Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI (New) EXAMINATION – WINTER 2019

Subject Code: 2160506 **Date: 13/12/2019**

Subject Name: Chemical Reaction 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.**

			MARKS
Q.1	**(a)**	Discuss variables affecting the rate of reaction.	**03**
	(b)	A rocket engine burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen). The combustion chamber is cylindrical, 75 cm long and 60 cm in diameter, and the combustion process produces 108 kg/s of exhaust gases. If combustion is complete, find the rate of reaction of hydrogen and of oxygen. $H_2 + ½\ O_2 \longrightarrow H_2O$	**04**
	(c)	For a uni-molecular irreversible first order reaction in series A → R → S; Derive an expression for concentration of reactant A, intermediate product R and final product S as a function of time. Find the expression in terms of time when formation of R becomes maximum.	**07**
Q.2	**(a)**	Differentiate molecularity and order of reaction.	**03**
	(b)	Give examples for catalytic homogeneous and heterogeneous reaction.	**04**
	(c)	A homogeneous gas reaction A ⟶ 3R has a reported rate at 215^{O}C $-r_A = 10^{-2}C_A^{1/2}$, [mol/liter sec] Find the space-time needed for 80% conversion of a 50% A, 50% inert feed to a plug flow reactor operating at 215^{O}C and 5 atm (C_{Ao} = 0.0625 mol/liter).	**07**
		OR	
	(c)	What is an autocatalytic reaction? For an autocatalytic reaction A + R → R + R show that $$\ln\left[\frac{(M+XA)}{M\ (1-XA)}\right] = CA0\ (M+1)kt$$	**07**
Q.3	**(a)**	Consider a feed C_{Ao} = 100, C_{BO} = 200, C_{io} = 100 to a steady-flow reactor. The isothermal gas-phase reaction is A + 3B ⟶ 6R If C_A = 40 at the reactor exit, what is C_B, X_A, and X_B there?	**03**
	(b)	Write in brief about Shifting order reaction.	**04**
	(c)	Reactant **A** decomposes in a batch reactor. A ⟶ Product The composition of A in the reactor is measured at various times. Find a rate equation to represent the data using integral method of analysis.	**07**

Time, t sec	0	20	40	60	120	180	300
Conc. C_A mol/ litre	11	9	7.2	6.5	4.3	3	2

OR

Q.3	**(a)**	Give examples for series, parallel and autocatalytic reactions.	**03**
	(b)	Explain Space time and space velocity in detail.	**04**
	(c)	Derive general equation showing the time required to achieve a conversion X_A for either isothermal or non-isothermal operation for ideal batch reactor with graphical representation.	**07**
Q.4	**(a)**	Define fractional yield and selectivity in detail.	**03**
	(b)	Explain Plug Flow Reactors in Series and in Parallel with equation.	**04**
	(c)	Discuss in detailed about product distribution for parallel reaction.	**07**

OR

Q.4	**(a)**	Liquid A decomposes by first-order kinetics, and in a batch reactor 50% of A is converted in a 5-minute run. How much longer would it take to reach 75% conversion?	**03**
	(b)	Discuss method of maximization of rectangles applied to find the optimum intermediate conversion and optimum sizes of two mixed flow reactors in series.	**04**
	(c)	Give detail classification of reactions.	**07**
Q.5	**(a)**	Give criteria for best Arrangement of a Set of Ideal Reactors.	**03**
	(b)	Give comparison for mixed Vs. plug flow reactor.	**04**
	(c)	Derive equation for complete conversion for adiabatic operation.	**07**

OR

Q.5	**(a)**	Write in brief about thermodynamic equilibrium constant.	**03**
	(b)	Write physical significance of activation energy. Also discuss temperature dependency of activation energy using Arrhenius theory.	**04**
	(c)	Derive performance equation for Recycle reactor.	**07**

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