GURU NANAK INSTITUTE OF TECHNOLOGY

An Autonomous Institute under MAKAUT

2020-2021

UNIT OPERATION OF CHEMICAL ENGINEERIN II

FT504 A

TIME ALLOTTED: 3 HOURS **FULL MARKS: 70**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable

GROUP – A

(Multiple Choice Type Questions)

Answer any *ten* from the following, choosing the correct alternative of each question: 10×1=10

		Marks	CO No
1(i)	Molecular diffusion is caused by a) transfer of molecules from low concentration to high concentration region b) activation energy of the molecules c) potential energy of the molecules d) transfer of molecules from high concentration to low concentration region	1	CO1
1 (ii)	Tea percolation employs a) liquid-liquid extraction b) leaching c) absorption d) none of these	1	CO 2
1(iii)	Milk is dried usually in a a) freeze drier b) spray drier c) tray drier d) rotary drier .	1	CO 3
1 (iv)	For total reflux in distillation the slope of the operating line for rectifying section is a) 0 b) 1 c) <1 d) >1	1	CO4
1(v)	In the constant rate period of the rate of drying curve for batch drying a) cracks develop on the surface of the solid , b) rate drying decreases abruptly , c) surface evaporation of free moisture occurs d) none of these .	1	CO3
1(vi)	The ratio of number of moles of species A to the total number of moles of the mixture is known as a) Mole fraction b) Mass fraction c) Partial pressure d) Mass density	1	CO1

1(vii)	Which of the following assumes constant molal vaporization and overflow ? a) McCabe Thiele method b) Ponchan- Savarit Method c) Enthalpy concentration method d) Plate absorption column.	1	CO 3
1(viii)	When the liquid phase and vapor phase of a binary system obeys Raoult's and Dalton's law respectively, the relative volatility is the ratio of a) vapor pressure of component A to that of component B b) vapor pressure of component A to the total pressure. c) vapor pressure of component A to the partial pressure of A d) partial pressure of component A to the total pressure.	1	CO2
1 (ix)	The dimension of diffusion coefficient is given by a) $M L T^{-2}$ b) $L^{2} T^{-1}$ c) $L T^{-1}$ d) $M L^{-2} T$	1	CO1
1(x)	The composition of substances in the extraction are represented by _____ a) Rectangle b) Isosceles triangle c) Equilateral triangle d) None of the mentioned	1	CO4
1 (xi)	Liquid-liquid mixture is separated with solvent extraction by adding _____ solvent. a) Soluble b) Insoluble c) Partially soluble d) All of the mentioned	1	CO4
1(xii)	How does packing the column help? a) Lessens the mass transfer b) Increases the mass transfer by not breaking the large drops c) Decreases the interfacial area d) Increases the mass transfer by breaking the large droplets thus increasing interfacial area	1	CO2

GROUP – B
(Short Answer Type Questions)

(Answer any *three* of the following) **3 x 5 = 15**

		Marks	CO No
2.(a)	Explain Fick's 1st law of diffusion.	2	CO2
2.(b)	NH_3 gas (A) diffuses through N_2 gas (B) at steady state condition with N_2 gas as non diffusing. At point 1 the partial pressure of NH_3 is $p_A = 1.5 \times 10^4$ pa & at point 2 $p_A = 5 \times 10^3$ pa . The total pressure is 1.01×10^5pa & temperature 298 K . At this temperature & pressure the value of diffusivity is $2.30 \text{ X } 10^{-5}$ m^2/S . The diffusing path is 0.15m. Calculate the flux of NH_3 at steady state.	3	CO3
3.	Show that for binary gas mixture, the diffusivity of A in B equals to the diffusivity of B in A i. e. $D_{AB} = D_{BA}$	5	CO2

4.	Explain the dew point and bubble poin diagram with graphical interpretation	5	CO3
5.	Explain surface renewal theory for mass transfer with diagram.	5	CO1
6.(a)	Find the partial pressure of A if the total pressure is 2 atm; Concentration of A is 2 mol/cu.m and total concentration is 5 mol/cu.m.	2	CO2
6.(b)	Describe the phenomena of absorption and stripping with suitable examples	3	CO2

GROUP – C
(Long Answer Type Questions)

(Answer any *three* of the following) **3 x 15 = 45**

		Marks	CO No
7.(a)	Define reflux ratio	3	CO1
7.(b)	A feed of 50mole% hexane and 50 mole% octane is fed into a pipe still through a pressure reducing valve and then flash disengaging chamber. The vapour and liquid leaving the chamber assumed to be in equilibrium. If the fraction of the feed converted to vapour is 0.5. Find the composition of the top and bottom products. The following table gives the equilibrium data for this system:	12	CO3

X	1.0	0.69	0.4	0.19	0.045	0.0
Y	1.0	0.93	0.78	0.54	0.18	0.0

8.(a)	Derive the expression of no. of theoretical stages for liquid-liquid extraction in case of co-current contact with immiscible solvents.	5	CO4
8.(b)	100kg/h of a nicotine-water solution containing 0.01 wt. fraction nicotine is extracted with 150kg/h of kerosene containing 0.0006 wt. fraction nicotine in counter current stage column. The concentration of nicotine is 0.001 wt. fraction in the exit water. Determine the no. of theoretical stages required for the above separation. The equilibrium data for the above system is as follows: X: 0.001 0.0025 0.005 0.0075 0.0099 Y: 0.00058 0.0019 0.0046 0.0069 0.0091 X= kg of nicotine/kg of water, Y= kg of nicotine/kg of kerosene	10	CO3
9.(a)	Describe the triangular diagram in case of ternary liquid-liquid extraction system.	8	CO4
9.(b)	Explain the interphase mass transfer with diagram.	7	CO3
10.(a)	A gas mixture containing 0.015 mole fraction of solute S at the inlet (and the rest inerts) is subjected to counter-current absorption with water in a packed tower. The outlet concentration of the solute is to be 1% of the inlet value. The total gas inlet flow rate is 1.0 kg/m^2.s (MW = 29) and the pure water entering is 1.6 kg/m^2.s. The system can be considered as dilute. The equilibrium condition can be described by Henry's Law and is given as y = 1.75 x, where y and x are the mole fraction of solute S in the vapour and liquid respectively. The column uses a certain type of packings which provides an overall gas-phase mass transfer	10	CO2

	coefficient ($K_Y a$) of 0.06 kg-mole/(m^3.s.mole fraction). Determine the height of packings required for the separation		
10.(b)	Explain the terms number of gas transfer unit (N_{OG}) and number of liquid transfer unit (N_{OL}) with formula.	5	CO2
11.(a)	Define relative volatility	3	CO3
11.(b)	100 moles of Benzene (A) and Toluene mixture containing 50% (mole) of Benzene is subjected to a differential distillation at atmospheric pressure till the composition of benzene in the residue is 33%. Calculate the total moles of the mixture distilled. Average relative volatility may be assumed as 2.16	12	CO3