Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2023

Programme Name: B. Tech. CERP **Semester : IV**
Course Name : Mass Transfer I **Time : 03 hrs**
Course Code : CHCE 2020 **Max. Marks : 100**
Nos. of page(s) : 2
Instructions : Attempt all questions. Assume any missing data with proper justification.

SECTION A
(Answer all) **4 x 5 =20 marks**

S. No.		Marks	CO
Q 1	Explain interphase mass transfer with a suitable example.	**5**	**CO1**
Q 2	Discuss the use of "Kremser Equation" in design of mass transfer operation unit.	**5**	**CO1**
Q 3	Explain the different types of trays used in distillation column.	**5**	**CO1**
Q.4	Discuss the characteristics of tower packings.	**5**	**CO1**

SECTION B
(4 x 10 = 40 marks)

Q 5	In a liquid-liquid contacting device, the equilibrium distribution of solute C in the solvents A and B can be expresses as $$y = 10.5\,x$$ where x and y are the concentration of solute in phases A and B respectively. If the individual mass transfer resistances are $$k_x = 10.21\,\frac{lbmol}{h\,ft^2}; k_y = 4.35\,\frac{lbmol}{h\,ft^2}$$ Determine the phase which controls the mass transfer.	**10**	**CO2**
Q.6	A square plate (0.5 m X 0.5 m) coated with a layer of benzoic acid, is placed in a stream of water flowing at a velocity of 0.25 m/s at a temperature of 25°C. Calculate the average rate of dissolution of the acid per unit area of the plate and also the equivalent thickness of a stagnant liquid film that would offer the same resistance to mass transfer. $$Sh_{avg} = 0.664\,(Re_l)^{1/2}(Sc)^{1/3}$$ The following data (at 25°C) are available: Solubility of benzoic acid is water = 3.01 kg/m^3 Diffusivity of benzoic acid in water = 10^{-9} m^2/s Viscosity of water = 8.9 X 10^{-4} kg/m-s	**10**	**CO2**

Q.7	One hundred kilogram of an aqueous solution of p-chloroform at a concentration of 1 g per kg water is to be treated with 2 kg of an adsorbent to recover the compound from the solution by a two-stage cross current contact. Calculate the recovery of the solute if the equilibrium relation at the operating temperature of 298 K is given by Y = 0.6 X where X = kg solute per 1000 kg water and Y = kg solute per kg adsorbent.	**10**	**CO3**
Q.8	It is required to remove 99 % of the solute C from a solution of C in G by using a pure solvent L in a counter-current cascade. The feed containing 12% C in the mixture enters the column at the bottom at the rate 6000 kg/h. The solvent enters at the top at a rate of 7685 kg/h. Write down the equation of the operating line. Determine the number of trays required to perform the separation using Kremser equation if the overall tray efficiency is 40 %. The equilibrium line is linear, Y = 1.32 X, where Y = kg C per kg C-free G, and X = kg C per kg C-free L.	**10**	**CO3**
SECTION C **(2 x 20 = 40 marks)**			
Q.9	Ethanol forms a nearly ideal solution with *iso*-butanol and has a relative volatility 2.2. A heated feed containing 40 mole % ethanol and 60 mole % *iso*-butanol enters a flash drum at a rate of 50 kmol/h. (a) What fraction of the feed should be vaporized in order to have a bottom product containing not more than 10 % ethanol (b) Consider a second flash drum that receives the bottom product from the first drum. If 60 % of the feed is vaporized in each drum, estimate the vapor and liquid flow rates from each chamber as well as their composition.	**20**	**CO4**
Q.10	A distillation column separates a saturated feed containing 25 mole % A and 75 mole % B. The relative volatility (α_{AB}) is 2.51. The vapor liquid equilibria is shown in Figure 1. The liquid concentration on the 5th tray is $x_5 = 0.54$. The distillate has 98 mole % A and the reflux ratio is 3. (a) Determine the concnetration of A in vapor phase entering and leaving the 5th tray. (b) Which section of the column does the 5th tray belong (c) Calculate the enrichment of the vapor across the 4th tray (d) If 97 % of A present in the feed goes to top product, calculate the moles of liquid vaporized in the reboiler per mole of distillate. Assume that trays are ideal	**20**	**CO4**