Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –III Examination Dec. - 2011

Subject code: 731602 **Date: 08/12/2011**

Subject Name: Computer Aided Product and Process Design

Time: 10.30 am – 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.**

Q.1 **(a)** Discuss Tinker's Flow Model and significance of sealing strips. **07**

(b) Define cycle time for design and scheduling of batch plant. Discuss effect of transfer policies on cycle with Gant chart. **07**

Q.2 **(a)** Consider a plant consisting of three stages that manufactures two products, A and B. The demands are 600,000 kg/year for A and 300,000 kg/year of B, and the production time considered is 6000 hours. Data for processing time and size factors are as follows: **07**

	Processing time (hr.)			Size Factors (m^3/kg prod)		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
A	4	2	3	2	5	3
B	3	2	5	1.5	6	2

Assume that both the products have same batch size

Determine the size of vessels of a multi-product batch plant if the production cycle is of 500 hrs consisting of two campaigns: one for A and one for B. Only one vessel is to be used in each stage.

(b) Explain Marginal Vapour flows and show how it will be useful for predicting the best sequence of distillation columns. **07**

OR

(b) We have a mixture of five alcohols labeled as A, B, C, D and E with flows in the feed of 1, 0.5, 1, 7 and 10 mol/s respectively, for a total of 19.5 mol/s and relative volatilities are 4.3, 4, 3, 2, and 1 respectively. The information about marginal vapor flows estimated for non-key species are as under: **07**

	A	B	C	D	E
A/B	--	--	2.6	6.5	3.2
B/C	5.3	--	--	9.3	4.0
C/D	2.4	1.3	--	--	6.7
D/E	1.5	0.8	2.0	--	--

Find the best distillation based separation sequence.

Q.3 **(a)** Explain Geometrical concept for Attainable Regions for reaction mechanism of your choice excluding van de Vusse reaction. **07**

(b) Discuss the criteria of selection of Packed tower and Venturi scrubber as absorption equipments. **07**

OR

Q.3 **(a)** Explain superstructure concept and its implementation for optimization of reactor network synthesis. **07**

(b) Discuss the Tridiagonal Metrix method for the multi component distillation. **07**

Q.4 Discuss Lewis-Matheson method for multicomponent distillation . **14**

Q.4 **OR** **14**

A saturated liquid, consisting of phenol and cresols with some xylenols, is fractioned to give a top product of
95.3 mole% phenol. Metacresol is heavy key and phenol is light key components. Total condenser is used.
The composition of the top product and of the phenols in the bottoms are given.
(a) Complete the material balance over the column for a feed rate of 100 kmol/h.
(b) Calculate the minimum reflux ratio by Underwood's method.
(c) For $\boldsymbol{R = 3R_m}$, calculate the composition of vapour entering to the top most tray by Lewis–Matheson method.

Distillation Column Data and Relatie Volatilities values are given in following Table.

Component	α_{av}	Feed, mole %	Top product, mole %	Bottom product, mole %
Phenol	1.98	35	95.30	5.24
o – Cresol	1.59	15	4.55	
m – Cresol	1.00	30	0.15	
Xylenols	0.59	20	–	
		100	100.00	

Q.5 Packed tower type scrubber is required for the following duty. **14**

(i) Feed gas : 80 kg/h Cl_2 + 320 kg/h air
(ii) Solvent : 15% NaOH solution
(iii) Specific heat of solvent : 0.9 kcal/(kg.^oC)
(iii) Concentration of Cl_2 in exit gas : 40 ppm
(iv) Chemical Reactions :

$$2NaOH + Cl_2 = NaOCl + NaCl + H_2O$$
$$\Delta H_R = -24.65 \text{ kcal/mol}$$

Calculate :

(a) Amount of solvent required. Tower diameter required for this scrubber is 0.4 m.

(b) Calculate the number of overall gas phase transfer unit.

(c) Calculate the height of packing required. Mass transfer coefficient, K_{Ga}=272 kmol/(m^3.h).
Atomic mass of Na:23, O:16, H:1, Cl:35.5

OR

Q.5 **Write short notes on any two of following.** 14

i Calculation of shell side heat transfer coefficient by Bell's method
ii Advantages of horizontal position over vertical position and significance of 'Inverted U-Seal' in design of multicomponent condenser
iii Selection of operating pressure in distillation column

****