Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(New) EXAMINATION – SUMMER 2016

Subject Code:2141306 **Date:26/05/2016**

Subject Name:Elements of Chemical Engg

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		**Short Questions**	
	(1)	Write the unit of rate constant for first order reaction.	**01**
	(2)	Write the unit of rate constant for n^{th} order reaction.	**01**
		Write TRUE or FALSE for following	
	(3)	For Elementary reactions, molecularity of reaction is equal to order of reaction.	**01**
	(4)	Parallel and series reactions does not have rate expressions.	**01**
	(5)	The higher the value of activation energy, the sensitivity of reaction to temperature is higher.	**01**
	(6)	If time (t) is replaced with space time (τ), the batch reactor performance equation will become plug flow reactor performance equation.	**01**
	(7)	The rate of disappearance of product is positive quantity.	**01**
	(8)	Higher the rate of reaction at given temperature, reactor volume required to achieve a specified conversion of reactant will be lower.	**01**
	(9)	The real reactor performance, i.e. conversion achieved, will be always in between the CSTR and PFR performance.	**01**
	(10)	For first order liquid phase reaction, CSTR always offers higher conversion than PFR.	**01**
	(11)	Time required in batch reactor for second order reaction shall be higher than time required for first order reaction for complete conversion.	**01**
	(12)	Batch reactor performance equation does not have input/output term.	**01**
	(13)	Exit age do not give any information about expected conversion of reactant for first-order reaction.	**01**
	(14)	Mean residence time is different than space time for ideal plug flow reactor.	**01**
Q.2	**(a)**	Differentiate between elementary and non-elementary reaction.	**03**
	(b)	Discuss "molecularity of reaction" and "order of reaction" with respect to elementary and non-elementary reaction.	**04**
	(c)	Define the rate of reaction based on unit volume of fluid, r_i, rate of reaction based on unit mass of solid, r_i', rate of reaction based on	**07**

unit surface of solid, r_i'', rate of reaction based on unit volume of solid, r_i''', rate of reaction based on unit volume of reactor, r_i''''. Give the interrelationship of all the above rate definitions.

OR

(c) Consider a municipal water treatment plant for a small community. Waste water, 32000 m^3/day, flows through the treatment plant with a mean residence time of 8 hr, air is bubbled through the tanks, and microbes in the tank attack and break down the organic material microbes as, **07**

$$\text{(organic waste)} + O_2 \rightarrow CO_2 + H_2O$$

A typical entering feed has a BOD (biological oxygen demand) of 200 mg O_2/liter, while the effluent has a zero BOD. Find the rate of reaction in
(mole of oxygen required/m^3 of tank-sec).
Take molecular weight of oxygen 32 gm/mol.

Q.3 (a) Write the classification of chemical reactions? **03**

(b) Differentiate between performance equations for constant volume batch reactor and varying volume batch reactor. **04**

(c) Milk is pasteurized if it is heated to 63^0C for 30 min, but if it is heated to 74^0C it only needs 15 sec for the same result. Find the activation energy of this sterilization process in J/mol. **07**

OR

Q.3 (a) Enlist the factors affecting the rate of reaction with example. **03**

(b) A certain reaction has a rate given by, **04**

$$-r_A = 0.005C_A^2 \qquad mol/(cm^3 - \text{min})$$

If the concentration is to be expressed in $mol/liter$ and time in hours, what would be the value and units of the rate constant?

(c) Using integral method of analysis of data, derive the following, **07**

$$-\ln(1 - X_A) = kt$$

for irreversible unimolecular-type first-order reactions in batch reactor. Where, X_A is fractional conversion, and k is rate constant, and t is time.

Q.4 (a) Derive the performance equation of ideal batch reactor. **03**

(b) Describe half-life method for finding the order of reaction. **04**

(c) After 8 minutes in a batch reactor, reactant (C_{AO} = 1 mol/liter) is 80% converted; after 18 minutes, conversion is 90%. Find a rate equation to represent this reaction. Determine whether the reaction is zeroth order or first order. **07**

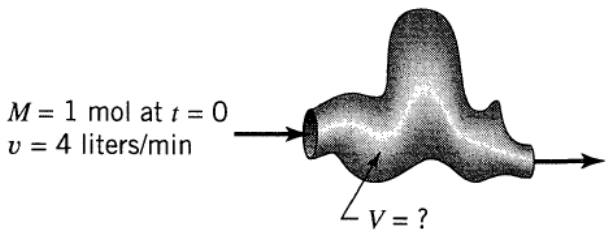
OR

Q.4 (a) Define Space-Time and Space-Velocity for flow reactors. **03**

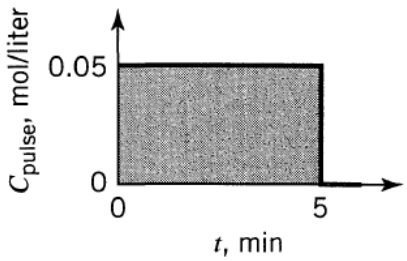
(b) Liquid A decomposes by first-order kinetics, and in a batch reactor 50% of A is converted in a 5-minute run. How much longer would it take to reach 75% conversion? **04**

(c) Derive the performance equation of ideal plug flow reactor. **07**
Write the expression of performance equation when $-r_A = kC_A$

Q.5 (a) A pulse input to a vessel as shown below, **03**



Gives the results as follows,



Check the material balance with the tracer curve to see whether the results are consistent.

(b) Explain the procedure to convert E curve to F curve obtained from Impulse Input. **04**

(c) In an isothermal batch reactor with first order reaction 70% of a liquid reactant is converted in 13 min. What space-time and space-velocity are needed to effect this conversion in a plug flow reactor and in a mixed flow reactor? **07**

OR

Q.5 (a) Describe step and impulse input test for determining exit age distribution in non-ideal chemical reactors. **03**

(b) Explain the procedure to convert F curve to E curve obtained from Step Input. **04**

(c) Liquid A decomposes by first-order kinetics, and in a CSTR, 50% of A is converted with 5-minute space-time. How much space-time would it take to reach 75% conversion? **07**

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