Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) • EXAMINATION – WINTER 2016

Subject Code:2173509 **Date:23/11/2016**

Subject Name:Environmental Reaction Engineering

Time:10.30 AM to 1.00 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)**	Write performance equations for ideal CSTR and PFR explaining each term with its SI units. Calculate the ratio of volume of CSTR to that of PFR for 50% conversion for a unimolecular liquid phase reaction conducted at same values of temperature, initial concentration and initial molar flow rate of reactant.	**07**
	(b)	At present the elementary liquid-phase reaction A + B $\rightarrow$ R + S takes place in a plug flow reactor using equimolar quantities of A and B. Conversion is 96%, $C_{A0} = C_{B0} = 1$ mol/liter. If a mixed flow reactor ten times as large as the plug flow reactor were hooked up in series with the existing unit, which unit should come first and what will be the conversion at the exit of the CSTR? Sketch the system.	**07**
Q.2	**(a)**	A liquid reactant stream (1 mol/liter) passes through two mixed flow reactors in a series. The concentration of A in the exit of the first reactor is 0.5 mol/liter. Find the concentration in the exit stream of the second reactor. The reaction is second-order with respect to A and the second reactor is twice as big as the first. Sketch the system.	**07**
	(b)	Describe with appropriate graphical representation the Jones graphical method to determine concentration in each MFR connected in a series of unequal sized MFR's.	**07**
		OR	
	(b)	Write the sequence of steps according to Langmuir-Hinshelwood approach for catalytic reactions.	**07**
Q.3	**(a)**	Mention at least two series-parallel reactions of industrial importance. Define selectivity and overall and instantaneous fractional yields.	**07**
	(b)	Describe the graphical method to determine the best arrangement for given conversion of unequal sized MFR's connected in a series.	**07**
		OR	
Q.3	**(a)**	Write the sequence of steps according to shrinking core model for gas-solid non-catalytic reactions. Draw a schematic figure to show these steps when reaction $A\ (g) + bB\ (s) \rightarrow products$ takes place on a solid spherical particle of unchanging size.	**07**
	(b)	Differentiate between physical and chemical adsorption.	**07**

Q.4 **(a)** Tabulate and plot the exit age distribution E using the following data. **07**

Time t, min	Tracer Output Concentration, C_{pulse} gm/liter fluid
0	0
5	3
10	5
15	5
20	4
25	2
30	1
35	0

(b) Give at least three examples of industrially important non-catalytic heterogeneous reactions. Write pertinent chemical reactions. **07**

OR

Q.4 **(a)** Evaluate the spread of distribution for the following data. **07**

Time t, min	Tracer Output Concentration, C_{pulse} gm/liter fluid
0	0
5	3
10	5
15	5
20	4
25	2
30	1
35	0

(b) Distinguish between packed bed and fluidized bed catalytic reactors. Draw diagrams. **07**

Q.5 **(a)** Derive the relation for C_R as function of time in a batch reactor for the following elementary reaction ($k_1 \neq k_2$). Sketch the curve C_R versus time. **07**

$$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$

(b) What are the reasons for exit age distribution? What are the techniques to evaluate the RTD? **07**

OR

Q.5 **(a)** Substance A in a liquid reacts to produce R and S as follows: **07**

$$\begin{array}{lll} & R & \text{first order} \\ A & \nearrow & \\ & \searrow & \\ & S & \text{first order} \end{array}$$

A feed ($C_{A0} = 1$, $C_{R0} = 0$, $C_{S0} = 0$) enters two mixed flow reactors in series, ($\tau_1 = 2.5$ min, $\tau_2 = 5$ min). Knowing the composition in the first reactor ($C_{A1} = 0.4$, $C_{R1} = 0.4$, $C_{S1} = 0.2$), find the composition leaving the second reactor.

(b) What is the significance of moments of RTD? Explain any two with their equations. **07**

****