**Seat No.: _____** **Enrolment No._____**

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VIII (OLD) - EXAMINATION – SUMMER 2017**

**Subject Code:180506** **Date:06/05/2017**

**Subject Name: Chemical System Modelling ( Department Elective-II )**

**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.**

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|---|---|---|---|
| **Q.1** | **(a)** | Distinguish independent variables, dependent variables, and parameters with suitable examples. | **07** |
| | **(b)** | Consider idealized single stage extraction of benzoic acid from toluene using water. Make a model for system and derive the equation for the proportion extracted E. | **07** |
| **Q.2** | **(a)** | Discuss various aspects involved in physical modeling. | **07** |
| | **(b)** | 1.26 kg/s of sulphuric acid of heat capacity 1508 J/ kg K is to be cooled in a two stage counter current cooler. Hot acid at 174 $^{o}$C is fed to a tank where it is stirred well in contact with cooling coils. The continuous discharge from the tank at 88 $^{o}$C flows to a second stirred tank and leaves at 45 $^{o}$C. Cooling water at 20 $^{o}$C flows into the coil of the second tank and then to the coil of the first tank. The water is at 80 $^{o}$C as it leaves the coil of the hot acid tank. To what temperature would the contents of each tank rise if, due to trouble in supply, the cooling water is suddenly stopped for 1 hr? Calculate also the intermediate water temperature before the failure. The capacity of each tank is 4536 kg of acid and the flow rate of water is 0.975 kg/s. | **07** |
| | | **OR** | |
| | **(b)** | Classify mathematical modeling in the form of a tree structure, and elaborate the various terms involved. | **07** |
| **Q.3** | **(a)** | Define modeling. Explain the procedure for model development. | **07** |
| | **(b)** | Differentiate:<br>i) Deterministic process and stochastic process<br>ii) Lumped parameter model and distributed parameter model | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Discuss with block diagram the stages in the development of a complete mathematical model for a chemical process. | **07** |
| | **(b)** | 160 $cm^3/s$ of a solvent S is used to treat 400 $cm^3/s$ of a 10% by weight solution of A in B, where A is being extracted from B in a two-stage counter-current liquid-liquid extraction column. What is the composition of the final raffinate and the fraction extracted if distribution coefficient = 3 and the densities of A, B, and S are 1200, 1000, and 800 $kg/m^3$, respectively? | **07** |
| **Q.4** | **(a)** | Construct a mathematical model of heat loss through pipe flanges. | **07** |
| | **(b)** | Derive mathematical model for steady state N-stage counter-current solvent extraction. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Develop a model of Laminar flow in a narrow slit. | **07** |
| | **(b)** | Derive temperature profile model equation for a fixed bed catalytic reactor for adiabatic operation. List all assumptions made. | **07** |

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| **Q.5** | **(a)** | Develop mathematical model for temperature distribution in a transverse cooling fin of triangular cross section. | **07** |
| | **(b)** | A hollow cylinder with an outer diameter of 10 cm and an inner diameter of 5 cm has an inner surface temperature of 200 °C and an outer surface temperature of 100 °C. Determine the temperature of the point halfway between the inner and outer surfaces. If the thermal conductivity of the cylinder material is 70 W/m.K, determine the heat flow through the cylinder per linear meter. | **07** |

**OR**

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|---|---|---|---|
| **Q.5** | **(a)** | Derive model for unsteady-state heat transfer in a tubular gas pre heater. | **07** |
| | **(b)** | Construct a mathematical model of the continuity equation, and write name of different methods used for solving partial differential equations. | **07** |

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