

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- Vth SEMESTER-EXAMINATION – MAY/JUNE - 2012****Subject code: 150403****Date: 04/06/2012****Subject Name: Chemical Reaction Engineering****Time: 02:30 pm – 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.

Q.1 (a) What are the different types of ideal reactors? Derive the performance equation of steady state mixed flow reactor. **07**

(b) Consider a feed $C_{A0}=100$, $C_{B0}=200$, $C_{i0}=100$ to a steady flow reactor. The isothermal gas phase reaction is $A+3B \rightarrow 6R$. If $C_A=40$ at the reactor exit what is C_B , X_A , and X_B there? Notations have their conventional meanings. **07**

Q.2 (a) Explain the Arrhenius theory of temperature dependency. How activation energy affects temperature sensitivity of reaction. **07**

(b) The decomposition of sulfuric chloride to sulfur dioxide and chlorine is carried out in closed vessel (Batch reactor) for 60 minutes at 610 °F. Calculate the time required to decompose 95% of sulfuric chloride, when the reaction proceeds according to first order reaction and the reverse reaction is negligible. The specific reaction rate constant at 610 °F is 0.00132 per minute. **07**

OR

(b) What do you understand by instantaneous fractional yield and overall fraction yield of a product? Give different contacting patterns for different concentration of reactant. **07**

Q.3 (a) How mixing of different composition of fluid is the key to the formation of intermediate for irreversible reactions in series? Discuss in detail the qualitative product distribution for series reaction. **07**

(b) Enzyme E catalyses the fermentation of substance A (the reactant) to product R. Find the size of mixed flow reactor needed for 95% conversion of reactant in a feed stream (25 liter/min) of reactant (2 mol/liter) and enzyme. The kinetics of the fermentation at this enzyme concentration are given by
 $A \rightarrow R$, $(-r_A)=0.1C_A/(1+0.5C_A)$ mol/lit min. **07**

OR

Q.3 (a) How will you compare the performance of single batch reactor with the flow reactor and mixed versus plug flow reactor for a first order reaction? **07**

(b) A first order irreversible reaction $A \rightarrow B$ is carried out in mixed flow reactor followed by an equal size plug flow reactor in series. The concentration A in the feed is 1 kg mole/m³ and the residence time in each reactor is 3600 sec. The specific reaction rate constant for the reaction is 1/3600 sec⁻¹. Find the conversion of A at the exit of the system. **07**

Q.4 (a) An irreversible bimolecular type reaction $A+B \rightarrow P$ is taking place in a constant volume batch reactor. Derive an expression for estimating conversion at any time 't'. **07**

(b) At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrase as, $\text{Sucrose} \rightarrow \text{Product}$, Starting with a sucrose concentration $C_{A0}=1.0$ milimole/liter and an enzyme concentration $C_{E0}=0.01$ milimole/liter, the following kinetics data are obtain in batch reactor. **07**

C_A , mmole/lit	0.84	0.68	0.53	0.38	0.27	0.04	0.006	0.0025
t, hr	1	2	3	4	5	8	10	11

Determine whether these data can be reasonably fitted by a kinetic equation

$$(-r_A) = (k_3 C_A C_{E0}) / (C_A + C_M), \text{ Where } C_M = \text{constant.}$$

If the fit is reasonable, evaluate k_3 and C_M by using integral method of analysis

OR

Q.4 (a) Define autocatalytic reactions. Derive an expression to find its kinetics. Explain plots of rate of reaction Vs. time and concentration Vs. time. **07**

(b) The gas phase decomposition of dimethyl ether takes place as reaction $(CH_3)_2O \rightarrow CH_4 + CO + H_2$ **07**
The following data are recorded in an isothermal constant volume reactor. Find the rate expression for the data given below,

t, sec	0	57	85	114	142	182	219	299
Pressur, mmHg	420	584	662	743	815	891	954	1054

Q.5 (a) 1) Explain differential method of analysis to find kinetics of any reaction of n^{th} order. **03**

2) Derive an expression to find kinetics of 1^{st} order reaction taking place in a variable volume batch reactor. **04**

(b) Explain the significance of space time and space velocity. Derive the performance equation of the plug flow reactor. **07**

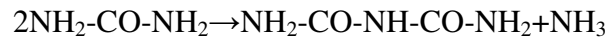
OR

Q.5 (a) Derive the $C_{R\text{max}}$ and $t_{R\text{max}}$ for the reaction first order followed by zero-order reaction for $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ **07**

(b) 1) In a homogeneous isothermal liquid polymerization 20% of the monomer disappears in 34 minute for initial monomer concentration of 0.04 and also for 0.8 mol/lit. What is rate expression for this polymerization reaction? **03**

2) When a concentrated urea solution is stored, it slowly decomposes to **04**

biuret by the following elementary reaction.



To study the rate of condensation a sample of urea ($C=20$ mol/liter) is stored at 100°C and after 7 hr 40 min we find that 1 mol% has turned into biuret. Find the rate equation for this condensation reaction.
