

JK LAKSHMIPAT UNIVERSITY, JAIPUR
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination November 2018

B. Tech/ M. Tech (as applicable) in Chemical Engineering, Semester Fifth

Roll No.....

COURSE CODE: CHE507

Time: 3 hours

Max. Marks: 80

COURSE TITLE: Mass Transfer Operations-II

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. **Assume suitable data wherever required and mention it clearly.**
3. Writing appropriate **units, nomenclature, and drawing neat sketches/** schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark) 10

- i. Which of the following conditions are valid at the plait point?
P. Density difference between the extract and raffinate phases is zero
Q. Interfacial tension between the extract and raffinate phases is zero
R. Composition difference between the extract and raffinate phases is zero.
(a) P and Q Only (b) Q and R Only (c) P and R Only (d) P, Q, and R
- ii. An azeotropic mixture of ethanol and water is to be separated in a distillation column using benzene as an entrainer. At the column operation condition, two liquid phases are formed on a tray. What are the degree(s) of freedom of the system for the choice of intensive properties at equilibrium is
(a) 1 (b) 3 (c) 2 (d) 0
- iii. From the following list, identify the properties which are equal in both vapour and liquid phases at equilibrium P-Density, Q-Temperature, R-Chemical Potential, S-Enthalpy
(a) P and Q Only (b) Q and R Only (c) R and S Only (d) P and S Only
- iv. Most distillation column are designed for reflux ratio between
(a) 1.2 to 1.7 times R_{min} (b) 3 to 5 times R_{min}
(c) 2 to 10 times R_{min} (d) .2 to .7 times R_{min}
- v. The slope of the operating line in the rectifying section of a distillation column is unity if the reflux ratio is
(a) Infinity (b) One (c) Zero (d) Minimum
- vi. Select the wrong statement. The selectivity of solvent for extraction operation
(a) is analogous to relative volatility for distillation operation
(b) must be unity for maximum possible separation with minimum amount of solvent
(c) is unity at the plait point (d) must be greater than unity
- vii. Flash distillation operation is suitable for separating components which :
(a) boil at very close temperature (b) from minimum boiling azeotrope
(c) boils at widely different temperature (d) from maximum boiling azeotrope
- viii. The temperature at which a vapour-gas mixture becomes saturated when cooled at constant total pressure with a liquid is called
(a) Bubble Point (b) Dry-bulb temperature (c) Wet-bulb temperature (d) Dew point
- ix. Solvent B is used to extract solute C for a given feed containing A and C. If solute C is more soluble in A than B, the distribution coefficient for C will be
(a) $\gg 1$ (b) 1 (c) > 1 (d) < 1
- x. For all useful liquid-liquid extraction operations the selectivity of the solvent must be
(a) less than 1 (b) more than 0 (c) more than 1 (d) less than or equal to 1

- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- What is meant by optimum reflux?
 - Draw the five feed conditions on x-y diagram for binary mixture.
 - List out the types of crystals
 - Define and derive the correlation for relative volatility for binary mixture.
- Q.3A Compare azeotropic and extractive distillation. 05
- Q.3B An aqueous salt-solution enters a crystallizer operating at steady state at 25°C. The feed temperature is 90°C and the salt concentration in the feed is 40 weight %. The salt crystallizes as a pentahydrate. The crystal and the mother liquor leave the crystallizer. The molecular weight of the anhydrous salt is 135. The solubility of the salt at 25°C is 20 weight %. Calculate the feed flowrate required for a production rate of 100 kg/s of the hydrated salt in kg/s. 05
- Q.4A Write the correlation for enthalpy balances of crystallizer with suitable diagram 05
- Q.4B The vapour phase composition and relative volatilities with respect to n-propane on an ideal tray of a distillation column are 05

Component	Methane	Ethane	n-Propane
Mole fraction in vapour	0.12	0.28	0.60
Relative volatility	10	4	1

Calculate the mole fraction of n-propane in the liquid phase, rounded off to 2 decimal places.

- Q.5A What is meant by Nucleation? How does crystal growth occurs? Give the influencing factors. 05
- Q.5B A binary distillation column is to be designed using McCabe Thiele method. The distillate contains 90 mol% of the more volatile component. The point of intersection of the q-line with the equilibrium curve is (0.45, 0.65). Calculate the minimum reflux ratio for this operation. 05
- Q.6A Derive the correlation for steam distillation for binary mixture. 05
- Q.6B1 Sodium acetate solution is available at a temperature of 70°C with solute content of 55%. Find out: Yield of crystal if 2000 kg of this solution is cooled to 10°C. Data solubility at 70°C and 10°C are 146 and 121 grams of sodium acetate/ 100 gram of water respectively. 05

OR

- Q.6B2 Derive the correlation for Rayleigh distillation for binary mixture with suitable diagram. 05
- Q.7 Describe the design methodology to determine the number of theoretical plates by Ponchon Savarit method with neat layout. 10
- Q.8A A distillation column operating at 1 atm is to be designed for separation an ethanol-water mixture. The feed is 20 mole% ethanol and the feed flow rate is 1000 kg-mole/hr. of saturated liquid. A distillate composition of 80mole% ethanol and a bottoms composition of not more than 2 mole% ethanol are desired. The reflux ratio is 5/3. Determine: (i) The total number of equilibrium stages required 10
(i) The optimum feed plate location
(ii) The distillate and bottoms flow rates in kg-mole/hr.

Equilibrium data for ethanol-water system at 1 atm pressure are given below:

x	1.9	7.2	12.4	26	39.5	52	57.3	74.7	89.4	100
y	17	38.9	47	55.8	61.2	66	68.4	78.1	91	100

OR

- Q.8B Derive the correlation for determination of the number of stages for multistage countercurrent leaching with suitable diagram. 10

*****All the Best*****