Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – WINTER • 2014

Subject Code: 170501 **Date: 25-11-2014**

Subject Name: Chemical Reaction Engineering - I

Time: 10:30 am - 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.**

Q.1 **(a)** Define elementary and non- elementary reactions, molecularity and order of reaction. Discuss in brief temperature dependency according to Arrhenius theory. **07**

(b) Compare Integral method of analysis and Differential method of analysis for finding order and reaction rate and derive equation for irreversible unimolecular-type first order reaction used in Integral method of analysis. **07**

Q.2 **(a)** Derive the expression for homogenous catalyzed reactions and explain its graph in detail **07**

(b) Derive the expression in terms of concentration for irreversible reactions in parallel for A decomposing by two competing paths, both elementary reactions: **07**

$$A \xrightarrow{k1} R$$

$$A \xrightarrow{k2} S$$

OR

(b) Derive the equation in terms of concentration for Irreversible reactions in series for unimolecular type first-order reaction such as **07**

$$A \xrightarrow{k1} R \xrightarrow{k2} S$$

Q.3 **(a)** Define space time and space velocity. Derive the performance expression for ideal steady state plug flow reactor. **07**

(b) Explain the theory of equal sized mixed flow reactors connected in series with diagram and derive the equation for N equal sized mixed flow reactors in series where $N \rightarrow \infty$ **07**

OR

Q.3 **(a)** Discuss the method of maximization of rectangles applied to find the optimum intermediate conversion and optimum sizes of two mixed reactors in series **07**

(b) Explain Autocatalytic reaction with diagram and derive an expression for the same **07**

Q.4 **(a)** Explain recycle ratio and derive the performance equation of recycle plug flow reactors **07**

(b) The primary reaction occurring in the homogeneous decomposition of nitrous oxide is found to be, **07**

$N_2O \rightarrow N_2 + ½ O_2$ with rate $-r_{N2O} = k_1 [N_2O]^2 / (1+k_2[N_2O])$. Derive a mechanism to explain this observed rate.

OR

Q.4 **(a)** Discuss the quantitative treatment for product distribution and reactor size for reactions in parallel such as **07**

$$A \xrightarrow{k1} R$$

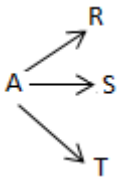
$$A \xrightarrow{k2} S$$

Where R is the desired and S is the unwanted product in case of both mixed flow and plug flow reactors.

(b) The first order reversible liquid reaction A=R, C_{A0} = 0.5 mol/lit, C_{R0} = 0 takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction. **07**

Q.5 **(a)** Discuss the effect of temperature on equilibrium conversion as predicted by thermodynamics keeping pressure fixed and discuss optimum temperature progression. **07**

(b) For the parallel decomposition of A where R is desired and C_{A0} = 1 **07**



What is the maximum C_R, we may expect in an isothermal operation in Batch reactor where the value of $r_R = 1$, $r_S = 2C_A$, $r_T = C_A^2$

OR

Q.5 **(a)** Discuss the effect of pressure and inerts on equilibrium conversion as predicted by thermodynamics keeping temperature fixed and discuss the method to find the size of reactor required for a given duty and for a given temperature progression **07**

(b) The elementary reaction A + B $\rightarrow$ R+ S is affected in a set up consisting of mixed reactor into which the two reactant solutions are introduced followed by a PFR. A large enough excess of B is used. Various ways of decreasing the production have been suggested one of which is to reverse the order of the two units. How would this change affect the conversion? **07**

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