13 NOV 2025 TE CHEMICAL SEM-V C SCHEME HTO QP CODE: 10094378

Time: 03 Hours **Marks:80**

N. B.: (1) Question No. **1** is **Compulsory.**

(2) Attempt any **Three** questions out of the remaining **Five** questions.

(3) Figures to the **right** indicate **full** marks.

(4) Make **suitable** assumptions wherever **necessary.**

Q1	Answer the following sub-questions (**Any Four**)	20
(a)	Derive an expression for Critical radius of insulation for sphere.	5
(b)	Explain effect of non-condensable gases.	5
(c)	Explain Pool Boiling Curve	5
(d)	Explain the Laws of Radiation	5
(e)	Write a short note on flow arrangements in heat exchanger.	5
(f)	Write a short note on Boiling Point Elevation of solution in Evaporator	5

Q2

(a) Derive an expression for heat transfer through composite cylinder made of three different materials. Assume K1, K2, K3, be the thermal conductivities of materials and X1, X2, X3, be the respective thickness. **hi and ho** be the convective heat transfer coefficients for inside hot gas and ambient air respectively? 10

(b) A cold storage room is constructed of an inner layer of 12.7 mm of pine, a middle layer of 101.6 mm of cork board, and an outer layer of 76.2 mm of concrete, the wall surface temperature is 255K inside the cold room and 297.1K at the outside surface of concrete k for pine = 0.151 W/m K k for corkboard = 0.0433 k for concrete =0.762.Calculate the heat loss for 1 m² and the temperature at the interface between the wood and corkboard. 10

Q3

(a) Derive an expression of LMTD for Counter Current Flow. Clearly state the assumption made. 10

(b) Hot liquid is flowing at a velocity of 2 m/s through a metallic pipe having an inner diameter of 3.5 cm and length 20 m. The temperature at the inlet of the pipe is 90◦C. calculate the heat transfer coefficient. **Following data is given for liquid at 90◦C:** 10
$\rho = 950$ kg/m^3, Cp = 4.23 kJ/kg◦C, $\mu = 2.55 \times 10^{-4}$ kg/ms, K = 0.685 W/m.◦C .

Q4

(a) Derive an expression for radiation shield 10

Q with 'n' Shield = (1/n+1) Q without Shield

(b) A hot water radiator of overall dimensions 2x1x0.2 m is used to heat the room at 18°C. The surface temperature of the radiator is 60°C and its surface is black. The actual surface of the radiator is 2.5 times the area of its envelope for convection for which the convection of coefficient is given by $h_c = 1.3(\Delta T)^{1/3}$ W/m^{2}K. Calculate the rate of heat loss from the radiator by convection and radiation. 10

Q5

(a) A vertical tube 40 mm diameter and 1 m long is used for condensing dry steam at atmospheric pressure. The tube surface temperature is 60°C. Determine the mass of condensate.If the tube is held in horizontal position, will there be any change in mass of condensate? If yes, calculate the value and change. **Use the properties of fluid as:** $\rho = 971.8$ kg/m^3, $\mu = 355 \times 10^{-6}$ kg/ms, $k_f = 0.675$ W/m.K, $h_{fg} = 2257$ kJ/kg. 10

(b) A pipe (k = 59 W/m.K) with an inner diameter of 3.75 cm and wall thickness of 0.318 cm is externally heated by steam at a temperature of 180°C. The water flows through the pipe with a velocity of 1.22 m/s. Calculate the length of pipe required to heat water from 30°C to 90°C. Assume the heat transfer coefficient on the steam side to be 11.3 kW/m² K. Properties of water at mean temperature (60°C): ρ = 982kg/m3, Cp = 4.186 kJ/kg.K, μ = 528x10-6 kg/ms, Pr = 3.42, kf = 0.645 W/m.K 10

Q6

(a) For Parallel flow heat exchanger Show that 10

$$\varepsilon = \frac{e^{-NTU(1+C)}}{1+C}$$

(b) Explain the methods used for feeding a multiple evaporation systems with neat diagram. 10

****