



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH(FT)/SEM-5/CHE-514/2011-12

2011

**UNIT OPERATION OF CHEMICAL
ENGINEERING -II**

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.*

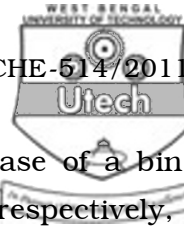
Graph sheet(s) is/are to be provided by the Institution.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10
 - i) In rectifying section of a continuous distillation column
 - a) vapour is enriched with low boilers
 - b) vapour is enriched with high boilers
 - c) liquid is stripped of high boilers
 - d) none of these.
 - ii) In steam distillation, the
 - a) temperature is 100° C
 - b) temperature is more than 100°C
 - c) product must be immiscible with water
 - d) temperature is higher than the boiling point of either component.

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- viii) When the liquid phase and vapour phase of a binary system obeys Raoult's and Dalton's law respectively, the relative volatility is the ratio of
- a) vapour pressure of component A to that of component B
 - b) vapour pressure of component A to the total pressure
 - c) vapour pressure of component A to the partial pressure of A
 - d) partial pressure of component A to the total pressure.
- ix) In azeotropic mixture, the equilibrium vapour composition is
- a) more than liquid composition
 - b) less than liquid composition
 - c) same as liquid composition
 - d) independent of pressure.
- x) Fenske equation determines
- a) maximum no. of ideal plates
 - b) height of the distillation column
 - c) minimum no. theoretical plates
 - d) optimum reflux ratio.

- GROUP – B**

Answer any *three* of the following. $3 \times 5 = 15$

- $$2 + 2 + 1$$

- $$1 + 2 + 2$$



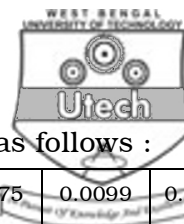
4. A hot solution containing 5,000 Kg of Na_2CO_3 & water with a concentration of 25 wt% Na_2CO_3 is cooled to 293 K and crystals of $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$ are precipitated. At 293 K, the solubility is 21.5 kg anhydrous Na_2CO_3 /100kg of total water. Calculate the yield of crystals obtained if 5% of the original water in the system evaporates on cooling. 5
5. Discuss the bubble point and dew point with the help of boiling point diagram. 5
6. Explain the term HETP in case of distillation. Calculate the equilibrium compositions of the liquid & the vapour phases for a mixture of CH_3OH & H_2O at 50°C & under a pressure of 40 kPa. ($P^\circ_{\text{CH}_3\text{OH}}=53.32$, $P^\circ_{\text{H}_2\text{O}}= 12.33$ kPa at 50°C) 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Derive the expression of no. of theoretical stages for liquid-liquid extraction in case of co-current contact with immiscible solvents.
- b) 100kg/h of 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=kg of nicotine/kg of water	0.001	0.0025	0.005	0.0075	0.0099	0.20
Y=kg of nicotine/kg of kerosene	0.00058	0.0019	0.0046	0.0069	0.0091	0.19

5 + 10

8. a) Define the term relative volatility.
- b) A mixture of benzene and toluene containing 40 mol% benzene is to be separated to give a product containing 90 mol% benzene at the top & a bottom product containing not more than 10 mol% benzene. The feed enters the column at its boiling point & the vapour leaving the column is condensed but not cooled, provides reflux & product with a reflux ratio of 3.0. It is required to find the no. of theoretical plates and the position of feed plate. The value of relative volatility is given as 2.4.
9. a) Show that for binary gas mixture, the diffusivity of A in B equals to the diffusivity of B in A.
- b) A narrow tube is partially filled with a liquid and maintained at a constant temperature. A gentle stream of gas is passing across the open end of the tube. As the liquid evaporates the level drops slowly. At a given time (t), the level is Z from the top. Derive an equation to calculate the value of diffusivity of the liquid in the gas.

7 + 8



10. a) Define the terms free and bound moisture content.
- b) A continuous counter current drier is used to dry 425.6 kg solid/h containing 0.035 kg total moisture/kg dry solid to a value of 0.0017 kg total moisture/kg dry solid. The granular solid enters at 25°C & leaves at 60°C. The heating medium is air which enters at 84.2°C, has a humidity of 0.0175 kg dry air & leaves at 32.8°C. Calculate the air flow rate & the outlet humidity, assuming the heat losses from the dryer to be 9300KJ/h.

(The constant heat capacity of dry solid is 1.465 KJ/kg-K)

3 + 12

11. Describe any *three* unit operations :

3 × 5 = 15

- a) Ultrafiltration
- b) Electrodialysis
- c) Pervaporation
- d) Reverse osmosis
- e) Dialysis
- f) Tray drier
- g) Spray drier
