

B.E. METALLURGICAL AND MATERIAL ENGINEERING THIRD YEAR FIRST SEMESTER - 2019

SUBJECT: PHYSICAL METALLURGY

Time: 3 hours

Full Marks: 100

Answer any four (4) questions. Answers must be brief and to the point. All parts of the same question must be answered contiguously.

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| 1 | (a) During sensitisation, precipitation of Chromium carbide takes place in stainless steel. Derive how the precipitate size varies with time. | 9 |
| | (b) What are the different mechanisms of diffusion? Why is vacancy mechanism of diffusion favourable? What is Kirkendall effect? | 4+3+
3 |
| | (c) Derive the maximum cooling rate necessary to initiate constitutional supercooling. | 6 |
| 2 | What are the different microstructural regions present in an ingot? Why does the grain size of a solidified structure in a ingot cast changes from the surface to the centre? Derive the necessary work required for homogeneous nucleation. How does chemical composition of the mould material influence the work required for the heterogeneous nucleation? Why does grain refinement in the cast structure increase with the degree of undercooling? | 2+6+
6+5+
6 |
| 3 | How does the composition of the solid and liquid change with the amount of solidification when mixing is allowed in the liquid? Derive the expression for the enthalpy of mixing. State the condition of formation of ideal solution, solution and compound. Why does free energy vs. composition diagram show a minima when the enthalpy of mixing is positive at elevated temperature? | 7+7+
6+5 |
| 4 | Explain the factors that will control recrystallisation. What is solute drag? What is microalloyed steel? What are the purposes of adding microalloying elements in the microalloyed steel? What is strain induced precipitation? | 6+5+
4+5+
5 |
| 5 | Explain the conditions necessary for spinodal decomposition. What is melt treatment? What is malleable cast iron? Why does cast iron offer good damping properties? | 10+6
+4+5 |
| 6 | What does velocity of solidification depend on? Derive. What is non-steady state diffusion? Give example of non steady state diffusion. Derive the expression for the diffusion controlled growth rate. | 8+4+
5+8 |