Name: **Enrolment No:**	

UPES

End Semester Examination, December 2024

Course: Process Heat Transfer **Semester: III**

Program: B.Tech Chemical Engineering **Time : 03 hrs.**

Course Code: CHCE2032 **Max. Marks: 100**

Instructions: In case of data missing make necessary assumptions

S. No.	**SECTION A (6Qx10M=60Marks)** Attempt all questions	**Marks**	**CO**
Q1	A furnace consists of a steel cylinder surrounded by an insulation layer. The steel cylinder has an inner radius of 10 cm and an outer radius of 15 cm. The insulation layer has an outer radius of 20 cm. The temperature inside the steel cylinder is maintained at 900°C, and the outer surface of the insulation is exposed to a surrounding temperature of 30°C. The thermal conductivities of the steel and insulation are 50 W/m.^{o}C and 0.25 W/m.^{o}C, respectively. The heat transfer area is 10 m², and the length of the cylinder is 2 meters. Calculate the rate of heat loss from the furnace per meter of length and the temperature at the interface between the steel and the insulation layer.	**10**	**CO2**
Q2	State the advantages of dimensional analysis. Derive the relationship for forced convective heat transfer, showing that the Nusselt number (Nu) is a function of the Reynolds number (Re) and Prandtl number (Pr).	**10**	**CO1**
Q3	What are dropwise condensation and filmwise condensation? Explain why drop wise condensation is preferred to film wise condensation?	**10**	**CO1**
Q4	A 100 W incandescent light bulb operates with a filament that can be approximated as a black body radiating heat into a surrounding black enclosure at 25°C. The filament has a diameter of 0.12 mm, and a length of 4 cm. Determine the temperature of the filament, assuming steady-state conditions and considering radiation heat transfer only	**10**	**CO2**
Q5	A single effect evaporator is to concentrate 9000 kg/hr of 20% solution of sodium hydroxide to 50% solids. The gauge pressure of the steam is 1.37 atm; the absolute pressure in the vapour space is 100 mmHg. The overall coefficient is estimated to be 1400 W/m^2. ^{o}C. The feed temperature is 37.8 ^{o}C. Calculate the amount of steam consumed, the economy and the heating surface required. Data: Enthalpy of 20% solution = 127.931 kJ/kg Enthalpy of 50% solution = 513.95 kJ/kg	**10**	**CO3**

	B.P. of water at 100 mmHg = 51.1 ^{o}C B.P. of solution at 100 mmHg = 91.67 ^{o}C Enthalpy of water vapour at 91.67 ^{0}C = 2672 kJ/kg Heat of vaporization of steam (B.P. 126.11 ^{0}C) at 1.37 atm(g) = 18466 kJ/kg The condensation temperature of steam= 126.1 ^{o}C		
Q6	Draw schematic diagram of the temperature profiles across the length of the heat exchanger for the following. i) Condenser ii) Boiler iii) 1-2 Shell & Tube heat exchanger iv) 2-4 Shell & Tube heat exchanger	**10**	**CO1**
SECTION-C (2Qx20M=40 Marks) Attempt all questions			
Q7	Using the principles of heat conduction, apply the necessary equations and coordinate transformations to derive the three-dimensional steady-state heat conduction equation in cylindrical coordinates.	**20**	**CO3**
Q8	A parallel-flow heat exchanger is designed to cool a hot liquid with an inlet temperature of 200°C. The hot liquid has a mass flow rate of 300 kg/h and a specific heat capacity of 4.5 kJ/kg.K. Cooling water, with a specific heat capacity of 4.15 kJ/kg.K, is used as the cooling medium, entering the heat exchanger at 45°C with a mass flow rate of 1000 kg/h. The heat exchanger has an overall heat transfer coefficient of 1000 W/m².K and a heat transfer area of 0.50 m². Determine the exit temperatures of both the hot liquid and cooling water streams, and the effectiveness of the heat exchanger.	**20**	**CO4**