Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VI EXAMINATION – WINTER 2025

Subject Code: 3160501 Date: 02-12-2025

Subject Name: Mass Transfer Operations II

Time: 02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define: 1) Relative humidity 2) Dew point 3) Minimum reflux	**03**
	(b)	Prove that 'Relative Volatility (α) is the ratio of vapor pressure of the components'.	**04**
	(c)	1000 kmol/h of an ethanol-propanol mixture containing 65 mole percent ethanol is to be separated in a continueous plate column operating at 101.325 kPa total pressure. The desired terminal composition in terms of mole fraction of ethanol are- x_d = 0.92 and x_w = 0.07. The feed is saturated vapour and total condenser is used. When the reflux flow rate is 4 times the amount of top product, find the number of theoretical plates required for the separation. Relative velocity of ethanol-propanol system is 2.10.	**07**
Q.2	**(a)**	Define: 1) Azeotrope 2) Reflux Ratio 3)Total reflux	**03**
	(b)	Explain effect of increased pressure on vapour-liquid equilibrium.	**04**
	(c)	A charge of 50 kmol of a mixture of benzene and chlorobenzene having 55 mol% of the less volatile is to be batch distilled. A) If 25 moles of the solution is vaporized and condensed as the distillate, calculate the concentration of the accumulated distillate. B) If the concentration of the accumulated product is found to be 72 mole% benzene, calculate its amount. The relative volatility of benzene in the mixture is 4.15.	**07**
		OR	
	(c)	A feed of 60 mole% hexane and 40 mole% octane is fed to a pipe still through a pressure reducing valve into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If 50 mole% of feed is vaporized, find the composition of the top and bottom products. Equilibrium data is given below:	**07**

x	1	0.69	0.4	0.192	0.045	0
y	1	0.932	0.78	0.538	0.1775	0

x = mole fraction of hexane in liquid and y = mole fraction of hexane in vapour.

Q.3	**(a)**	Define: 1) Absolute Humidity 2) Lewis relation 3) Humid heat	**03**
	(b)	Explain natural draft cooling tower.	**04**
	(c)	Derive the expression for wet bulb depression.	**07**

OR

Q.3	**(a)**	Define: 1) Percentage saturation 2) Humid Volume 3) Dry bulb temperature	**03**
	(b)	Explain concept of wet bulb temperature.	**04**
	(c)	Derive the equation of adiabatic saturation curve.	**07**
Q.4	**(a)**	State any four commercial adsorbents.	**03**
	(b)	Explain selection criteria of adsorbents and adsorption process.	**04**
	(c)	Explain Freundlich isotherm. Write material balance for a single stage adsorption and apply Freundlich equation in it.	**07**

OR

Q.4	**(a)**	State the various industrial applications of adsorption operation.	**03**
	(b)	Explain Adsorption hysteresis.	**04**
	(c)	Explain the principles of ion exchange and describe its various techniques and industrial applications.	**07**
Q.5	**(a)**	Classify dryers and discuss selection criteria for dryers.	**03**
	(b)	Explain flash distillation operation.	**04**
	(c)	A 50 Kg batch of granular solids containing 25% moisture is to be dried in a tray dryer to 12% moisture by passing a stream of air at 363 K (90 ºC) tangentially across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.0008 Kg moisture/m^2s and the critical moisture content is 10%, calculate the drying time. The surface area available for drying is 1 m^2.	**07**

OR

Q.5	**(a)**	Describe the factors affecting on rate of drying.	**03**
	(b)	Explain differential distillation operation.	**04**
	(c)	Slabs of paper pulp 100 cm x 100 cm x 1.5 cm is to be dried under constant drying conditions from 67% to 30% moisture. The value of equilibrium moisture for the material is 0.5%. If the critical moisture content is 60% and rate of drying at the critical point is 1.5 kg/m^2h, calculate the drying time. The dry weight of each slab is 2.5 Kg. All moisture contents are on weight basis.	**07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VI (NEW) EXAMINATION – WINTER 2024

Subject Code:3160501 Date:20-11-2024

Subject Name:Mass Transfer Operations II

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define relative volatility. Discuss its importance.	**03**
	(b)	Explain the effect of temperature on the adsorption operation.	**04**
	(c)	Explain the various types of cooling towers and discuss their selection criteria.	**07**
Q.2	**(a)**	Define the following terms 1) Free moisture 2) Reflux ratio 3) Wet bulb temperature	**03**
	(b)	Explain principles of ion exchange in brief. Also list its applications.	**04**
	(c)	Explain the effect of increasing pressure on vapour liquid equilibrium for a binary mixture. Justify using T-xy, P-xy and xy diagrams.	**07**
		OR	
	(c)	Differentiate between extractive and azeotropic distillation and discuss their selection criteria.	**07**
Q.3	**(a)**	Explain range and approach with reference to cooling tower.	**03**
	(b)	State the various industrial applications of adsorption.	**04**
	(c)	A feed of 60 mole% hexane and 40 mole % octane is fed to a pipe still through a pressure reducing valve into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If 50 mole% of feed is vaporized, find the composition of the top and bottom products. Equilibrium data is as follows:	**07**

x	1.0	0.69	0.4	0.192	0.045	0
y	1.0	0.932	0.78	0.538	0.1775	0

OR

Q.3	**(a)**	Define the following terms 1) Dew point 2) Adiabatic Saturation temperature 3) Absolute Humidity	**03**
	(b)	Compare and contrast physisorption and chemisorption.	**04**
	(c)	100 moles of mixture of components A and B containing 60 mole % of A is subjected to a differential distillation at atmospheric pressure till the composition of A in the residue is 30%. Calculate the total moles of distillate and residue. Average relative volatility is constant at 2.25.	**07**
Q.4	**(a)**	List out the various types of reboilers used in industry. Explain any one in detail.	**03**
	(b)	Write a short note on Rotary Dryer	**04**
	(c)	Explain Freundlich equation. Derive the relation for single stage adsorption using the Freundlich equation.	**07**
		OR	

Q.4	**(a)**	Briefly discuss about optimum reflux ratio.	**03**
	(b)	Write a short note on Tray Dryer	**04**
	(c)	What is pressure swing adsorption (PSA)? With a neat and clean diagram, discuss PSA with industrial applications and advantages.	**07**
Q.5	**(a)**	Enlist the principal adsorbents generally used in adsorption.	**03**
	(b)	Enlist the assumptions of McCabe-Thiele method for determination of number of stages in a distillation column.	**04**
	(c)	A slab of paper pulp 1.5 m * 1.5 m having 5 mm thickness is to be dried under constant drying condition from 18% to 8% on dry basis. Equilibrium moisture is 2.5 % while critical moisture is 0.46 kg moisture/ kg dry pulp. Drying rate at the critical point is found out to be 1.4 kg/ m^2 hr. Density of pulp is 0.22 g/cc. If drying takes place from two large faces, calculate the drying time.	**07**

OR

Q.5	**(a)**	Explain the adsorption wave in adsorption operation.	**03**
	(b)	Define the quantity 'q'. Discuss the different types of feed to a distillation column and their 'q' values using relevant diagram.	**04**
	(c)	A wet solid of 28% moisture is to be dried to 0.5% moisture in a tray dryer. A laboratory test shows that it requires 8 hours to reduce the moisture content of the same solid to 2%. The critical moisture content is 6% and the equilibrium moisture is 0.2%. The falling rate of drying is linear in the free moisture content. Calculate the trying time of the solid if the drying conditions similar to those in the laboratory test are maintained. All moistures are expressed as percent of 'bone dry' mass of the solid.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2023

Subject Code:3160501 Date:02-12-2023

Subject Name:Mass Transfer Operations II

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

MARKS

Q.1 **(a)** Define: 1) Lewis Relation 2) Chemisorption 3) Equilibrium moisture **03**

(b) Explain the effect of increasing pressure on separation of components in binary distillation column? Justify with appropriate T-x.y and y vs x diagram. **04**

(c) A bubble cap fractionating column consisting of 12 plates working at an average efficiency of 75% is being used to distill 1000 kg/hr of aqueous methanol at its bubble point entering the tower. The feed, overhead product and bottom product are 50 mole %, 90 mole% and 10 mole% methanol respectively. A total condenser is provided. The reflux is sent at its saturation temperature. If the reflux ratio is 1.7 times the minimum. Calculate ideal plates and check whether the column available is satisfactory. The VLE data are: **07**

x	8	10	20	30	40	50	70	80	95
y	36.5	41.8	57.9	66.5	72.9	77.9	87	95.8	97.9

Q.2 **(a)** Define: 1) Minimum Reflux Ratio 2) Quantity ‘q’ 3) Boil up Ratio **03**

(b) Prove that ‘Relative Volatility (α) is the ratio of vapor pressure of the components’ **04**

(c) A mixture of benzene and toluene containing 60 mole% benzene is to be separated to give a product of 95 mole% benzene and bottom product containing 10 mole% benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. Calculate number of theoretical plates needed by Mccabe-Thiele method and position of feed plate. The vapor liquid equilibrium data are given as below: **07**

x	0	0.05	0.1	0.2	0.3	0.4	0.5
y	0	0.13	0.21	0.375	0.5	0.6	0.7

x	0.6	0.7	0.8	0.9	1.0
y	0.77	0.83	0.9	0.95	1.0

OR

(c) A feed of 60 mole% hexane and 40 mole% octane is fed to a pipe still through a pressure reducing valve into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If 50 mole% of feed **07**

is vaporized, find the composition of the top and bottom products. Equilibrium data is given below:

x, mole fraction of hexane in liquid	1.0	0.69	0.40	0.192	0.045	0
Y, mole fraction of hexane in vapour	1.0	0.932	0.78	0.538	0.1775	0

Q.3 **(a)** Define: 1) Relative humidity 2) Percentage saturation 3) Humid Heat **03**

(b) A mixture of gas (B) and benzene (A) is saturated at 1 std. atmosphere and 50 °C. Calculate the absolute humidity if B is (a) Nitrogen and (b) Carbon dioxide. Vapor pressure of benzene at 50 °C is 275 mmHg. **04**

(c) Explain classification of cooling tower and brief induced draft cooling tower with neat sketch. **07**

OR

Q.3 **(a)** Define: 1) Wet bulb temperature 2) Dew point 3) Humid volume **03**

(b) In a mixture of benzene vapor (A) and nitrogen gas (B) at a total pressure of 800 mmHg and a temperature of 60 °C., the partial pressure of benzene is 100 mmHg. Calculate the a) Mole fraction of benzene b) Molal absolute humidity c) Absolute Humidity. **04**

(c) Explain the theory of adiabatic saturation temperature and derive the equation for adiabatic saturation temperature determination. **07**

Q.4 **(a)** Define: 1) Adsorption hysteresis 2) Azeotrope 3) Total Reflux **03**

(b) Explain pressure swing adsorption (PSA) and discuss its industrial application **04**

(c) Using Freundlich equation, derive the expression for a two-stage counter current adsorption operation. **07**

OR

Q.4 **(a)** List the principal adsorbents which is generally used in adsorption. **03**

(b) Explain the adsorption wave in adsorption operation. **04**

(c) Define Ion Exchange? Describe techniques and applications of ion exchange and list out the factors on which rate of ion exchange is dependent. **07**

Q.5 **(a)** Define: 1) Bound moisture content 2) Unbound moisture content 3) Free Moisture content **03**

(b) Explain Tray dryer and give its applications **04**

(c) A wet solid is to be dried from 35% to 10% moisture under the constant drying condition in 5 hours. If the equilibrium moisture content is 4% and the critical moisture content is 14%, how long it will take to dry solids to 6% moisture under the same conditions? **07**

OR

Q.5 **(a)** Define: 1) Critical moisture content 2) moisture content on wet **03**

basis 3) moisture content on dry basis

(b) Derive expression of time of drying in the constant rate period in drying operation. **04**

(c) Find out the rate of drying and moisture content from the following data: **07**

Weight of wet saw dust	Weight of saw dust after drying	Time (hour)
250 gm	230 gm	0.5
250 gm	215 gm	0.75

Dimensions of tray is 10 cm x 10 cm

Weight of the dry saw dust on tray is 150 gm.

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BE - SEMESTER–VI(NEW) EXAMINATION – WINTER 2022

Subject Code:3160501 Date:13-12-2022

Subject Name:Mass Transfer Operations II

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

MARKS

Q.1 **(a)** Define: 1) Humid Volume 2) Humid heat 3) Lewis Relation **03**

(b) Explain effect of temperature on adsorption with one example. **04**

(c) A mixture of benzene and toluene containing 60 mole% benzene is to be separated to give a product of 95 mole% benzene and bottom product containing 10 mole% benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. Calculate number of theoretical plates needed by Mccabe-Thiele method and position of feed plate. The vapor liquid equilibrium data are given as below: **07**

x	0	0.05	0.1	0.2	0.3	0.4	0.5
y	0	0.13	0.21	0.375	0.5	0.6	0.7

x	0.6	0.7	0.8	0.9	1.0
y	0.77	0.83	0.9	0.95	1.0

Q.2 **(a)** Explain constant pressure equilibria with neat sketch. **03**

(b) Explain feed tray location in distillation operation. **04**

(c) A liquid mixture containing 40 mole% methanol and 60 mole% water is fed to the differential distillation at atmospheric pressure with 60 mole% of the liquid is distilled. Find the composited distillate and the residue. Equillibrium Data: **07**

x	0.05	0.1	0.2	0.3	0.4	0.5
y	0.27	0.42	0.57	0.66	0.73	0.78

OR

(c) A liquid mixture containing 60 mole% acetone (1), 40 mole% water (2) at 1 atm pressure in differentially distilled to vaporize 30 mole% of the feed. Compute the composition of composite distillate and residue. The VLE data are: **07**

x	0.01	0.05	0.1	0.2	0.4	0.5
y	0.253	0.625	0.755	0.815	0.839	0.849

x	0.6	0.7	0.8	0.9	0.95
y	0.859	0.874	0.898	0.935	0.963

Q.3	**(a)**	Define: 1) Relative saturation 2) Percentage saturation 3) Dew point	**03**
	(b)	Explain principle and applications of steam distillation.	**04**
	(c)	Derive equation for Adiabatic Saturation Curve.	**07**

OR

Q.3	**(a)**	Discuss range and approach with reference to cooling tower.	**03**
	(b)	Explain Azeotropic distillation.	**04**
	(c)	Explain the various types of cooling towers and discuss their selection criteria.	**07**
Q.4	**(a)**	List assumptions of McCabe-Thiele method and its limitations.	**03**
	(b)	Compare and contrast physical adsorption and chemisorptions.	**04**
	(c)	Explain Ion Exchange and describe techniques and applications of ion exchange and list out the factors on which rate of ion exchange is dependent.	**07**

OR

Q.4	**(a)**	Define: 1) Total reflux ratio 2) Minimum reflux ratio 3) Quantity 'q'.	**03**
	(b)	Explain in brief on Pressure Swing Adsorption (PSA).	**04**
	(c)	Explain Freundlich equation. Derive the relation for single stage adsorption using the Freundlich equation.	**07**
Q.5	**(a)**	List types of distillation operation.	**03**
	(b)	Explain rate of drying curve with neat diagram.	**04**
	(c)	A 100 kg batch of granular solid containing 30% moisture is to be dried in a tray dryer to 16% moisture by passing a current of air at 350 K across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.7×10^{-3} kg/m^{2}s and the critical moisture content is 15%. Calculate the drying time.	**07**

OR

Q.5	**(a)**	Draw schematic diagram of conventional fractionating column.	**03**
	(b)	Explain principle and working of fluidized bed drier with neat sketch.	**04**
	(c)	A 50 kg batch of granular solid containing 25% moisture is to be dried in a tray dryer to 12% moisture by passing a current of air at 363 K across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.0008 kg/m^{2}s and the critical moisture content is 10%. Calculate the drying time. The surface area available for drying is 1.0 m2.	**07**

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