Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII • EXAMINATION – WINTER • 2014

Subject Code: 180506 Date: 25-11-2014

Subject Name: Chemical System Modeling

Time: 02:30 pm - 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.**

Q.1	**(a)**	Give a detailed account of the fundamental laws used in modeling.	**07**
	(b)	Define modeling and explain the procedure for model development.	**07**
Q.2	**(a)**	Explain independent variables, dependent variables and parameters with suitable examples.	**07**
	(b)	Differentiate between deterministic process and stochastic process.	**07**
		OR	
	(b)	Describe various stages in the development of a complete mathematical model for a process using a neat flow diagram.	**07**
Q.3	**(a)**	Classify mathematical modeling in the form of a tree structure and elaborate the various terms involved.	**07**
	(b)	Compute the fraction of solute that could be extracted in a single-stage solvent extraction using the numerical values of S = 12R, m = 1/8, and c = 0.1 kg/m^3.	**07**
		OR	
Q.3	**(a)**	Consider idealized two stage extraction of benzoic acid from toluene using water. Make a model for the system and derive the equation for the proportion extracted E.	**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 m (distribution coefficient) = 3 and the densities of A, B and S are 1200, 1000 and 800 kg/m^3 respectively?	**07**
Q.4	**(a)**	Develop a model of Laminar flow in a narrow slit.	**07**
	(b)	Derive the equation of continuity.	**07**
		OR	
Q.4	**(a)**	Construct a model of concentration and temperature profile of fixed bed catalytic reactor. List all assumptions made.	**07**
	(b)	Develop mathematical model for heat losses through pipe flange, clearly mentioning all the assumptions.	**07**
Q.5	**(a)**	Derive model for counter cooling of tanks.	**07**

(b) 1.26 kg/s of sulphuric acid of heat capacity 1508 J/ kgK 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 the intermediate water temperature before failure. The capacity of each tank is 4536 kg of acid and the flow rate of water is 0.975 kg/s. **07**

OR

Q.5 **(a)** Develop mathematical model for temperature distribution in a transverse cooling fin of triangular cross section. **07**

(b) Derive model for Unsteady-state heat Transfer in a Tubular Gas Pre heater. **07**

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