

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-VII • EXAMINATION – SUMMER • 2014

Subject Code: 170501**Date: 22-05-2014****Subject Name: Chemical Reaction Engineering - I****Time: 02:30 pm - 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. All notations have conventional meaning.

- Q.1** (a) Classify chemical reactions and discuss the variables affecting the rate of reaction. **07**
- (b) Define reaction rate. Explain molecularity and order of reaction giving typical example. **07**

- Q.2** (a) Compare Arrhenius law with Collision Theory and Transition-state theory. **07**
- (b) Experiments show that the homogeneous decomposition of ozone proceeds with a rate,

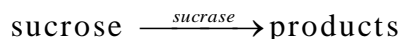
$$-r_{O_3} = k [O_3]^2 [O_2]^{-1}$$
 (i) What is overall order of reaction?
 (ii) Suggest a two-step mechanism to explain this rate and how that mechanism will be verified? **07**

OR

- (b) At 500 K the rate of a bimolecular reaction is ten times the rate at 400 K. Find the activation energy of this reaction using Arrhenius law and Collision theory. **07**
- Q.3** (a) Derive the integrated rate expression for First order and Second order ($2A \rightarrow \text{products}$) irreversible reactions. **07**
- (b) Derive the integrated rate expression for First order reversible reactions. **07**

OR

- Q.3** At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows: **14**



Starting with a sucrose concentration $C_{A0} = 1.0$ millimol/liter and an enzyme concentration $C_{E0} = 0.01$ millimol/liter, the following kinetic data are obtained in a batch reactor: (C_A is in millimol/liter and t is in hr)

C_A	0.84	0.68	0.53	0.38	0.27	0.16	.09	.04	.018	.006
t	1	2	3	4	5	6	7	8	9	10

Determine whether these data can be reasonably fitted by a kinetic equation of the Michaelis-Menten type, or

$$-r_A = \frac{k_3 C_A C_{E0}}{C_A + M}$$

where M = Michaelis constant. Calculate the value of constant using integral method of analysis.

Q.4 (a) Derive the performance equation for steady-state mixed flow reactor. **07**

(b) Derive the performance equation for ideal batch reactor. **07**

OR

Q.4 (a) A homogeneous liquid phase reaction $A \rightarrow R$, $-r_A = KC_A^2$ takes place with 50% conversion in a mixed reactor. **07**

(i) What will be the conversion if this reactor is replaced by one 6 times as large, all else remaining unchanged?

(ii) What will be the conversion if the original reactor is replaced by a plug flow reactor of equal size, all else remaining unchanged?

(b) Assuming a stoichiometry $A \rightarrow R$ for a first order gas phase reaction, the size of a plug flow reactor for 99% conversion of pure A is calculated to be 32 liters. In fact, however the reaction stoichiometry is $A \rightarrow 3R$. With this corrected stoichiometry, what is the required volume of a reactor? **07**

Q.5 (a) Write short note on Autocatalytic reactions. **07**

(b) Describe quantitative discussion about product distribution for reactions in parallel. **07**

OR

Q.5 The homogeneous gas reaction $A \rightarrow 2B$ is run at 100°C at a constant pressure of 1 atm in an experimental batch reactor. The data in table were obtained starting with pure A. What size of plug flow reactor operated at 100°C and 10 atm would yield 90% conversion of A for a total feed rate of 10 mol/sec, the feed consisting of 40% inerts? **14**

Time, min	V/V_0	Time, min	V/V_0
0	1.00	8	1.82
1	1.20	9	1.86
2	1.35	10	1.88
3	1.48	11	1.91
4	1.58	12	1.92
5	1.66	13	1.94
6	1.72	14	1.95
7	1.78		
