

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VI • EXAMINATION – WINTER 2013****Subject Code: 160405****Date: 04-12-2013****Subject Name: Principles of Process Engineering-III****Time: 02:30 pm to 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Notations used have their conventional meanings.

- Q.1** (a) With reference to humidification operations, define and explain ... **08**
 i) Saturated and unsaturated vapor-gas mixtures
 ii) Molal and mass absolute humidity
 iii) Percentage and relative humidity
 iv) Humid heat and enthalpy
 (b) For Adsorption operations, explain... **06**
 (i) Types of Adsorption (ii) Nature of Adsorbents.

- Q.2** (a) Define wet-bulb temperature. Derive the expression for wet-bulb depression using concepts of wet-bulb theory, simultaneous heat and mass transfer and Lewis relation. Also, prove that wet-bulb temperature and adiabatic saturation temperature are same for air-water system. **07**
 (b) Write a short note on principle, mechanism, equilibrium and rate of ion exchange. **07**

OR

- (b) A coloured impurity in an aqueous solution is to be removed by adsorption on a decolourizing carbon. It is desired to reduce the colour to 10% of its original value 9.6. Estimate the quantity of fresh carbon required per ton of solution for two stage counter- current operation. The system obeys Freundlich equilibrium isotherm :

$$Y^* = 8.91 \times 10^{-5} X^{1.66}$$

Where $Y^* \rightarrow$ equilibrium colour, units/kg solution,

$X \rightarrow$ adsorbate concentrations, units/kg carbon

Equation for intermediate concentration Y_1 for specified terminal concentrations

$$Y_0 \text{ and } Y_2 \text{ is given by } \left(\frac{Y_0}{Y_2} - 1 \right) = \left(\frac{Y_1}{Y_2} \right)^{\frac{1}{n}} \left(\frac{Y_1}{Y_2} - 1 \right)$$

- Q.3** (a) Explain Flash distillation in detail with neat diagram. **07**
 (b) Derive Rayleigh's equation for differential distillation. **07**

OR

- Q.3** (a) Explain in brief McCabe Thiele method used for obtaining theoretical plates required for given degree of separation. **07**

- (b) Define reflux ratio and explain in detail about Total, Minimum and Optimum reflux ratio. **07**
- Q.4** (a) Explain Mier's supersaturation theory of crystallization with neat diagram. **07**
- (b) With the help of diagram, define and explain following types of moistures. **07**
- Moisture content on dry and wet basis
 - Bound and unbound moisture
 - Free and equilibrium moisture

OR

- Q.4** (a) Mention various crystallizers and discuss any one in detail with neat diagram. **07**
- (b) Explain positive and negative deviations from ideality – Raoult's law, with examples in brief. **07**

- Q.5** A mixture of benzene and toluene containing 45 mole % benzene is to be separated to give an overhead product of 95 mole % benzene and a bottom product containing 5 mole % benzene. The feed is at its boiling point, and the vapor leaving the column is condensed but not cooled and provides reflux and product. Equilibrium data for mol fractions of benzene in liquid, x and vapor, y is given as follows: **14**

x	0.78	0.581	0.411	0.258	0.130	0.017
y	0.90	0.777	0.632	0.486	0.261	0.039

Using McCabe-Thiele method, calculate:

- Minimum reflux ratio.
- Number of theoretical plates required when total reflux is used.

OR

- Q.5** (a) Classify dryers used in industry. Explain construction, working, advantages, disadvantages and applications of tray dryer with neat sketch. **07**
- (b) Explain constant rate and falling rate periods in drying. Also, describe different methods to find time of drying in falling rate period. **07**
