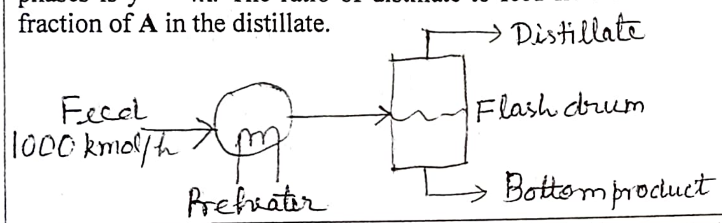
मोतीलालनेहरूराष्ट्रीयप्रौद्योगिकीसंस्थानइलाहाबाद
प्रयागराज-211004 (भारत)
Motilal Nehru National Institute of Technology Allahabad
Prayagraj - 211 004 (India)

Department of Chemical Engineering
Mid sem(odd). Examination, Session 2024-25

Programme:	*B.Tech.*	**Branch:**	*Chemical Engg*
Course Name:	*Mass Transfer operations-II*		
Course Code:	*CHN15110*	**Max. Marks:**	*20*
Time:	*1.5 h*	**Registration No.:**	20222068

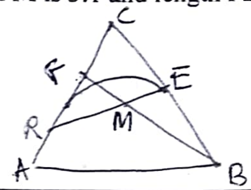
Instructions:
1. *Attempt all questions.*
2. *Assume suitable data, wherever necessary.*

			Marks	Corresponding course outcome
Q1	a	Calculate the composition of the equilibrium vapor phase at 60 ^{0}C for a liquid mixture consisting of 40 mol% benzene and 60 mol% toluene considering that the given mixture follows Raoults law.Also find the composition of a liquid mixture of benzene and toluene that boils at 90 ^{0}C under a pressure of 760 mmHg. **Given:** The saturated vapor pressures of benzene at 60 ^{0}C and 90 ^{0}C are 385 and 1013 mmHg, respectively whereas those of toluene at the respective temperatures are 140 and 408 mmHg.	(4)	CO1
	b	A flash distillation drum (figure) is used to separate methanol(**A**)-water(**B**) mixture. The mol fraction of methanol in the feed is 0.5 and the feed flow rate is 1000 kmol/h. The equilibrium relationship between the mol fraction of **A** in the vapor and the liquid phases is $y^* = 4x$. The ratio of distillate to feed flow rate is 0.5. Calculate the mol fraction of **A** in the distillate.	(3)	CO2



			Marks	Corresponding course outcome
Q2		A liquid mixture of benzene & toluene is to be distilled in a tower at 101.3 kPa pressure. The feed of 100 kmol / h is liquid and it contains 45 mole% benzene & 55 mol% toluene and enters at 327.6 K (54.6 °C). A distillate containing 95 mol% benzene and bottom containing 10 mol% benzene are to be obtained. The reflux ratio (R) is 3.5 times R_m. The average heat capacity of the feed is 159 kJ / (kmol.K) and the average latent heat is 32099 kJ/ (kmol). Calculate the following: (i) kmol / h of distillate & bottom products. (ii) the number of theoretical plates in the column. (iii) minimum reflux ratio (R_m). Data: B.P. of Benzene and Toluene are 353 K and 383.8 K respectively.	(6)	CO2

x	0	0.130	0.258	0.411	0.581	0.78	1.0
y	0	0.261	0.450	0.632	0.777	0.90	1.0

Q3	a	Define the selectivity and the distribution coefficient in liquid-liquid extraction.	(2)	CO1
	b	Describe the mixture rule on triangular coordinate system.	(3)	CO1
	c	In the triangular diagram represented below for a batch separation process, a stream F is mixed with a solvent B to produce products R and E. Substance A is the carrier liquid and C is the solute to be extracted. The amounts of B and E are 1 kg and 1.2 kg respectively. The length FM is 3.1 and length FB is 8.5 units. Calculate the ratio R/E.  Note: Figure not to scale.	(2)	CO3

Course Outcomes:	CO1	explain the concept of mass transfer operations in process industries.
	CO2	calculate the extent of separation for single stage batch and continuous , multistage continuous and differential contact distillation for binary mixtures.
	CO3	calculate number of theoretical stages required for a given extent of separation for liquid-liquid extraction and solid-liquid mass transfer operations for cross current and counter-current flows.
	CO4	design the mass transfer equipment for given separation in process industries.

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Department of Chemical Engineering
End (odd) sem. Examination, Session 2024-25

Programme:	*B.Tech.*	**Branch:**	*Chemical Engg*
Course Name:	*Mass Transfer operations-II*		
Course Code:	*CHN15110*	**Max. Marks:**	*40*
Time:	*2.5 h*	**Registration No.:**	20222068

Instructions:
1. *Attempt all questions.*
2. *Assume suitable data, wherever necessary.*

			Marks	Course outcome
Q1		Attempt any two of the following:	(2x3=6)	CO1
	a	What is minimum reflux ratio? Explain the concept of optimum reflux ratio in fractionating column.		
	b	Explain the transfer unit concept in packed column for liquid extraction		
	c	State Freundlich isotherm and its limitations. How the constants are evaluated.		
Q2		A mixture consisting of 40 mol% A and 60 mol% B is distilled in a plate column equipped with a total condenser at the top. A test run gave the following compositions (mole fraction of A) for liquid and vapor streams taken from three adjacent plates in the enriching (rectifying) section of the distillation column.	(4)	CO2
Q3		Nicotine-water solution containing 1% nicotine by weight is to be extracted with kerosene at 293 K. water and kerosene are essentially insoluble. Determine: The percentage extraction of nicotine (i) if 100 kg of feed solution is extracted with 150 kg of solvent in single stage. (ii) Repeat for three theoretical stages using 50 kg of solvent each time.	(10)	CO3

Q2 data:

Plate	x	y
n-1	0.68	0.795
n	0.60	0.740
n+1	0.51	0.679

Determine: (i) The reflux ratio (ii) The distillate composition

Q3 data:

$x' = \frac{\text{kg nicotine}}{\text{kg water}}$	0.0010	0.0024	0.0050	0.0075	0.0099	0.0204
$y' = \frac{\text{kg nicotine}}{\text{kg kerosene}}$	0.0008	0.0019	0.0045	0.0068	0.0091	0.0187

Q4	a	Explain the constant underflow and variable underflow conditions with the help of equilibrium diagrams occurs in leaching.	5	CO3
	b	100 kg of flaked soybeans containing 25% oil by weight is leached with 100 kg fresh hexane solvent. If the underflow solids retain 2 kg solution with every 3 kg of insoluble solids, calculate the amount and composition of overflow and underflow from the single stage operation assuming no insoluble in overflow.	5	CO3
Q5	a	Describe the multistage countercurrent adsorption with graphical construction for number of stages.	5	CO4
	b	Experiments on decolourization of oil yielded the following equilibrium relationship: $$Y = 0.004X^2$$ Where, Y = kg of color / kg of color free oil; X = kg of color / kg adsorbent. 100 kg oil containing 1 part of color to 3 part of oil is agitated with 25 kg of the adsorbent in two stages. Calculate the % of color removed after each stage, if 12.5 kg adsorbent is used initially, followed by another 12.5 kg of adsorbent.	5	CO4

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Course Outcomes:	CO1	explain the concept of mass transfer operations in process industries.
	CO2	calculate the extent of separation for single stage batch and continuous , multistage continuous and differential contact distillation for binary mixtures.
	CO3	calculate number of theoretical stages required for a given extent of separation for liquid-liquid extraction and solid-liquid mass transfer operations for cross current and counter-current flows.
	CO4	design the mass transfer equipment(adsorption) for given separation in process industries.