Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2021

Programme Name: B.Tech (CE+RP) **Semester : IV**

Course Name : Heat Transfer **Time : 3 h**

Course Code : CHCE2009 **Max. Marks: 100**

Nos. of page(s) : 03

Instructions: In case of data missing make necessary assumptions

S.No.	SECTION A (6X10=60) (Attempt **all** questions)	Marks	CO
Q 1	Derive an expression for three dimensional steady state heat conduction in a cylindrical coordinate system	10	CO1
Q 2	A counter-flow double-pipe heat exchanger is to heat water from 20 ^oC to 40 ^oC at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160 ^oC at a mass flow rate of 2kg/s. The inner tube is thin-walled and has a diameter of 1.5cm. If the overall heat transfer coefficient of the heat exchanger is 640 $W/m^2.^oC$, determine the length of the heat exchanger required to achieve the desired heating.	10	CO3
Q3	Obtain an expression for the effectiveness of a counter flow heat exchanger in terms of NTU and the capacity ratio C.	10	CO2
Q4	i) With the help of typical experimental boiling curve explain the different regimes of pool boiling. (ii) Water is boiled at atmospheric pressure on a polished copper surface, which is electrically heated. Estimate the heat flux from the surface to water, if the surface is maintained at 110 ^0C. The properties of water at 100^oC 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, $\mu_l = 282 \times 10^{-3}$ kg/m.s, Pr_l=1.75. The value of vapour liquid surface tension $\sigma = 58.9 \times 10^{-3}$ N/m and C_{sf} = 0.013 and n=1. For Nucleate boiling: $$q_{nucleate} = \mu_l h_{fg} \left[\frac{g(\rho_l - \rho_v)}{\sigma}\right]^{1/2} \left[\frac{C_p(T_s - T_{sat})}{C_{sf} h_{fg} P_{rl}^{\ n}}\right]^3$$	6+4	CO2

Q5	A steam consisting of 2500 kg/h of saturated n-propyl alcohol (1-propanol) vapor at 100 ^{o}C and approximately atmospheric pressure will be condensed using a 90cm tube bundle consisting 1200 tubes arranged for a single pass. The tubes are 0.75 inch OD, 14 BWG, with a length of 12 feet and 1.25 square pitch. Physical properties of the condensate at condensate film temperature are as follows: k_l=0.164 W/m. ^{o}C, ρ_L=784.9 kg/m^3, μ_L=0.5 mNs/m^2, ρ_v=17 kg/m^3 Estimate the condensing side heat-transfer coefficient if the tube bundle is horizontal and condensation occurs outside the tubes. $$(h_c)_b = 0.95 k_L \left[\frac{\rho_L(\rho_L - \rho_v)g}{\mu_L \Gamma_h}\right]^{1/3} N_r^{-1/6}$$	10	CO2
Q6	A single effect evaporator is to concentrate (***xxxx***) kg/hr of 20% solution of sodium hydroxide to 50% solids, where (***xxxx***) are the ***last four digits*** of your **SAP ID**. 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 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	10	CO2
SECTION B (2X20=40M) Question **No. 7** compulsory. Answer **any one** in question **No. 8**			
Q7	10000 kg/h of furnace oil is heated from 30 ^{o}C to 90 ^{o}C in a shell and tube type heat exchanger. The oil is flowing through the tube while steam at 150 ^{o}C is to flow through the shell (T_{hi}=T_{ho}=150 ^{o}C). The tubes are 20mm ID and 25 mm OD in size. The heat transfer coefficient on oil side and steam side are 200 and 60**YZ** W/m^2.K. If the length of each tube is limited to 50 cm, use the effectiveness-NTU method to (a) calculate the number of tubes required in each pass, (b) the number of tube passes and (c) the tube length if the velocity oil is limited to 20 cm/s. The properties of oil are the following: density is 900 kg/m^3, C_P=1970 J/kg K. Where **YZ** is the last two digits of your SAP ID.	20	CO3

Q8	In a counter flow double pipe heat exchanger, water is heated from 25 ^{o}C to 65 ^{o}C by oil with a specific heat of 1.45kJ/kg-K and mass flow rate of 0.9kg/s. The oil is cooled from 230 ^{o}C to 160 ^{o}C. If overall heat transfer coefficient is 420W/m^2.K. Calculate the rate of heat transfer, mass flow rate of water and surface area of heat exchanger. OR Steam in a condenser of a steam power plant is to be condensed at a temperature of 30 ^{0}C with cooling water entering at 14 ^{0}C and leaving at 22 ^{0}C. The surface area of tubes is 45 m^2 and the overall heat transfer coefficient is (***xxxx***) W/m^2-K, where (***xxxx***) are the ***last four digits*** of your **SAP ID**. Determine the mass flow rate of the cooling water needed and the rate of condensation of steam. Heat of condensation of steam, h_{fg} at 30 ^{0}C is 2430.5 kJ/kg.	20	CO2