Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. Sem. - V - Examination – June- 2011

Subject code: 150403

Subject Name: Chemical Reaction Engineering

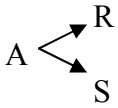
Date:24/06/2011 **Time: 10:30 am – 01:00 pm**

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)** Reactant A in a liquid produces R and S by the following reactions: **07**



Both these reactions are first order.

A feed with C_{A0} = 1, C_{R0} = 0 enters in two mixed flow reactors in series (Residence Time T_1 = 2min; T_2 = 5min). The composition in the first reactor is C_{A1} = 0.40, C_{R1} = 0.40 and C_{S1} = 0.2. Find the composition leaving the second reactor.

(b) Define Recycle ratio R and derive the equation for optimum recycle ratio. Discuss with figure about the correct recycle ratio **07**

Q.2 **(a)** Explain how to find the minimum size of two mixed reactors in series to achieve a specified conversion of the feed. Discuss the theory of maximization of rectangles. **07**

(b) A first order reaction is to be carried out in a series of two mixed reactors. Show that the total volume of the two reactors is minimum when the reactors are of equal size. **07**

OR

(b) At present conversion is 66.67% for the elementary second order liquid reaction 2A⟶2R when operating in an isothermal plug flow reactor with a recycle ratio of unity. Determine the conversion if the recycle stream is shut off. **07**

Q.3 **(a)** Derive the performance equation for the steady state plug flow reactor and steady state mixed flow reactor. **07**

(b) A gaseous feed with C_{A0}=100, C_{B0} = 200 and C_{i0}= 100 enters a steady-flow reactor in which the isothermal gas phase reaction A + 3B⟶ 6R takes place. Determine C_B, X_B, and XA at the exit of the reactor if C_A at exit is 40. **07**

OR

Q.3 **(a)** Explain the theory of irreversible reactions in parallel for A decomposing by two competing paths in to product R and S, both elementary reactions: Derive the equation in terms of C_R and C_S **07**

(b) In a homogeneous isothermal liquid polymerization, 20% of the monomer is disappeared in 34 min for initial monomer concentration of 0.04 and also for 0.8mol/l. Find a rate equation to represent disappearance of the monomer? **07**

Q.4 **(a)** Consider a bimolecular –type second-order reaction A+B⟶ Products and derive the equation in terms of conversion X_B and X_A. What would be the order of reaction if the initial concentration C_{B0} is larger than C_{A0}? **07**

(b) The elementary liquid phase reaction A+B⟶ R+S is conducted in a setup consisting of a mixed reactor into which two reactant solutions are introduced followed by a plug flow reactor. The component B is used in a large excess so that the reaction is first order with respect to A. Various ways to increase the production are suggested, one of which is to reverse the order of these units. How would this change affect conversion? **07**

OR

Q.4 **(a)** Discuss Molecularity and order of reaction. Define Elementary and Non Elementary reactions with an example. Mention the general formulae for the unit of rate constant K. **07**

(b) Liquid A decomposes by first order kinetics, and in a batch reactor 50% of A is converted in 5 minutes. How long it will take to reach 75% conversion? **07**

Q.5 **(a)** The irreversible reaction $2A + B = A_2B$ has been studied kinetically, and the rate of formation of product has been found to be well correlated by the following rate equation: $r_{A2B} = 0.72\ C_A^2 C_B / (1+2C_A)$. What reaction mechanism is suggested by this rate expression if the chemistry of the reaction suggests that the intermediate consists of an association of reactant molecules and that a chain reaction does not occur? **07**

(b) Show how the rate equation depends on temperature according to Thermodynamics and Arrehius Law. **07**

OR

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

(b) Discuss homogenous catalyzed reactions and derive the equation for the same. Define Autocatalytic reactions. **07**