Name: **Enrolment No:**	UPES

END SEMESTER EXAMINATIONS MAY-2018
Course: CHEG 211 – Mass Transfer Operations
Program: B.Tech. (APE Gas) **Semester: IV**
Time: 03 hrs. **Max. Marks:100**

Instructions:

1. Attempt any 2 questions from **Section A** (each carry 10 marks); any **two Questions (4 is compulsory)** from **Section B** (each carry 15 marks); any **two Questions (7 is compulsory)** from **Section C** (each carry 25 marks).
2. Strictly, students should suitably assume the Missing data, if any, clearly mention the same in the answer sheet.
3. Each student should avail 5 graph sheets maximum.

	Section A (Answer any TWO question (2* 10m =20m)		
1.	Answer briefly a. State Fick's law of diffusion b. Differentiate between J-flux and N-flux c. State the relation between overall mass transfer coefficient (K_y) and individual mass transfer coefficient (k_y)? d. Define relative volatility (α), express y = f (x,α) e. Five types of feeds to distillation and draw their q-lines.	**[10]**	**CO1 CO2**
2.	In continuous distillation, what does the following terms signify ? a. Reflux ratio. b. Total reflux conditions c. Minimum reflux ratio d. Actual reflux ratio?	**[10]**	**CO3**
3.	*The performance and efficiency of plates in distillation column is reduced drastically at adverse gas flow rates.* **Justify this statement** with, **four** commonly occurring problems in a plate column due to variation in gas flow rates.	**[10]**	**CO3**
	Section B (Q. No. 4 is compulsory & Answer either Q.no. 5 or 6 (2* 15m =30m)		
4.	**Compulsory Question**: It is desired to **absorb** 95% of acetone by water from a mixture of acetone and nitrogen containing 1.5% of the component in a countercurrent tray tower. Total gas input is 30 kmol/hr and water enters the tower at a rate of 90 kmol/hr. The tower operates at 27ºC and 1 atm. The equilibrium relation is Y=2.53X. Determine the number of ideal stages necessary for the separation using **graphical** method	**[15]**	**CO4**

5	A mixture of benzene and toluene containing 40 mole % of benzene is to be separated to give a product of 90 mole % of benzene at the top and bottom product with not more than 10 mole % of benzene. Using an average value of 2.4 for the volatility of benzene relative to toluene, plot x vs y and label equilibrium line, diagonal line , W, F and D points. Calculate the number of theoretical plates required **at total reflux,** using **graphical** method.	**[15]**	**CO4**
6	Differentiate (in tabular form) between Packed bed column and Plate columns for gas-liquid contactors.	**[15]**	**CO4**
	SECTION C (Q.No. 7 is compulsory & Answer either 8 or 9 **(02*25m =50m)**		
7	**Compulsory question:** 1000 kg/hr of a mixture containing 42 mole percent heptane and 58 mole percent ethyl benzene is to be fractionated to a distillate containing 97 mole percent heptane and a residue containing 99 mole percent ethyl benzene using a total condenser and **feed at its saturated liquid condition**. The enthalpy-concentration data for the heptane-ethyl benzene at 1 atm pressure are as follows: $x_{heptane}$ 0 0.08 0.18 0.25 0.49 0.65 0.79 0.91 1.0 $y_{heptane}$ 0 0.28 0.43 0.51 0.73 0.83 0.90 0.96 1.0 H_l (kJ/kmol) **x 10^{-3}** 24.3 24.1 23.2 22.8 22.05 21.75 21.7 21.6 21.4 H_v (kJ/kmol) **x 10^{-3}** 61.2 59.6 58.5 58.1 56.5 55.2 54.4 53.8 53.3 Calculate the following: Plot H vs. (x,y) (2) Plot x vs. y with same scale as above. (2) Mark W,D,F in x vs y and Mark F in H vs x curve (2) Construct F-a-b-C and Mark C in H vs y curve (2) Find Q'_{min} point and evaluate R_{min} (2) If R_{actual} is 2.5, Determine Q'_{actual} (2) Construct ΔD-F-ΔW line. Report Condenser duty (Q'_{actual}) and Reboiler duty (Q"). (4) Draw atleast 4 tie lines from ΔW and determine x", y" data. Draw atleast 4 tie lines from ΔD and determine x', y' data. (2) Construct Operating lines for enriching section using x', y'passing through D. Construct Operating lines for stripping section using x", y" passing through W. (4) Determine number of plates. (2) If efficiency of the plate is 50%, determine number of actual stages including reboiler. (1)	**[25]**	**CO4**

8	A **saturated liquid** mixture containing 60 mole % benzene and 40 mole % toluene is to be distilled continuously into a distillate product containing 90 mole % benzene and the bottom product containing 5 mole % benzene. The fractional distillation column will operate at approximately constant pressure of 1 atm. Find minimum reflux ratio If actual reflux ratio is 2, determine the theoretical number of plates Suggest optimum feed plate location If efficiency of the plate is 50%, determine the actual number of plates including reboiler. Equilibrium data are: x 0 0.017 0.075 0.13 0.211 0.288 0.37 0.411 0.581 0.78 1 y 0 0.039 0.161 0.261 0.393 0.496 0.591 0.632 0.777 0.9 1	**[25]**	**CO4**
10	[a] A liquid feed consisting of 1200 gmoles of mixture containing 30% naphthalene and 70% dipropylene glycol is differentially distilled at 100 mm Hg pressure and final distillate contains 55% of the feed solution. The VLE data are x % 8.4 11.6 28.0 50.6 68.7 80.6 88 y % 22.3 41.1 62.9 74.8 80.2 84.4 88 Determine the amount of residue and distillate (2) Determine LHS value of Rayleigh's equation (2) Plot 1/y*-x vs x for the give equilibrium data: (6) Determine the concentration of naphthalene in the residue (x_W) from graph such that LHS and RHS of the Rayleigh's equation is balanced (10). [b] Justify why and when the following gas liquid contactors are used: i. Steam distillation (2.5) ii. Azeotropic distillation (2.5)	**[25]**	**CO4**