Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160506 Date:14-12-2022

Subject Name:Chemical Reactions Engineering I

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 rate constant. Derive the unit of rate constant.	**03**
	(b)	Discuss the variables affecting the rate of reaction.	**04**
	(c)	Derive performance equation for a CSTR.	**07**
Q.2	**(a)**	Define space time, space velocity& mean residence time.	**03**
	(b)	Discuss in detail about Integral method and Half life Method.	**04**
	(c)	Discuss the analysis of total pressure data obtained in a constant volume system and establish the relation used to calculate the partial pressure of gaseous component in reaction mixture.	**07**
		OR	
	(c)	Show that $$\ln \frac{M - X_A}{M\,(1 - X_A)} = C_{A0}\,(M-1)\,k\,t, M \pm 1$$ for second order irreversible bimolecular type reaction A + B ⟶ Products with different concentration of reactants A and B.	**07**
Q.3	**(a)**	State the points to be considered to find the size of reactor required for given duty and for a given temperature progression	**03**
	(b)	Discuss method of maximization of rectangles applied to find the optimum intermediate conversion and optimum sizes of two mixed flow reactors in series.	**04**
	(c)	An aqueous reactant stream with C_{AO}= 4 mol/lit passes through a mixed flow reactor followed by a plug flow reactor. The reaction is 2nd order with respect to A. The volume of plug flow reactor is 3 times that of the mixed flow reactor. Find the concentration of A at the exit of the plug flow reactor if the concentration of A in the mixed flow reactor is 1 mol/lit.	**07**
		OR	
Q.3	**(a)**	Discuss fractional yield, overall yield and selectivity for parallel reaction	**03**
	(b)	Discuss autocatalytic reaction with conversion-time and rate concentration Curves.	**04**
	(c)	When elementary 2nd order liquid reaction 2A ⟶ 2R carried in a plug flow reactor, operated isothermally, with a recycle ratio of unity, conversion is found to be 66.67%. Determine the conversion if the recycle stream is shut off.	**07**
Q.4	**(a)**	Discuss equal sized mixed flow reactors in series	**03**
	(b)	Explain Plug Flow Reactors in Series and in Parallel with	**04**

equation.

(c) Discuss in detailed about product distribution for parallel reaction. **07**

OR

Q.4 **(a)** Define zero order reaction with suitable example. **03**

(b) Define Overall Fractional yield and Instantaneous fractional yield for the decomposition of A into product R. **04**

(c) First order unimolecular irreversible reaction in series **07**
$A \longrightarrow R \longrightarrow S$ takes place with specific reaction rate k1 and k2. Express the variation of concentration of A, R and S with time. Find the expression for the time when formation of R becomes maximum.

Q.5 **(a)** Define Residence Time Distribution and explain E-Curve. **03**

(b) A closed vessel has flow for which dispersion number is 0.3. We wish to represent this vessel by tanks in series model. What value of number of tanks should be selected? **04**

(c) Write a short note on equilibrium constants from thermodynamics clearly indicating the equations. **07**

OR

Q.5 **(a)** List out characteristics of good tracer **03**

(b) From the first principle prove that for a back mix reactor **04**
(i) $E\theta = e^{-\theta}$ and (ii) $F\theta = 1 - e^{-\theta}$

(c) Find out relation between conversion and temperature **07**
(a) Between 0 ^{o}C and 100 ^{o}C determine the equilibrium conversion of A for the aqueous reaction

$$A \leftrightarrow B$$

$\Delta G^{o}_{298} = -3375$ cal/mol; $\Delta H^{o}_{r,298} = -18{,}000$ cal/mol
Plot a graph between conversion and temperature.
(b) What the restrictions should be placed on a reactor operating isothermally if we have to obtain fractional conversion of 75% or higher?

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