GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code:3160506   **Date:22-05-2025**
Subject Name: Chemical Reactions Engineering I
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.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define rate constant with its significance.	**03**
	(b)	Define rate of reaction considering unit volume, mass and surface of solid in fluid solid system.	**04**
	(c)	Derive performance equation for steady state plug flow reactor.	**07**
Q.2	**(a)**	Derive equation for a unimolecular type first order reaction for constant volume batch reactor using integral method.	**03**
	(b)	Give brief about shifting order reaction.	**04**
	(c)	Give detail classification of reactions with example.	**07**

OR

	(c)	For the decomposition A $\rightarrow$ R, C_{A0} = 1 mol/liter, in a batch reactor conversion is 75% after 1 hour, and is just complete after 2 hours. Find a rate equation to represent this kinetics.	**07**
Q.3	**(a)**	Write in brief about variables affecting rate of reactions.	**03**
	(b)	Discuss about various types of nonideality exists in different reactors.	**04**
	(c)	Derive the equation for half life using overall order of irreversible reaction.	**07**

OR

| **Q.3** | **(a)** | The concentration readings in Table represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel. | **03** |

Time, t min	0	5	10	15	20	25	30	35
Tracer output conc. C pulse, gm /liter	0	3	5	5	4	2	1	0

	(b)	Discuss autocatalytic reaction with conversion-time and rate-concentration Curves.	**04**
	(c)	Discuss optimum temperature progression in detail.	**07**
Q.4	**(a)**	Discuss parallel reactions with examples.	**03**
	(b)	Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15 sec for the same result. Find the activation energy of this sterilization process.	**04**
	(c)	Derive performance equation for steady state ideal batch reactor.	**07**

OR

| **Q.4** | **(a)** | Explain recycle ratio and the performance equation of recycle plug flow reactors. | **03** |
| | **(b)** | Show the graphical representation of energy balance equation for adiabatic operation. | **04** |

	(c)	Explain tracer experiment with equations for pulse response in non-ideal flow reactor with equations and curves.	**07**
Q.5	**(a)**	Define: Conversion, yield, space time.	**03**
	(b)	Explain differential method of analysis to find rate of reaction.	**04**
	(c)	Discuss qualitative product distribution for irreversible first order reaction in series.	**07**

OR

Q.5	**(a)**	Explain selectivity with its equation.	**03**
	(b)	Discuss about different size of mixed flow reactors in series.	**04**
	(c)	Differentiate between contacting patterns in continuous flow operations and noncontinuous operations for various combination of high and low concentration of reactants for maximizing the desired product.	**07**

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GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2024

Subject Code:3160506   **Date:17-05-2024**

Subject Name:Chemical Reactions Engineering I

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

Q.1	**(a)**	Answer the following questions.	**03**
		1) Why can molecularity never be more than three?	
		2) Why can the order of reaction be zero, but the molecularity of a reaction cannot be?	
	(b)	Define Elementary and Non-elementary reactions with suitable example.	**04**
	(c)	Discuss the variables affecting rate of homogeneous and heterogeneous reactions with suitable example.	**07**
Q.2	**(a)**	Discuss the conditions required for steady state approximation.	**03**
	(b)	Write a short note on 'Variable volume batch reactor'.	**04**
	(c)	List various theories of temperature dependency on rate of reaction and discuss any one in detail.	**07**

<div align="center">OR</div>

	(c)	Derive the equation for half-life using overall order of irreversible reaction.	**07**
Q.3	**(a)**	Define space time and space velocity.	**03**
	(b)	Discuss in detail about Integral method of analysis of batch reactor kinetic data.	**04**
	(c)	Phosphine decomposes when heated according to the following reaction : $4\,PH_{3\,(g)} \rightarrow P_{4\,(g)} + 6\,H_{2\,(g)}$. At a given instant, the rate at which phosphine decomposes is 2.4×10^{-3} mol/(l.s). (a) Express the rate in three different ways, using differential notation and show the relationship between them. (b) What is the rate of formation of (i) P_4 and (ii) H_2?	**07**

<div align="center">OR</div>

Q.3	**(a)**	Discuss autocatalytic reaction with conversion-time and rate-concentration curves.	**03**
	(b)	Write a short note on Recycle reactor.	**04**
	(c)	A certain reaction has a rate given by $$-r_A = 0.005\,C_A^2,\ (mol/cm^3.min)$$ If the concentration is expressed in mol/l and time in hours, what would be the value and units of rate constant?	**07**

Q.4 (a) Derive performance equation for a ideal batch reactor. **03**

(b) Prove that N number of plug flow reactor connected in series and its total volume V gives the same conversion as a single plug flow reactor of volume V. **04**

(c) At 500 K the rate of a bimolecular reaction is ten times the rate at 400 K. Find the activation energy for this reaction (a) from Arrhenius law, (b) from collision theory, (c) what is the percentage difference in rate of reaction at 600 K predicted by these two methods? **07**

OR

Q.4 (a) Explain-advantages, disadvantages and applications of batch reactors and continuous reactors. **03**

(b) Discuss equal sized mixed flow reactors in series. **04**

(c) The activation energy of a chemical reaction is 17982 cal/mol in the absence of a catalyst, and 11980 cal/mol with a catalyst. By how many times will the rate of the reaction will grow in the presence of a catalyst, if a reaction proceeds at 25°C? **07**

Q.5 (a) Discuss significance of RTD studies. **03**

(b) Discuss the non-ideal flow patterns which may exist in reactor. **04**

(c) In an isothermal batch reactor, the conversion of a liquid reactant A achieved in 13 min is 70%. Find the space time and space velocity necessary to effect this conversion in a plug flow reactor and in a mixed flow reactor. Consider first order kinetics. **07**

OR

Q.5 (a) Discuss earliness of mixing and lateness of mixing. **03**

(b) Write in brief about thermodynamic equilibrium constant. **04**

(c) Explain qualitative discussion about the product distribution for reaction in parallel. **07**

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GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3160506   **Date:06-07-2023**

Subject Name:Chemical Reactions Engineering I

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

			MARKS
Q.1	**(a)**	Describe the variables affecting the rate of reactions.	**03**
	(b)	Define moleculartiy, order of reaction and rate constant 'k'. State the general unit for rate constant 'k'.	**04**
	(c)	At 1100 K n-nonane thermally cracks (breaks down into smaller molecules) 20 times as rapidly as at 1000 K. Find the activation energy for this decomposition. molecules) 20 times as rapidly as at 1000 K. Find the activation energy for this decomposition.	**07**
Q.2	**(a)**	What do you mean by constant volume and variable volume system?	**03**
	(b)	Explain homogeneous and heterogeneous catalytic reaction with suitable example.	**04**
	(c)	Differentiate integral and differential method of analysis.	**07**
		OR	
	(c)	Explain with example autocatalytic reaction.	**07**
Q.3	**(a)**	What is multiple-reactor systems? Explain its importance.	**03**
	(b)	Derive the design equation for steady state plug flow reactor.	**04**
	(c)	In a homogeneous isothermal liquid polymerization, 20% of the monomer disappears in 34 minutes for initial monomer concentration of 0.04 and also for 0.8 mol/liter. What rate equation represents the disappearance of the monomer?	**07**
		OR	
Q.3	**(a)**	What is recycle reactor? Write its uses.	**03**
	(b)	Derive the design equation for steady state mixed flow reactor.	**04**
	(c)	The first-order reversible liquid phase reaction mentioned below takes place in a batch reactor. $$A \leftrightarrow R, \quad C_{A0} = 0.5 \ mol/lit, \quad C_{R0} = 0$$ After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction.	**07**
Q.4	**(a)**	What is yield, selectivity and product distribution?	**03**
	(b)	Derive the equation in terms of concentration and conversion for zero order reaction.	**04**
	(c)	An aqueous feed of A and B (400 liter/min, 100 mmol A/liter, 200 mmol, B/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by $$A + B \to R, \quad -r_A = 200C_A C_B \ mol/lit.min$$ Find the volume of reactor needed for 99.9% conversion of A to product.	**07**

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Q.4 **(a)** Discuss earliness and lateness of mixing in RTD.   **03**

(b) What are the various non-idealities that can exist in a reactor?   **04**

(c) Derive the design equation for recycle reactor.   **07**

Q.5 **(a)** What do you mean by optimum temperature progression?   **03**

(b) Describe in detail biochemical reactions.   **04**

(c) Derive the relation between conversion and temperature for adiabatic operation.   **07**

OR

Q.5 **(a)** Define half-life time and write the formula to calculate $t_{1/2}$.   **03**

(b) Describe the mechanism of non-elementary reaction.   **04**

(c) The concentration readings in table below represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor.   **07**

Time, (min)	0	5	10	15	20	25	30	35
Output Tracer Concentration, (mol/lit)	0	3	5	5	4	2	1	0

Calculate the mean residence time of fluid in the vessel $\bar{t}$ and tabulate and plot the exit age distribution E.

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GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2022

Subject Code:3160506   **Date:03/06/2022**
Subject Name:Chemical Reactions Engineering I
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.
4. Simple and non-programmable scientific calculators are allowed.

			Marks
Q.1	**(a)**	Explain elementary reaction with example.	**03**
	(b)	Give difference between molecularity and order of reaction.	**04**
	(c)	Discuss the temperature dependence term from Arrhenius Law.	**07**
Q.2	**(a)**	What is activation energy? Explain the importance of activation energy in chemical reaction.	**03**
	(b)	Develop an expression that facilitates calculation of units of rate constant for any order. Give the unit of rate constant for first, second and third order reaction.	**04**
	(c)	Show that the time required for 99% conversion is double the time required for 90% conversion for first order irreversible, unimolecular reaction.	**07**

OR

	(c)	The first order reversible liquid reaction A↔R, C_{AO} = 0.5 mol/liter, C_{RO} = 0 ,takes place in a batch reactor. After 9 minutes, conversion of A is 30% while equilibrium conversion is 70%. Devise the rate equation for this reaction.	**07**
Q.3	**(a)**	What is bio-chemical reaction? Explain with example.	**03**
	(b)	Explain the procedure to determine the best system for a given conversion when two CSTR of different sizes are connected in series.	**04**
	(c)	Define and write about the advantages and disadvantages of Ideal batch reactor and also give industrial application of the same	**07**

OR

Q.3	**(a)**	Explain autocatalytic reaction with example.	**03**
	(b)	Discuss the stepwise procedure for differential method of analysis	**04**
	(c)	Define and write about the advantages and disadvantages of Ideal plug flow reactor and also give industrial application of the same	**07**
Q.4	**(a)**	Give detail classification of chemical reaction.	**03**
	(b)	Discuss the working of PFR in series and parallel connection.	**04**
	(c)	The rate equation of a chemical reaction is given as $-r_A = C_A^n$. On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order.	**07**

OR

Q.4	(a)	Discuss the working of equal size CSTR in series.	03
	(b)	Give criteria for best arrangement of a set of ideal reactors.	04
	(c)	Derive equation for complete conversion for adiabatic operation.	07

Q.5	(a)	Sketch and explain RTD curves for Ideal Plug Flow Reactor and Ideal Mixed flow Reactor.	03
	(b)	Discuss the non-ideal flow patterns which may exist in Reactor and reactor deviates from ideal flow reactor.	04
	(c)	Derive the performance equation of Recycle reactor.	07

OR

Q.5	(a)	What is equilibrium conversion? Discuss	03
	(b)	What is effect of temperature and pressure on equilibrium conversion from thermodynamics?	04
	(c)	Dispersed non coalescing droplets [Cao = 2 mol/liter] react as per the reaction A→R with rate equation $-r_A = k\,C_A^2$, k=0.5 lit/(mol.min) as they pass through the contactor. Find the average concentration of A remaining in the droplets leaving the contactor. (Use E=0.50 for 1<t<3)	07

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