

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 fractionated 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 $R = 3R_m$, calculate the composition of vapour entering to the top most tray by Lewis–Matheson method.

Distillation Column Data and Relative 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
<i>o</i> – Cresol	1.59	15	4.55	
<i>m</i> – 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.

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- (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.°C)
- (iii) Concentration of Cl_2 in exit gas : 40 ppm
- (iv) Chemical Reactions :



$$\Delta H_R = -24.65 \text{ kcal/mol}$$

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, $K_{Ga}=272 \text{ kmol}/(\text{m}^3 \cdot \text{h})$.
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
