

B.E. METALLURGICAL AND MATERIAL ENGINEERING THIRD YEAR FIRST SEMESTER – 2024

Time: 3 hours

PHYSICAL METALLURGY

Full Marks: 100

Answer any four (4) questions.

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| 1 | (a) 0.1 wt% plain carbon steel is carburized at 930 °C. The carbon content at the surface is 1 wt%. Calculate the time for the diffusion of carbon at 1.00 mm distance from the surface to ensure the concentration of carbon 0.4 wt%. (erf(x)=x) | 13 |
| | (b) The diffusion coefficient of A in B at 900 °C is $10^{-16} \text{ m}^2\text{s}^{-1}$. At 550 °C, the diffusion coefficient of A in B is $10^{-19} \text{ m}^2\text{s}^{-1}$. What is the activation energy of diffusion? | 12 |
| 2 | (a) The concentration of A is 100000 mol m^{-3} in one side of a plate. The thickness of the plate is 1500 micron. The flux is $3 \times 10^{-4} \text{ mol m}^{-2}\text{s}^{-1}$. The diffusivity is $10^{-13} \text{ m}^2\text{s}^{-1}$. What is the concentration of A in the other side of the plate? | 13 |
| | (b) The secondary dendritic arm spacing is 60 micron of a cast microstructure. The time require for homogenization is 6 hours at 1000 °C. When the secondary dendritic arm spacing is 65 micron, what is the time required to homogenize at 1000 °C? | 12 |
| 3 | A melts at 950 °C. 1 kg of A is cooled to 850 °C. Calculate the enthalpy, entropy and the free energy at 850 °C. The latent heat is 20kJ/kg. The heat capacity is 25 J/mol K. The atomic weight of A is 205. | 8+8+9 |
| 4 | What are the different types of variations of enthalpy of mixing with temperature? At lower temperature, does enthalpy or entropy control the formation of cluster? Does cluster form at high temperature? Why? | 12+5+2
+6 |
| 5 | What is the driving force of solidification? Does enthalpy or entropy control the diffusivity with temperature? Justify. What are the influences of Silicon in cast iron? | 9+2+8+
6 |
| 6 | What is recrystallization? What are the applications of recrystallization? What is the minimum temperature of recrystallization of Aluminum? What is the influence of strain in recrystallization? | 3+7+8+
7 |