Enrolment No./Seat No_____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2024**

**Subject Code:3154402 Date:09-12-2024**

**Subject Name:Chemical Reaction Engineering - I**

**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.**
4. **Simple and non-programmable scientific calculators are allowed.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Define the following terms with their respective units: i) Space time, and ii) Space velocity. | **03** |
| | **(b)** | Difference between (i) Elementary reaction and non-elementary reaction (ii) Order and molecularity. | **04** |
| | **(c)** | State Arrhenius equation? Establish the relation between activation energy and temperature? | **07** |
| **Q.2** | **(a)** | Define zero order reaction with suitable example. | **03** |
| | **(b)** | Name the methods used for analyzing kinetic data of batch reactor | **04** |
| | **(c)** | Define variable batch reactor and establish Its performance equation. | **07** |
| | | **OR** | |
| | **(c)** | The primary reaction occurring in the homogeneous decomposition of nitrous oxide is found to be<br>$N_2O \rightarrow N_2 + \frac{1}{2} O_2$<br>With rate<br>- $r_{N_2O} = \frac{k_1 [N_2O]^2}{1+k'[N_2O]}$<br>Devise a mechanism to explain this observed rate | **07** |
| **Q.3** | **(a)** | Difference between F curve and E curve | **03** |
| | **(b)** | Derive RTD in Mixed flow reactor | **04** |
| | **(c)** | Derive the performance equation for Plug Flow reactor | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Give detail classification of chemical reaction | **03** |
| | **(b)** | A certain reaction has a rate given by<br>$-r_A = 0.005\ C_A^2$ mol/(cc.min)<br>If the concentration is expressed in mol/ l and time in hours, what would be the value and units of rate constant? | **04** |
| | **(c)** | Establish the relation between conversion – time and reaction rate constant using the half-life method for irreversible unimolecular type reactions using integral method of analysis | **07** |
| **Q.4** | **(a)** | Discuss significance of RTD studies | **03** |
| | **(b)** | Define Residence Time Distribution and explain E-Curve | **04** |
| | **(c)** | Derive the performance equation for recycle reactor | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Discuss fractional yield, overall yield and selectivity for parallel reaction | **03** |

**(b)** Discuss the theory of maximization of rectangle for finding the optimum volume of MFR in series **04**

**(c)** First order unimolecular irreversible reaction in series **07**

$$A \rightarrow R \rightarrow S$$

takes place with specific reaction rate $k_1$ and $k_2$. Express the variation of concentration of A, R and S with time. Find the expression for the time when formation of R becomes maximum

**Q.5** **(a)** Write a short note on 'heat of reaction from thermodynamics' **03**

**(b)** Describe the optimum temperature progression and its application **04**

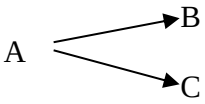
**(c)** Product distribution of irreversible zero order reaction followed by first order reaction **07**

**OR**

**Q.5** **(a)** Discuss equilibrium conversion. **03**

**(b)** Discuss the steps for calculation of equilibrium constant from thermodynamics point of view **04**

**(c)** Substance A in liquid phase produces R and S by the following reactions **07**




With $r_R = k_1 C_A^2$ and $r_S = k_2 C_A$

The feed ($C_{A0}$ = 1.0, $C_{R0}$ = 0, $C_{S0}$ = 0.30) enters two mixed flow reactors in series ($\tau_1$ = 2.5 min, $\tau_2$ = 10 min). Knowing the composition in the first reactor ($C_{A1}$ = 0.40, $C_{R2}$ = 0.20, $C_{S1}$ = 0.70), find the composition leaving the second reactor.

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