Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2023

Subject Code:3160506 Date:05-12-2023

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**

Q.1	**A**	1) Justify- Molecularity of reaction can never be more than three. 2) Why can the order of reaction be zero, but the molecularity of a reaction cannot be? 3) Define an intermediate. What are the different types of intermediates that are suggested by the chemistry of the materials?	**3**
	B	Discuss merits and demerits of batch and continuous modes of reactor operation.	**4**
	C	A human being (75 kg) consumes about 6000 kJ of food per day. Assume that the food is all glucose and that the overall reaction is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$, $-\Delta Hr = 2816$ kJ Find man's metabolic rate (the rate of living, loving, and laughing) in terms of moles of oxygen used per m^3 of person per second. (Assume density of man = 1000 kg/m^3)	**7**
Q.2	**A**	The activation energy of a bimolecular reaction is about 9150 cal/mol. How much faster does this reaction take place at 500 K than at 400 K?	**3**
	B	Write a short note on temperature dependency of reaction rate constant from Arrhenius law. Compare the same with transition state and collision theories.	**4**
	C	The reaction between nitric oxide and oxygen given below $2NO + O_2 \rightarrow 2NO_2$ follows the rate law $-\frac{d[O_2]}{dt} = k[NO]^2[O_2]$ Suggest a reaction mechanism which is consistent with this rate law. OR Explain theory – Analysis of total pressure data obtained in constant-volume system.	**7**

Q.3	**A**	On doubling the concentration of the reactants, the rate of reaction increase four times. Find the order of reaction.	**3**
	B	It is stated that the half-life method for finding reaction order can be used to any fractional-life data. Do this, defining $t_{1/m}$ as the time required for the concentration of the reactant to drop to $1/m^{th}$ of its original/initial value.	**4**
	C	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.	**7**
		OR	
Q.3	**A**	Differentiate between Integral and Differential method of analysis for analysing batch reactor data.	**3**
	B	Define: Space time, Space velocity, Holding time, Mean residence time.	**4**
	C	Derive performance equation for steady-state mixed flow reactor and discuss fractional conversion in terms of Damkohler number.	**7**
Q.4	**A**	Define an equilibrium state and discuss characteristics of chemical equilibrium.	**3**
	B	What is the use of tracer? Discuss desired characteristics of tracer.	**4**
	C	Discuss the effect of pressure on equilibrium conversion as predicted by thermodynamics keeping temperature fixed.	**7**
		OR	
Q.4	**A**	Discuss effect of temperature on heat of reaction.	**3**
	B	Sketch and explain RTD curves for Ideal Plug Flow Reactor and Ideal Mixed flow Reactor.	**4**
	C	Discuss the effect of temperature on equilibrium conversion as predicted by thermodynamics keeping pressure constant.	**7**
Q.5	**A**	Classify chemical reactions on the basis of (a) number of phases involved and (b) heat or reaction with suitable example.	**3**
	B	Which are various non-idealities that can exist in a reactor? Also suggest solution to remove such non-idealities from the reactor.	**4**
	C	Write a short note on Qualitative product distribution for reactions in parallel.	**7**
		OR	
Q.5	**A**	Explain the method for searching the mechanism of chemical reaction.	**3**
	B	Explain equal sized mixed flow reactors connected in series.	**4**
	C	Derive the performance equation of recycle reactor and discuss its graphical representation for constant and variable density.	**7**

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