Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME – SEMESTER III (NEW) – • EXAMINATION – SUMMER 2016**

**Subject Code: 2731602** **Date:03/05/2016**

**Subject Name: Computer Aided Product and Process Design**

**Time:10:30 am to 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)** Explain Marginal Vapour flows and show how it will be useful for predicting the best sequence of distillation columns. **07**

**(b)** Discuss separation train synthesis for non-ideal fluid mixtures. **07**

**Q.2** **(a)** Discuss the criteria of selection of spray tower and falling film absorber as absorber. **07**

**(b)** Explain the step-by-step process of selecting best sequence for ternary feed mixture based on minimum vapor rates. **07**

**OR**

**(b)** 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.

**Q.3** **(a)** Define cycle time for design and scheduling of batch plant. Discuss effect of transfer policies on cycle with Gant chart. **07**

**(b)** You are to separate the following relatively ideally behaving mixture of A, B, and C. The feed is at its bubble point of 345.8 K at 1 bar. The Underwood roots for the original feed are 1.116 and 2.826. The minimum vapor flow of the columns are as under: **07**

$V_{min}$(A/BC) = 828 kmol/hr
$V_{min}$(AB/C) = 254 kmol/hr
$V_{min}$(A/B) = 830 kmol/hr
$V_{min}$(B/C) = 183 kmol/hr

- Which sequence is to be preferred? Why?
- Explain the method of calculating marginal vapor flows. (Very approximate method.)

**OR**

**Q.3** **(a)** Write a generalize MILP model for synthesizing distillation sequences for any mixture of n components that is to be separated into pure components. **07**

**(b)** For the objective to minimize the investment cost given fixed product demand write MINLP design model for flow shop plants - single product campaigns. **07**

**Q.4** Packed tower type scrubber is required for the following duty. **14**

(i) Feed gas : 15 Kg/h HCl + 15 Kg/h $Cl_2$ + 600 Kg/h air
(ii) Solvent : 10% NaOH solution
(iii) Concentration of HCl and $Cl_2$ in exit gas: 20 mg/m³.
(iv) Chemical Reactions :

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

$$NaOH + HCl \;====\; NaCl + H_2O$$
$$\Delta H_R = -31.4 \text{ Kcal / mol}$$

Calculate :

(a) Amount of solvent required. Tower diameter required for this scrubber is 0.36m.

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

(c) Calculate the height of packing required. Mass transfer coefficient, $K_{Ga}$=272 kmol/(m³.h)

**OR**

**Q.4** Discuss the step wise procedure for the process design of multicomponent batch distillation with rectification and with constant overhead composition. **14**

**Q.5** **(a)** Discuss the advantages of horizontal position over vertical position and significance of 'Inverted U-Seal' in design of multi component condenser. **07**

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

**OR**

**Q.5** **(a)** Discuss the advantages and disadvantages of induced draught fan over Forced draught fan for air cooler. Explain also various design conditions of atmospheric air for the different applications of air cooler. **07**

**(b)** Discuss the step wise procedure for the process design of air cooler. **07**

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