Seat No.: _____  Enrolment No. 

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2018**

**Subject Code:2160506** **Date:07/12/2018**

**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.**

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|---|---|---|---|
| **Q.1** | **(a)** | Classify reactions giving example of each | **03** |
| | **(b)** | Differentiate elementary and non elementary reactions. | **04** |
| | **(c)** | List various theories of temperature dependency on rate of reaction and discuss any one in detail. | **07** |
| **Q.2** | **(a)** | Write a short note on 'Variable volume batch reactor' | **03** |
| | **(b)** | The rate constant k at 27°C is $1.3\times10^{-3}sec^{-1}$ and its frequency factor is $2.785*10^{-6}$ $sec^{-1}$. Determine its Entropy of activation and Enthalpy of activation. | **04** |
| | **(c)** | Derive integrated rate expression for a liquid phase reaction<br>$2A \rightarrow$ Products.<br>**OR** | **07** |
| | **(c)** | At certain temperature, the half-life period and initial concentration for a reaction are,<br>$t_{1/2}$ = 420 sec; $C_{A0}$ = 0.405 mole/lit<br>$t_{1/2}$ = 275 sec; $C_{A0}$ = 0.640 mole/lit<br>Calculate the order of reaction and rate constant of the reaction. | **07** |
| **Q.3** | **(a)** | Define space time and space velocity. | **03** |
| | **(b)** | Derive performance equation for a ideal batch reactor | **04** |
| | **(c)** | The reaction $A \rightarrow B$, $r = k C_{A0}^2$, occurs in CSTR with 90% Conversion, if k= 0.5 liter/mole min, $C_{A0}$ = 2 mole/liter and ν = 4 liter/ min, what residence time and reactor volume will be required?<br>**OR** | **07** |
| **Q.3** | **(a)** | Explain the method for searching the mechanism of chemical reaction. | **03** |
| | **(b)** | Compare and contrast Integral method of analysis with differential method of analysis of kinetic data. | **04** |
| | **(c)** | In a batch reactor, assuming first order kinetics, the conversion of a liquid reactant A is 70% in 13 min. Find the space time required to effect this conversion in a plug flow reactor and a mixed flow reactor. | **07** |
| **Q.4** | **(a)** | Discuss equal sized mixed flow reactors in series | **03** |
| | **(b)** | Derive performance equation for a CSTR. | **04** |

**(c)** The thermal cracking of ethane is carried out in a tubular reactor for large scale production of ethylene. The reaction is **07**

$$C_2H_6 \rightarrow C_2H_4 + H_2$$

The ethane fed at the rate of 10 tons/hr, is diluted with steam (0.5 mole of steam: 1 mole of Ethane) before entering the reactor to reduce amount of undesired products. The reaction is maintained at 900 °C and 1.4 atm total pressures. Reaction is first order irreversible and rate constant is 12.8 $sec^{-1}$ at 900°C. Calculate the volume of reactor required for 60% conversion of ethane per pass.

**OR**

**Q.4** **(a)** Show how fractional conversion X, is related to temperature for any exothermic reaction being carried out in an adiabatic batch reactor. **03**

**(b)** Write a short note on Recycle reactor. **04**

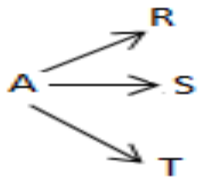
**(c)** Derive the equation in terms of concentration for irreversible reactions in series for uni-molecular type first-order reaction such as **07**

$$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$

**Q.5** **(a)** Discuss the effect of pressure on equilibrium conversion as predicted by thermodynamics keeping temperature fixed **03**

**(b)** Discuss the method of maximization of rectangles applied to find the optimum intermediate conversion and optimum sizes of two mixed reactors in series **04**

**(c)** For the parallel decomposition of A where R is desired and $C_{A0}= 1$ **07**




What is the maximum $C_R$, we may expect in an isothermal operation in Batch Reactor , where the value of $r_R = 1$, $r_S = 2C_A$, $r_T = C_A^2$

**OR**

**Q.5** **(a)** Discuss the effect of inert on equilibrium conversion as predicted by thermodynamics keeping temperature fixed **03**

**(b)** Explain optimum temperature progression in brief. **04**

**(c)** Describe quantitative discussion about product distribution for reactions in parallel. **07**

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