Seat No.: \_

Enrolment No.\_\_

# GUJARAT TECHNOLOGICAL UNIVERSITY M.E. SEMESTER III–EXAMINATION – WINTER 2015

Subject code: 2731602

Subject Name: Computer Aided Product and Process Design

Time: 2:30 PM to 5:00 PM

# Instructions:

- **1.** Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- **Q.1** Packed tower type scrubber is required for the following duty.

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Date: 04/12/2015

**Total Marks: 70** 

- (i) Feed gas :  $45\% \text{ CO}_2 + 3\% \text{ H}_2\text{S} + 52\% \text{ CH}_4$  (by mole)
- (ii) Feed gas flow rate = 900  $\text{Nm}^3/\text{h}$  at 1.2 bar a and 40°C
- (iii) Solvent : 10% NaOH solution
- (iv) Specific heat of solvent : 0.9 kcal/(kg.°C)
- (iii) Concentration of  $CO_2$  and  $H_2S$  in exit gas : 100 ppm
- $\begin{array}{ll} (iv) & Chemical \ Reactions: \\ & 2 \ NaOH_{(aq)} + CO_{2(g)} = \ Na_2CO_{3(aq)} + H_2O_{(l)} \\ & \Delta H_R = -104.67 \ kJ/mol \end{array}$

$$\begin{array}{ll} 2 \; NaOH_{(aq)} + H_2S_{(g)} = \; Na_2S_{(aq)} + 2 \; H_2O_{(l)} \\ \Delta H_R = -52.73 \; kJ/mol \end{array}$$

( Atomic mass : Na 23,O 16,H 1,C 12,S 32)

Calculate :

- (a) Amount of solvent required. Tower diameter required for this scrubber is 0.95 m.
- (b) Calculate the number of overall gas phase transfer unit.
- Q.2 (a) Explain Marginal Vapour flows and show how it will be useful for 07 predicting the best sequence of distillation columns.
  - (b) Explain how to calculate the number of sequences for a ordinary multicomponent distillation. If other type of separators are used, then how to calculate the number of possible sequences?

### OR

- (b) Discuss separation train synthesis for non-ideal fluid mixtures. 07
- Q.3 (a) Define cycle time for design and scheduling of batch plant. Discuss 07 effect of transfer policies on cycle with Gant chart.
  - (b) Explain how MINLP can be used to design model for flow shop plants. 07

- Q.3 A two stage plant produces 250000 kg per year of product C. The plant 14 operates 6000 hours per year. The steps to produce C is as follows: Step 1 Mix 0.5 kg of A, 0.5 kg of B and react for 4 hours to form C. The yield is 40% in weight and the density of the mixture is 90 kg/m<sup>3</sup>. Step 2- Add 0.5 kg of solvent and separate by centrifuge during 1 hour to recover 95% of product C. The density of mixture is 97 kg/m<sup>3</sup>. Draw a neat sketch to demonstrate the system and do the following:
  i) Determine the size of both the vessel.
  ii) If two reactors are used instead of one, then what will be changes in the system.
- Q.4 (a) Discuss the criteria of selection of tray tower and spray tower (chamber) 07 as absorber.
  - (b) Discuss the advantages and disadvantages of induced draught fan over
     67 Forced draught fan for air cooler. Explain also various design conditions of atmospheric air for the different applications of air cooler.

### OR

- Q-4 Discuss the step wise procedure for the process design of air cooler. 14
- Q.5 Discuss the step wise procedure for the process design of 14 multicomponent batch distillation with rectification and with constant overhead composition.

#### OR

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#### Q.5 Write short notes on following.

- i Process design of venturi scrubber and its selection criteria as absorber
- **ii** Advantages of horizontal position over vertical position and significance of 'Inverted U-Seal' in design of multicomponent condenser.

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