

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP2023)

CLASS: B.TECH
BRANCH: CHEMICAL ENGG

SEMESTER : IV
SESSION : SP2023

SUBJECT: CL223 CHEMICAL REACTION ENGINEERING - I

TIME: 02 Hours

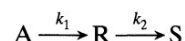
FULL MARKS: 25

INSTRUCTIONS:

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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|---|-----|--|-----|----|
| Q.1(a) Differentiate between elementary and non-elementary reactions. | [2] | | CO | BL |
| Q.1(b) Define the following terms: | [3] | | CO1 | 1 |
| (i) molecularity | | | | |
| (ii) order of reaction | | | | |
| (iii) heterogeneous non catalytic reactions with example | | | | |

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|---|-----|--|-----|---|
| Q.2(a) Derive the following expression for a series reaction. | [3] | | CO1 | 3 |
|---|-----|--|-----|---|



$$C_R = C_{A0} k_1 \left(\frac{e^{-k_1 t}}{k_2 - k_1} + \frac{e^{-k_2 t}}{k_1 - k_2} \right)$$

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| Q.2(b) What are the factors on which rate constant depends? | [2] | | CO1 | 2 |
|---|-----|--|-----|---|

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| Q.3 Pure gaseous reactant A ($C_{A0} = 100$ millimole/liter) is fed at a steady rate into a mixed flow reactor ($V = 0.1$ liter) where it dimerizes ($2A \rightarrow R$). For different gas feed rates, the following data are obtained: | [5] | | CO3 | 3 |
|--|-----|--|-----|---|

Run number	1	2	3	4
vo, liter/hr	30.0	9.0	3.6	1.5
CAf, millimole/liter	85.7	66.7	50	33.4

Find a rate equation for this reaction.

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| Q.4(a) Derive the expression of Half-life for a n-th order irreversible reaction | [2] | | CO3 | 2 |
| Q.4(b) For the reaction $A \rightarrow R$, second-order kinetics and $C_{A0} = 1 \text{ mol/litre}$, 50% conversion achieved after 1 hour in a batch reactor. What will be the conversion and concentration of A after 1 hour if $C_{A0} = 10 \text{ mol/litre}$. | [3] | | CO3 | 5 |

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|--|-----|--|-----|---|
| Q.5(a) Reactant A decomposes to products B and C in the presence of an enzyme in a well-stirred batch reactor. The kinetic rate expression is given by | [2] | | CO2 | 5 |
|--|-----|--|-----|---|

$$-r_A = \frac{0.01C_A}{0.05 + 0.01C_A} (\text{mol.L}^{-1}.\text{min}^{-1})$$

If the initial concentration of A is 0.02 mol/litre, find the time taken to achieve 50% conversion of A.

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|---|-----|--|-----|---|
| Q.5(b) Gaseous reactant A decomposes as follows: | [3] | | CO2 | 5 |
| $A \rightarrow 3R$, $-r_A = (0.6 \text{ min}^{-1})C_A$. Find the conversion of A in a 50%- 50% inert feed ($v_o = 180 \text{ litre/min}$, $C_{A0} = 300 \text{ mmol/litre}$), to a one m^3 mixed flow reactor. | | | | |