Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code: 3160501 Date: 20-05-2025

Subject Name: Mass Transfer Operations II

Time: 10:30 AM TO 01:00 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)**	Describe the concept of Flash Distillation.	**03**
	(b)	Discuss importance of vacuum distillation.	**04**
	(c)	Discuss positive deviations from ideality with neat sketch.	**07**
		OR	
Q.2	**(a)**	Define Reflux Ratio.	**03**
	(b)	List assumptions of McCabe-Thiele method and its limitations.	**04**
	(c)	Write a short note on Azeotrope.	**07**
		OR	
	(c)	Explain Adsorption hysteresis with figure.	**07**
Q.3	**(a)**	Explain Extractive distillation.	**03**
	(b)	Describe Azeotropic distillation briefly.	**04**
	(c)	A gas (B)–benzene (A) mixture is saturated at 1 std atm, 50° C. Calculate the absolute humidity if B is (a) nitrogen and (b) carbon dioxide. Vapor pressure of nitrogen at 50°C is given as 0.362 std atm.	**07**
		OR	
Q.3	**(a)**	Explain physical adsorption.	**03**
	(b)	Classify rotary dryer and explain any one in brief.	**04**
	(c)	Define: (1) Absolute humidity (2) Relative humidity (3) Dry-bulb temperature (4) Wet-bulb temperature (5) Humid volume (6) Humid Heat (7) Lewis relation	**07**

Q.4	**(a)**	Define Moisture content on wet basis and dry basis.	**03**
	(b)	With neat sketch, explain drum dryer.	**04**
	(c)	Why cooling towers are used in chemical process industries, give the classification and explain in detailed about cooling tower used in power plants.	**07**

OR

Q.4	**(a)**	Explain Freeze Drying with application.	**03**
	(b)	Explain: i) Bound moisture ii) Free moisture iii) Equilibrium moisture iv) Critical moisture	**04**
	(c)	Write Freundlich equation. How is it applied to two-stage cross current adsorption?	**07**
Q.5	**(a)**	Explain nature of adsorbents.	**03**
	(b)	Explain rate of drying curve with neat diagram.	**04**
	(c)	Write brief note on Pressure Swing Adsorption (PSA).	**07**

OR

Q.5	**(a)**	Explain Vacuum drying with example.	**03**
	(b)	Explain cross current adsorption.	**04**
	(c)	What do you mean by Ion Exchange? Describe techniques and application of ion exchange and list out the factors on which rate of ion exchange is dependent.	**07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160501 Date:15-05-2024

Subject Name:Mass Transfer Operations II

Time:10:30 AM TO 01:00 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) Absolute Humidity 2) Unbound Moisture 3) Humid Volume	**03**
	(b)	Generally, adsorption is preferable at low temperature and high pressure. True or false. Justify.	**04**
	(c)	Enlist various types of distillation in brief and explain azeotropic distillation in detail.	**07**
Q.2	**(a)**	Classify drying equipment in depth.	**03**
	(b)	Explain q line for distillation. Also derive equation for q-line.	**04**
	(c)	A fractional column separates a liquid mixture entering at 5000 kmol/h containing 50 mole % A and rest B into an overhead product of 95 mole % A and a bottom product of 96 % mole B. $R = 2R_{min}$ is used and feed enters at boiling point. Determine number of theoretical stages required and feed point location.	**07**

x	0.03	0.06	0.11	0.14	0.26	0.39	0.53	0.66	0.76	0.86	1
y	0.08	0.16	0.27	0.33	0.50	0.63	0.71	0.83	0.88	0.93	1

OR

	(c)	It is desired to separate a mixture of 50 % vapor and 50 % liquid in a plate type ditillation column. The feed contains 45 mole % A and top product has 96 mole % A whereas bottom product has 5 mole % A. Determine minimum reflux ratio and number of theoretical plates needed if reflux ratio is twice the minimum is used.	**07**

x	0	0.1	0.16	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
y	0	0.215	0.30	0.52	0.625	0.725	0.78	0.89	0.89	0.95	1

Q.3	**(a)**	Steam distillation takes place at reduced temperature. Justify. Also explain the reason behind the same.	**03**
	(b)	Classify cooling towers in detail.	**04**
	(c)	Explain principle and working of fluidized bed dryer with neat sketch.	**07**

OR

Q.3	**(a)**	Briefly explain steam distillation by stating proper example.	**03**
	(b)	Distillation tower can not be operated at minimum reflux or total reflux. Justify.	**04**
	(c)	Derive equation for retention time in continuous dryer at low temperature.	**07**
Q.4	**(a)**	Discuss about the different factors affecting drying operation.	**03**

	(b)	Explain equilibrium with reference to adsorption. State characteristics of adsorbent as well.	**04**
	(c)	A woolen cloth is dried in hot air dryer from 100 % to 10 % moisture. If the equilibrium and critical moisture content is 6 % and 55 % respectively. Estimate the reduction in time needed to dry the solid to 16 % moisture instead of 10 % under the same conditions. (All the moisture contents are on dry basis) Also mention major applications of drying and resistances acting while drying.	**07**

OR

Q.4	**(a)**	Define: 1) Relative humidity, 2) Humid heat, 3) Dew point	**03**
	(b)	Explain principles of ion exchange in brief. Also list its applications.	**04**
	(c)	Explain the theory of adiabatic saturation temperature and derive the equation for adiabatic saturation temperature.	**07**
Q.5	**(a)**	Brief about optimum reflux ratio.	**03**
	(b)	Explain moisture movement mechanism within solid for drying.	**04**
	(c)	Explain Freundlich equation. Derive the relation for two stage counter current adsorption using the Freundlich equation.	**07**

OR

Q.5	**(a)**	Brief about elution and chromatography.	**03**
	(b)	Explain range and approach with reference to cooling tower. Also explain losses taking place in cooling tower.	**04**
	(c)	In detail explain about Pressure Swing Adsorption. Also cite few industrial examples of the same.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160501 Date:04-07-2023

Subject Name:Mass Transfer Operations II

Time:10:30 AM TO 01:00 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) Grosvenor Humidity 2) Critical Moisture 3) Bound Moisture	**03**
	(b)	Define volatility. Prove that: $y = \alpha x/(1+(\alpha-1)x)$	**04**
	(c)	Differentiate between extractive and azeotropic distillation and discuss its selection criteria. Also explain extractive distillation at length.	**07**
Q.2	**(a)**	Explain adsorption with example by citing proper industrial examples and also enlist commonly used adsorbents and their characteristics.	**03**
	(b)	Define quantity 'q'. Derive equation for q-line.	**04**
	(c)	A continuous distillation column is used to separate a feed mixture at its boiling point, containing 24 mole % acetone and rest methanol into a distillate product containing 77 mole % acetone and residue product containing 5 mole % acetone. A reflux ratio of twice the minimum is to be used. The overall plate efficiency is 60 %. Determine number of plates required for the separation.	**07**

x	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.102	0.186	0.322	0.428	0.513	0.586	0.656	0.725	0.82	0.9

OR

	(c)	A mixture of benzene and toluene having 40 % benzene is to be separated at 200 kmol/h into a top product having 95 % benzene and bottom product with 4% of it. Column is operated at total reflux condition during start up period. Determine number of stages if its operated at total reflux condition. Calculate the same using Fenske equation. The average volatility is 2.5.	**07**
Q.3	**(a)**	At higher pressure, distillation is difficult. True or false? Justify.	**03**
	(b)	Explain various losses in cooling towers and explain need of make-up water in cooling towers.	**04**
	(c)	Explain principle and working of rotary dryer with neat sketch.	**07**

OR

Q.3	**(a)**	In perfumery industries, steam distillation is preferable. True or false? Justify the statement. Also cite few examples of steam distillation.	**03**
	(b)	Wet bulb temperature is generally less than dry bulb temperature. True or False? Justify. Also define Humid Heat and Humid Volume.	**04**
	(c)	Describe the different zones in continuous drying operation and derive equation for retention time in continuous dryer at low temperature.	**07**
Q.4	**(a)**	List characteristics of ideal solutions and explain Raoult's law.	**03**

	(b)	Define range and Approach with reference to cooling towers. Determine range and approach of cooling tower if its inlet temperature is 41 ℃ and outlet water temperature is 31 ℃. Wet bulb temperature is 24 ℃.	**04**
	(c)	A wet solid is to be dried from 40 % to 10 % moisture in 5 hrs. If the equilibrium and critical moisture content is 5 % and 15 % respectively. i) Estimate the excess time needed to dry the solid to 8 % moisture under the same conditions. (All the moisture contents are on dry basis) ii) Compare the time required to dry the material from 40 % to 10 % moisture if moisture content is on wet basis, if other conditions remain the same.	**07**

OR

Q.4	**(a)**	Derive equation for falling rate period if rate is proportional to square of moisture content.	**03**
	(b)	A mixture of nitrogen and acetone vapor at 800 mm Hg total pressure and 25℃ temperature has 80 % saturation. Calculate molal and absolute humidity, partial pressure of acetone. Also determine relative humidity if vapor pressure of acetone is 190 mm Hg.	**04**
	(c)	Classify cooling towers. Compare induced draft cooling tower with forced draft cooling tower.	**07**
Q.5	**(a)**	Discuss the effect of temperature and pressure on adsorption.	**03**
	(b)	Explain principles of ion exchange in brief. Also list its applications.	**04**
	(c)	Explain Freundlich equation. Derive the relation for single stage adsorption using the Freundlich equation.	**07**

OR

Q.5	**(a)**	At 30 °C the amount of acetone adsorbs at partial pressure of 10 and 100 mm Hg are 0.1 and 0.4 kg Acetone per kg activated carbon respectively. Assume Langmuir isotherm describe the adsorption of acetone on activated carbon. Determine the amount of acetone adsorbed at a partial pressure of 50 mm Hg and 30 °C.	**03**
	(b)	Explain equilibrium with reference to adsorption. Also discuss hysteresis.	**04**
	(c)	Define adsorption. Compare physical and chemical adsorption. Discuss about pressure swing adsorption (PSA) in detail and also explain the industrial applications of PSA by stating proper examples.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160501 Date:01/06/2022

Subject Name:Mass Transfer Operations II

Time:10:30 AM TO 01:00 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)** Explain briefly optimum reflux ratio. **03**

(b) List out various types of reboiler used in industry. Explain any one in detail. **04**

(c) Write a short note on azeotropic distillation with suitable example. **07**

Q. 2 **(a)** Show that the relative volatility of an ideal binary system is equal to the ratio of vapor pressure of two components. **03**

(b) Define: (i) Humid volume (ii) Wet bulb temperature (iii) Bound moisture (iv) Unbound Moisture **04**

(c) A fractionating column separates a liquid mixture entering at 5000 kmol/h containing 50 mole % A and 50 mol % B into an overhead product of 95 mole % A and a bottom product of 96 mole % B. A reflux ratio of twice the minimum will be used and the feed enters at its boiling point. Determine the number of theoretical stages required and the location of feed point. **07**

Equilibrium Data:

x	0.03	0.06	0.11	0.14	0.26	0.39	0.53	0.66	0.76	0.86	1.0
y	0.08	0.16	0.27	0.33	0.50	0.63	0.710	0.83	0.88	0.93	1.0

OR

(c) 1000 kmol/hr of an ethanol-propanol mixture containing 65 mole percent ethanol is to be separated in a continuous plate column operating at 101.325 kPa total pressure. The desired terminal composition in terms of mole fraction of ethanol are $x_D = 0.90$ and $x_W = 0.1$. The feed is saturated vapour and total condenser is used. When the reflux flow rate is four times the amount of top product, find the number of theoretical plate required for the separation and location of feed plate. Relative volatility of ethanol-propanol system may be taken as 2.10 **07**

Q.3 **(a)** Define quantity ‘q’. Derive equation for q-line. **03**

(b) Compute the equilibrium data from following data at 760 mm Hg pressure and relative volatility. **04**

Vapour Pressure, A (mm Hg)	760	830	920	1060	1200	1360
Vapour Pressure, B (mm Hg)	200	350	420	550	690	760

(c) Discuss differential distillation and derive Rayleigh equation for a binary mixture. **07**

OR

Q.3 **(a)** State the various industrial applications of adsorption. **03**

(b) State the significance of Freundlich equation applicable to adsorption. **04**

(c) Explain principles of ion exchange and describe its various techniques and industrial applications. **07**

Q.4 **(a)** Explain various losses in cooling towers and explain why make water is required in cooling towers. **03**

(b) Classify various types of cooling towers with neat sketches. **04**

(c) Explain the concept of wet-bulb temperature curve and adiabatic saturation curve. Explain Lewis relation. **07**

OR

Q.4 **(a)** In a mixture of benzene (A) vapor and nitrogen (B) gas at a total pressure of 800 mmHg and temperature of 60˚ C, the partial pressure of benzene is 100 mmHg calculate the (i) Mole fraction of benzene, (ii) Molal absolute humidity and (iii) Absolute humidity. **03**

(b) Differentiate between physical adsorption and chemisorptions. **04**

(c) Explain mechanism of cooling in upper part and lower part of a cooling tower operating counter currently. **07**

Q.5 **(a)** Write a short note on sublimation drying. **03**

(b) Classify drying equipments. **04**

(c) What is critical moisture content? Derive the equations for time of drying for (i) Initial and final moisture content greater than critical moisture content (ii) Initial and final moisture content less than critical moisture content (iii) Initial moisture content greater than critical moisture content and final moisture content less than critical moisture content. **07**

OR

Q.5 **(a)** Write a short note on vacuum drum drier. **03**

(b) Explain hold up in Rotary Dryer. **04**

(c) A granular solid with dry bulk density of 1600 kg/m^3 being dried in a batch drier in air at 65˚ C, with a humidity of 0.005 kg water / kg dry air. The solid containing 0.5 kg water / kg dry solids are in 2.54 cm pans insulated so that mass and heat transfer occurs from top surface only. The solids are to be to a final moisture content of 0.02 kg water / kg dry solid and havecritical moisture contnt of 0.01 02 kg water / kg dry solid. air passes over the pans at a mass velocity of 1.7 kg/m^2 s. Heat transfer by conduction and radiation may be neglected. For this granular materials, equilibrium moisture content is zero. (i) Calculate the drying time required and (ii) What will be the drying time if air flow rate is increased to 2.5 kg/m^2 s. **07**

Psychrometric data: At 65˚ c dry bulb temperature and 0.005 kg water / kg dry air absolute humidity, wet bulb temperature = 26˚ C and λ_w = 2440 kJ/kg.

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