Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course : Process Heat Transfer | **Semester : IV**
Program : B. Tech. (CERP) | **Time : 03 hrs.**
Course Code: CHCE 2021 | **Max. Marks : 100**

Instructions:

- ✓ Attempt **all** questions from **Section-A** (each carrying 4 marks), **Section-B** (each carrying 10 marks) and **Section-C** (carrying 20 marks).

Assume suitable data wherever necessary. The notations used here have the usual meanings.

SECTION-A

S. No.		Marks	CO
1.	What is the concept of critical thickness of insulation?	4 M	CO2
2.	Define and give the significance of Nusselt and Prandtl number	4 M	CO2
3.	Explain the difference between boiling and evaporation?	4 M	CO3
4.	Distinguish between a black body and gray body?	4 M	CO1
5.	Discuss the advantage of NTU method over the LMTD method?	4 M	CO4

SECTION-B

6.	A thick-walled tube of stainless steel [18% Cr, 8% Ni, k = 19 W/m·°C] with 2-cm inner diameter (ID) and 4-cm outer diameter (OD) is covered with a 3-cm layer of asbestos insulation [k = 0.2 W/m·°C]. If the inside wall temperature of the pipe is maintained at 600 °C, calculate the heat loss per meter of length. Also, calculate the tube–insulation interface temperature.	10	CO2
7.	Water is boiled at atmospheric pressure on a polished copper surface of 50 cm dia, which is electrically heated. Calculate the surface heat flux and the rate of evaporation, if the surface is maintained at 120 ^{0}C. The properties of water at 100^{o}C are: h_{fg} = 2257 kJ/kg, ρ_l = 957.9 kg/m^3, ρ_v = 0.5977 kg/m^3, C_{pl} = 4.211 kJ/kg-K, μ_l = 282 × 10^{-3} kg/m.s, Pr_l=1.75. The value of vapour liquid surface tension σ = 58.9 × 10^{-3} N/m and C_{sf} = 0.013 and n=1. For Nucleate boiling: $$\dot{q}_{nucleate} = \mu_l h_{fg} \left[\frac{g(\rho_l - \rho_v)}{\sigma}\right]^{1/2} \left[\frac{C_p(T_s - T_{sat})}{C_{sf} h_{fg} P_{rl}^{\,n}}\right]^3$$	10	CO3

8.	Water at 75 ^{o}C flows through a 0.01 m diameter tube with a velocity of 1.5m/s. If the tube wall temperature is 25 ^{o}C, make calculations for the heat transfer coefficient. Use the correlation, $Nu = 0.023\ Re^{0.2}\ Pr^{-0.667}$. The thermo-physical properties of water are: Thermal conductivity is 0.647 W/(m.K); Viscosity is 1.977 kg/h.m; Density is 1000 kg/m^3; Specific heat 4.187 kJ/(kg.K).	**10**	**CO2**
9.	How are the heat exchangers classified? Sketch the temp variations in (i) parallel flow heat exchanger (ii) counter-flow heat exchangers (iii) Boiler (iv) Condenser	**10**	**CO4**
	SECTION-C		
10	In a counter flow double pipe heat exchanger, water is heated from 35 ^{o}C to 75 ^{o}C by oil with a specific heat of 1.55kJ/kg-K and mass flow rate of 0.9kg/s. The oil is cooled from 220 ^{o}C to 150 ^{o}C. If overall heat transfer coefficient is 400 W/m^2.K. Calculate the rate of heat transfer, mass flow rate of water and surface area of heat exchanger.	**20**	**CO4**
11.	The wall of cold storage consists of three layers – an outer layer of ordinary brick, 25 cm thick, a middle layer of cork, 10 cm thick, and an inner layer of cement, 6 cm thick. The thermal conductivities of the materials are- brick: 0.7, cork: 0.043, and cement: 0.72 W/m. ^{o}C. The temperature of the outer surface of the wall is 30 ^{o}C, and that of the inner is -15 ^{o}C. Calculate (a) the steady state rate of heat gain per unit area of the wall (b) the temperatures at the interfaces of the composite wall the percentages of the total heat transfer resistance offered by the individual layers. What additional thickness of cork should be provided to make the rate of heat transfer 30% less than the present value?	**20**	**CO2**