B. Tech-3rd(MME)

Introduction to Physical Metallurgy

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer **all** questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

Any supplementary materials to be provided

1. Answer *all* questions : 2×5

   (a) Draw [120] and (212)?

   (b) Convert the (111) and $(0\bar{1}2)$ Miller indices into Miller-Bravais indices ?

   (c) What is the difference between CCT and TTT ?

(d) What is the maximum solubility of carbon in austenite and ferrite ?

(e) Define recrystallization. What happened to strength of materials during recrystallization ?

2. (a) On the stress-strain graph, for a load beyond the yield strength that is suddenly removed, show the elastic strain and the plastic strain ? 4

(b) Calculate the inter-plannar spacing for the (110), (111), (120), (221) and (123) planes of copper. Which of the above planes has the greatest inter-planar spacing ? 4

Or

(a) To define a tetragonal system how many lattice parameters are needed and why a face-centered cubic lattice cannot be redrawn as a body-centered tetragonal lattice ? 4

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(b) Calculate value of c/a in HCP unit cell and find out the packing factor by using the value of c/a.   4

3. (a) Derive Gibb's phase rule. What is the minimum and maximum number of phases which could exist in a pure metal ?   4

(b) Describe each section of the cooling curve with proper labeling for pure metal and alloy.   4

Or

(a) Explain briefly the BCC and FCC structure and calculate the atomic packing factor for BCC structure.   4

(b) Briefly explain the Eutectic and Peritectic reactions using proper examples. Write a note on allotropy.   4

4. (*a*) Hume Rothery rule applies to which type of solid solutions and mention all the factors for this rule.   4

(*b*) Mention any two differences between interstitial solid solutions and substitutional solid solutions.   4

Or

(*a*) Calculate the amount of ferrite and cementite in pearlite and also calculate the amount of austenite and cementite present in ledeburite by using the Lever rule.   4

(*b*) Sketch the microstructure of 0.2% C steel. Calculate % Pearlite % cementite, % proeutectoid ferrite and % total ferrite.   4

5. (*a*) Draw a $Fe-Fe_3C$ phase diagram with proper labeling of the following points :   4

(*i*) Invariant reaction

(ii) Critical line

(iii) Phases exist at different temperature

(iv) Composition of each phase

(v) Curie points

(vi) Steel and cast iron region

(b) What are the major differences between an edge & screw dislocation ? Which of these can cross slip ?   4
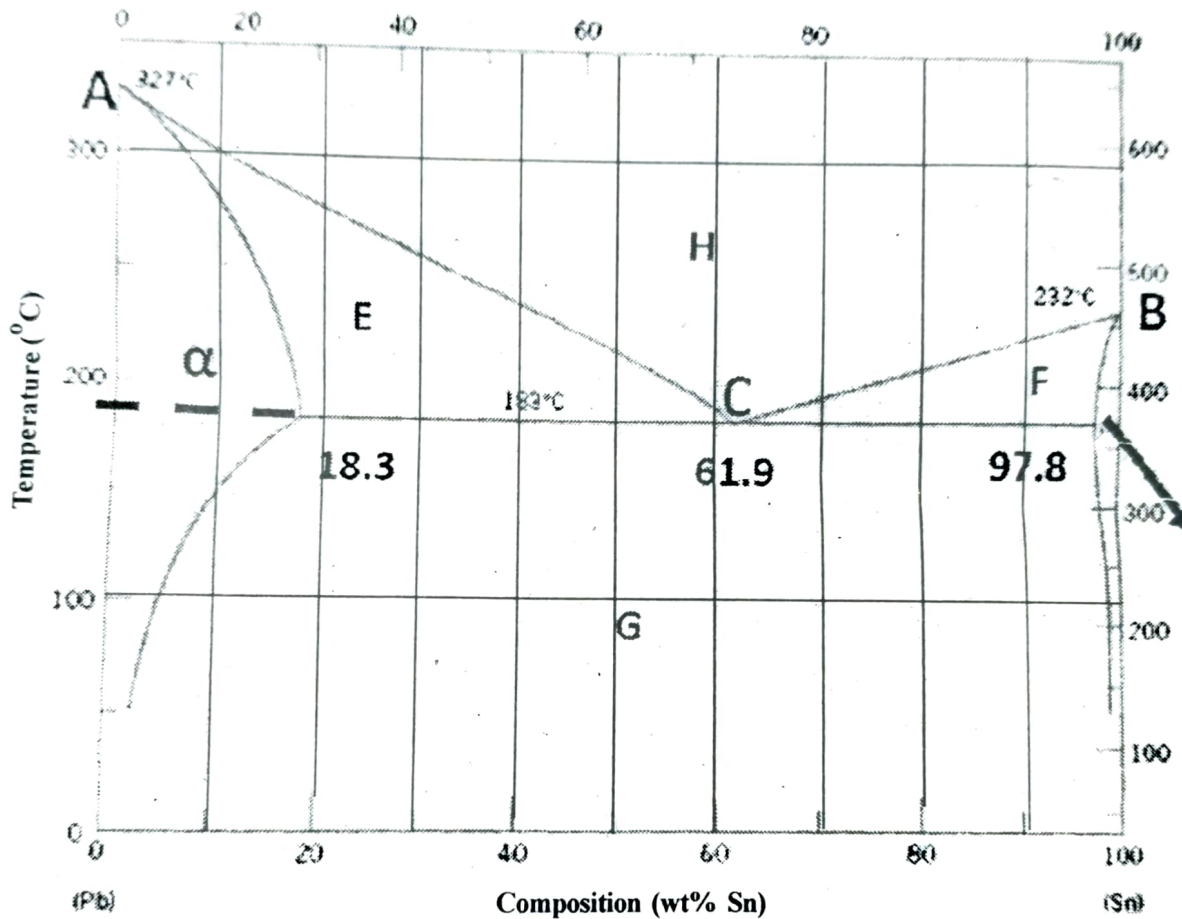
Or

(a) In the Pb - Sn eutectic phase diagram find out   4

(i) Significance of A, B and C point ?

(ii) In terms of solid solution define α and β. (Hint: the size difference between α and β is less than 15 %)

(iii) At 183 °C, what is the amount of α and β ?

(iv) Which phases exit at E, F, G, and H ?

(v) Show liquidus and solidus line.

(b) Determine the tensile stress that is applied along the $[1\bar{1}0]$ axis of a silver crystal to cause slip on the $(1\bar{1}\bar{1})[0\bar{1}1]$ system. The critical resolved shear stress is 6 MPa.

4

6. (a) Derive the relationship

    (i) $\varepsilon = \ln(1+e)$

    (ii) $\sigma = S(1+e)$

(b) A bar 10 cm long is elongated by (1) drawing it to 15 cm, and then (2) drawing it to 20 cm.

   (i) Calculate the engineering strains for the two steps and compare the sum of these with the engineering strain calculated for the overall deformation.

   (ii) Repeat the calculation with true strains

Or

(a) Describe the recovery and recrystallization of annealing mentioning the properties affected by these processes.   4

(b) Discuss the mechanism of age hardening in Al-Cu system.   4

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