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. 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?	**03**
	(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**

OR

	(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**

OR

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 **04** volume V gives the same conversion as a single plug flow reactor of volume V.

(c) At 500 K the rate of a bimolecular reaction is ten times the rate at 400 K. **07** 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?

OR

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

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

(c) The activation energy of a chemical reaction is 17982 cal/mol in the **07** 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?

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 **07** 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.

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 **07** parallel.

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