for precipitates?

f) Define composite.

g) It is often thought that the species having lower activation energy diffuses faster than the one having higher activation energy. Is this always true?

h) What is constitutional super-cooling? When does this take place?

i) What is Burger's vector?

j) What is Zener pinning effect?

Part-II

Q2   Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)   (6 × 8)

a) What is cooling curve? Draw the cooling curves for binary solid solution alloy and binary eutectic alloy?

b) For a 0.35 wt% C plain carbon steel at a temperature just below the eutectoid temperature determine:
  I. Fraction of total ferrite and cementite phase.
  II. Fraction of the pro-eutectoid ferrite and pearlite.
  III. Fraction of eutectoid ferrite.

c) Derive c/a ratio of HCP crystal. Find out its APF.

d) Explain different point defects.

e) Write short note on: Scattering.

f) What is Metallography? Discuss about polishing techniques for metals and alloys. Give the requirements of etching in microscopic observation.

g) Explain the factors affecting hardenability.

h) Mention the properties and applications of grey cast iron and compare it with white cast iron.

i) Explain briefly the SC, BCC, and FCC structure and calculate the atomic packing factor for BCC structure.

j) What is CRSS? Write the expression for CRSS. Determine tensile stress that is applied along $[1\bar{1}0]$ axis of a silver crystal to cause slip on the $(1\bar{1}1)$ $[0\bar{1}1]$ system. Given CRSS = 6 MPa.

k) What is recrystallization? What are the factors affecting recrystallization temperature?

l) Explain Fick's first and second laws of diffusion.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3   Explain the Precipitation hardening mechanism for Al-4%Cu alloy. Also mention crystallographic aspects. Nickel, Aluminium, and Copper have face centered cubic structure yet Ni is soluble in copper whereas Al has only a limited solubility. Explain why it is so?   **(16)**

Q4   What are polymers? Discuss the different Polymerization mechanisms with sketch.   **(16)**

Q5   Draw a neat sketch of $Fe-Fe_3C$ phase diagram. Show different phases. Explain different invariant reactions taking place in the system.   **(16)**

Q6   Draw properly the T-T-T diagram of eutectoid, hypoeutectoid, and hypereutectoid steel. State its utility and limitations. Define critical cooling rate and actual cooling rate.   **(16)**