Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2018

Subject Code: 2173612 **Date: 03/12/2018**

Subject Name: Fundamentals of Reaction Engineering

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.**

			MARKS
Q.1	**(a)**	Differentiate elementary and non-elementary reactions.	**03**
	(b)	Write a short note on various reaction intermediates used to elucidate kinetics of non – elementary reactions.	**04**
	(c)	Compare theories available for predicting the temperature dependency of reaction rate.	**07**
Q.2	**(a)**	On doubling concentration of reactant rate of reaction triples. Find the order of reaction.	**03**
	(b)	Derive integrated form of rate expression for n^{th} order reaction	**04**
	(c)	An aqueous solution of ethyl acetate is to be saponifed with sodium hydroxide. The initial concentration of ethyl acetate is 5g/l and that of caustic is 0.1N. The values of second order reaction rate constant at 0 °C and 20 °C are k = 0.235 and 0.924 (l/mol min) respectively. The reaction is reversible. Calculate the time required to saponify 95% ester at 40 °C.	**07**
		OR	
	(c)	For the reaction A → R → S estimate the maximum concentration of R and time at which maximum concentration of R occurs.	**07**
Q.3	**(a)**	Write on (i) Space time (ii) Space velocity (iii) Residence time	**03**
	(b)	For a gaseous feed of C_{A0} = 100 C_{B0} = 200 enters an isothermal flow reactor. For X_A = 0.8. Find C_A,C_B and X_B	**04**
	(c)	Describe differential and integral method of analysis of rate data.	**07**
		OR	
Q.3	**(a)**	Explain correlation between fractional conversion and Damkohler number for a first order gas phase reaction of constant volume.	**03**
	(b)	Write a short note on batch reactor systems used in process industries with advantages and disadvantages.	**04**
	(c)	A parallel liquid phase reaction A → R (k_1); A → S (k_2) has rate constants k_1 = 5 hr^{-1} and k_2 = 0.8 hr^{-1}. Find the moles of R produced in 15 min. Take C_{A0} = 8.5 mol/l. C_{R0} = C_{S0} = 0	**07**
Q.4	**(a)**	Explain (i) standard heat of formation (ii) standard heat of combustion (iii) standard heat of reaction	**03**
	(b)	Establish concentration levels that needs to be maintained for a bi-molecular reaction inorder to maximize formation of desired product.	**04**
	(c)	Prove that for reaction of first order occurring in a system of N CSTR's connected in series the behavior of overall system matches that of PFR.	**07**
		OR	
Q.4	**(a)**	Differentiate overall fractional yield and selectivity.	**03**
	(b)	The standard heat of a gas phase reaction at 25 °C A + B → 2R is ΔH_R^0 = $\Delta H_{R\ (25°C)}$ = - 50000 J indicating that reaction is strongly exothermic. It is desired to run this reaction at 1000 °C. What is the nature and value of heat of reaction at that temperature?	**04**

Data: The mean/average C_p values between 25 °C and 1000 °C for various reaction components are

$\bar{C}_{pA}$ = 35 J/mol K $\bar{C}_{pB}$ = 45 J/mol K $\bar{C}_{pR}$ = 70 J/mol K

(c) An aqueous reactant stream (4 mol A/l) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at exit of plug flow reactor if in mixed flow rector the concentration is 1 mol/l. The reaction is second order with respect to A and volume of plug flow reactor is three times volume of mixed flow reactor. **07**

Q.5 **(a)** Write a short note on catalyst deactivation **03**

(b) Discuss essential properties required for a catalyst. **04**

(c) For decomposition of cumene to benzene synthesize a rate law considering surface reaction as rate determining step. **07**

OR

Q.5 **(a)** N_2O_4 decomposes according to relation **03**

$N_2O_{4\,(g)} \rightleftharpoons NO_{2\,(g)}$

At 27 °C and 1 atm, 20% of N_2O_4 is dissociated. Calculate equilibrium constant K_P. (Take basis as 1 mol of N_2O_4 gas)

(b) Differentiate modifiers and inhibitors. **04**

(c) Mention the seven steps governing the rate of conversion of reactant to product in a catalytic reaction. **07**

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