Name:

Enrolment No:

UPES

End Semester Examination, May 2024

Course: Mass Transfer 1 **Semester: IV**

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

Course Code: CHCE 2020 **Max. Marks: 100**

Instructions: (1) Answer ALL questions
(2) Assume appropriate value of missing data, if any
(3) Notations have their usual meanings

SECTION A (20Marks)

S. No.		Marks	CO
Q 1	Discuss the concept of relative volatility and its significance.	**4**	**CO1**
Q2	Discuss the significance of tray efficiency in distillation. How does tray efficiency impact the separation performance of a distillation column?	**4**	**CO1**
Q3	Describe the concept of two film theory using a neat sketch the showing concentration profile.	**4**	**CO1**
Q4	Describe four examples of the occurrence of molecular diffusion in your day to life or in some industrial processes.	**4**	**CO1**
Q5	A student attempt to measure the diffusivity of A in air using Stefan tube apparatus. If the boiling point of A is only several degrees higher than the experimental temperature. Do you think that the pseudo-steady state assumption is valid in this case? Provide a quantitative explanation.	**4**	**CO2**
	SECTION B (40 Marks)		
Q6	A volatile organic compound (C_6 H_6) costing Rs. 50 a kg is stored in a tank 10.0 in diameter and open at the top. A stagnant air film 10 mm thick is covering the surface of the compound beyond which the compound is absent. If the atmospheric temperature is 25°C, vapor pressure of the compound is 150 mm Hg and its molar diffusivity 0.02 m^2 / hr, calculate the loss in Rs./day.	**10**	**CO3**
Q7	An Ethanol (A) –water (B) Solution in the form of stagnant film 2.0 mm thick at 293 K is in contact at one surface with an organic solvent in which ethanol is soluble and water is insoluble. At point 1 the concentration of ethanol is 16.8 wt % and the solution density is 972.8 kg/m^3. At point 2 the concentration of ethanol is 6.8 wt % and the	**10**	**CO2**

	solution density is 988.1 kg/m^3. The diffusivity of ethanol is 0.74 ×10^{-9} m^2/s. Calculate the steady state flux N_A.		
Q8	A continuous rectification column is used to separate a binary mixture of A and B. Distillate is produced at 100 kg moles/hr containing 98 mole % of A. The mole of A in liquid and in the vapors, x and y respectively, from two adjacent ideal plates in the enriching section are as follows x: 0.65, 0.56 y: 0.62, 0.78 If the latent heat of vaporization is same for all mixtures and the feed is saturated liquid, find the reflux ratio.	**10**	**CO3**
Q9	In a mass transfer apparatus operating at 1 atmosphere the individual mass transfer coefficients have the following values k_x= 22 kg-mol/m^2 h, k_y = 1.07 kg-mol/m^2 h. The equilibrium compositions of the gaseous and liquid phases are characterized by Henry's law, $p^* = 0.08 \times 10^6 x$ mm Hg. (a) Determine the overall mass transfer coefficients K_X and K_y. (b) How many times the diffusion resistance of the liquid phase differs from that of the gaseous phase?	**10**	**CO2**
	SECTION-C **(40 Marks)**		
Q10	It is desired to separate a mixture containing 42% heptane and 58% ethyl benzene by distillation at 760 mm Hg to produce a distillate containing 97% heptane and a residue containing 99% ethyl benzene. (a) With a reflux ratio of 2.5, how many equilibrium stages are needed for a saturated liquid feed and bubble point reflux using the McCabe-Thiele method? (b) What is the minimum reflux ratio required? (c) How many equilibrium stages are needed at total reflux?	**40**	**CO4**

	(d) Identify the feed location and find the actual number of plates if the overall efficiency is 60%. Equilibrium data: the vapor liquid equilibria for heptane-ethyl benzene system at 760 mm Hg here, y and x are mole fractions heptane in vapor and liquid respectively.		

x	0	0.233	0.428	0.514	0.608	0.729	0.814	0.904	0.963	1.0
y	0	0.08	0.185	0.251	0.335	0.489	0.651	0.788	0.914	1.0