TE-ME.
Sem V (Old)
HMT

4(a) Explain hydrodynamic and Thermal Boundary Layer 5

(b) With the help of dimensional analysis method, prove that for convection:-

$Nu = \text{constant} \times (Re)^m \times (Pr)^n$ 8

(c) Explain shape factor and its properties. Find the shape factor of a cylindrical cavity of diameter D and depth H w.r.t. itself. 7

5(a) A hot cylinder ingot of 60 mm diameter and 200 mm long is taken out from the furnace at 900°C and dipped in water till its temperature falls to 500°C. Then it is directly exposed to air till its temp falls to 100°C. Find the total time required for the ingot to reach the temperature from 900°C to 100°C. Take the following properties K=50 W/m°C, C (specific heat of ingot) =200 J/m°C, ρ (density of ingot) =800 kg/m^3, h_w (heat transfer coefficient in water =200 W/m^2 °C, h_a (heat transfer coefficient in air) =20 W/m^2 °C, temperature of air or water as 30°C. 8

(b) Write short notes on: 12

(1) Boiling Curve
(2) Shape Factor Algebra
(3) Critical Radius and Thickness of insulation.

6(a) Explain the terms: Effectiveness, NTU, and LMTD 6

(b) What are Fourier and Biot numbers ? What is the physical significance of these numbers? 8

(c) Distinguish between Specular and diffuse radiation 6

7(a) A distillation column containing a mixture of benzene and toluene is at pressure of 1 bar and temperature of 105°C . The liquid vapor phase contain 20 mol% of benzene and 55 mol% of toluene respectively. At 105°C vapor pressure of the toluene is 0.72 bar and its diffusivity is 5.2 x10^{-6} m^2/s. Assuming the equimolar diffusion , calculate the molar diffusion flux of toluene if the diffusion zone is 0.35 m thick. Take universal gas constant as 8.314 kJ/kg mol K. 12

(b)State and explain Fick's law of diffusion and derive the condition for equimolar diffusion. 08
