Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VI(NEW) EXAMINATION – WINTER 2022**

**Subject Code:3160501 Date:13-12-2022**

**Subject Name:Mass Transfer Operations II**

**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. **Simple and non-programmable scientific calculators are allowed.**

**MARKS**

**Q.1** **(a)** Define: 1) Humid Volume 2) Humid heat 3) Lewis Relation **03**

**(b)** Explain effect of temperature on adsorption with one example. **04**

**(c)** A mixture of benzene and toluene containing 60 mole% benzene is to be separated to give a product of 95 mole% benzene and bottom product containing 10 mole% benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. Calculate number of theoretical plates needed by Mccabe-Thiele method and position of feed plate. The vapor liquid equilibrium data are given as below: **07**

| x | 0 | 0.05 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|---|
| y | 0 | 0.13 | 0.21 | 0.375 | 0.5 | 0.6 | 0.7 |

| x | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
|---|---|---|---|---|---|
| y | 0.77 | 0.83 | 0.9 | 0.95 | 1.0 |

**Q.2** **(a)** Explain constant pressure equilibria with neat sketch. **03**

**(b)** Explain feed tray location in distillation operation. **04**

**(c)** A liquid mixture containing 40 mole% methanol and 60 mole% water is fed to the differential distillation at atmospheric pressure with 60 mole% of the liquid is distilled. Find the composited distillate and the residue. Equillibrium Data: **07**

| x | 0.05 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| y | 0.27 | 0.42 | 0.57 | 0.66 | 0.73 | 0.78 |

**OR**

**(c)** A liquid mixture containing 60 mole% acetone (1), 40 mole% water (2) at 1 atm pressure in differentially distilled to vaporize 30 mole% of the feed. Compute the composition of composite distillate and residue. The VLE data are: **07**

| x | 0.01 | 0.05 | 0.1 | 0.2 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| y | 0.253 | 0.625 | 0.755 | 0.815 | 0.839 | 0.849 |

| x | 0.6 | 0.7 | 0.8 | 0.9 | 0.95 |
|---|---|---|---|---|---|
| y | 0.859 | 0.874 | 0.898 | 0.935 | 0.963 |

| | | | |
|---|---|---|---|
| **Q.3** | **(a)** | Define: 1) Relative saturation 2) Percentage saturation 3) Dew point | **03** |
| | **(b)** | Explain principle and applications of steam distillation. | **04** |
| | **(c)** | Derive equation for Adiabatic Saturation Curve. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.3** | **(a)** | Discuss range and approach with reference to cooling tower. | **03** |
| | **(b)** | Explain Azeotropic distillation. | **04** |
| | **(c)** | Explain the various types of cooling towers and discuss their selection criteria. | **07** |
| **Q.4** | **(a)** | List assumptions of McCabe-Thiele method and its limitations. | **03** |
| | **(b)** | Compare and contrast physical adsorption and chemisorptions. | **04** |
| | **(c)** | Explain Ion Exchange and describe techniques and applications of ion exchange and list out the factors on which rate of ion exchange is dependent. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Define: 1) Total reflux ratio 2) Minimum reflux ratio 3) Quantity 'q'. | **03** |
| | **(b)** | Explain in brief on Pressure Swing Adsorption (PSA). | **04** |
| | **(c)** | Explain Freundlich equation. Derive the relation for single stage adsorption using the Freundlich equation. | **07** |
| **Q.5** | **(a)** | List types of distillation operation. | **03** |
| | **(b)** | Explain rate of drying curve with neat diagram. | **04** |
| | **(c)** | A 100 kg batch of granular solid containing 30% moisture is to be dried in a tray dryer to 16% moisture by passing a current of air at 350 K across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is $0.7 \times 10^{-3}$ kg/m$^2$s and the critical moisture content is 15%. Calculate the drying time. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Draw schematic diagram of conventional fractionating column. | **03** |
| | **(b)** | Explain principle and working of fluidized bed drier with neat sketch. | **04** |
| | **(c)** | A 50 kg batch of granular solid containing 25% moisture is to be dried in a tray dryer to 12% moisture by passing a current of air at 363 K across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.0008 kg/m$^2$s and the critical moisture content is 10%. Calculate the drying time. The surface area available for drying is 1.0 m2. | **07** |

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