05-06-2026 TE CHEMICAL SEM-V C SCHEME HTO QP CODE: 20009464

[03 Hours] **[Total 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) What do you mean by Critical radius? Derive an expression for the Critical radius of the sphere. **5**

(b) Write a note on Wilson's plot. **5**

(c) Explain Kerns Method for design of heat exchanger. **5**

(d) Differentiate between forward and backward feed evaporator. **5**

(e) Write a short note on Double Pipe heat exchanger. **5**

(f) Explain the Laws of Radiation **5**

Q2

(a) A steel ball 50mm in diameter and initially at uniform temp. of 723K is suddenly placed in a controlled environment in which is maintained at 373K. Calculate the time required for a ball to attain a temperature of 423K. **10**
Data- K for steel = 35W/m K, Specific heat = 0.16KJ/Kg K,
h = 10 W/m^2K, Density of steel = 7800Kg/m^3

(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 **10**
k for pine = 0.151 W/m K, k for corkboard = 0.0433, k for concrete =0.762,
Calculate the heat loss for 1 m^2 and the temperature at the interface between the wood and corkboard.

Q3

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

(b) A Circular disc heater 0.2 m in diameter is exposed to ambient air at 25C. One surface of thedisc is insulated and other surface is maintained at 130C. Calculate the amount of heat transferred from the disc when it is: **10**
1. Horizontal with hot surface facing up. 2. Horizontal with hot surface facing down
3. Vertical Data: $\vartheta = 2.08 \times 10^{-5}$ m^2 /s, kair = 0.03 W/m.K Pr = 0.697

Q4

(a) Show that Nusselt Number is a function of Reynolds Number and Prandtl Number in forced convection. **10**

(b) Derive the expression of Radiation Shield and prove **10**

Q with n shields = (1/ n+1) Q without shield

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Q5

(a) A steam condenser consists of 16 tubes arranged in 4 x 4 array. The tubes are 25 mm in diameter and 1.2 m long. Water flows through the tube at 65°C while steam condenses at 75°C over the tube surface. Find the rate of condensation, if (a) tubes are horizontal; (b) tube are vertical. **10**

Take latent heat of steam as 2300 kJ/kg and properties of water at 70°C:
$\rho = 977.8$ kg/m^3, Cp = 4.187 kJ/kg K, $\upsilon = 0.415$x10-6 m^2/s, k = 0.668 W/m.K,
$\beta = 5.7 \times 10^{-3}$ K^{-1}

(b) A heat exchanger contains 4500 tubes, each having a diameter of 2.54 cm, through which 11.3 kg/s of air to be cooled from 538°C to 148°C. Water passes in counter flow over the tubes, rising in temperature from 38°C to 85°C. Determine the tube length required for this duty, if the water side resistance to heat flow is negligible. The physical properties of air at average temperature are as: $\rho = 1.009$ kg/m^3, $\mu = 2.075 \times 10^{-5}$ kg/ms, $k = 3.003 \times 10^{-5}$ kW/m.K,, Cp= 1.0082 kJ/kg.K. **10**

For turbulent flow inside tubes, use relation
$Nu = 0.023\ Re^{0.8}\ Pr^{0.4}$

Q6

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

(b) For Parallel flow heat exchanger Show that **10**

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

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