

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur (GIET University)



B. Tech (Fifth Semester - Regular) Examinations, November – 2024

22BCHPC35002 - Chemical Reaction Engineering-I

(Chemical Engineering)

Time: 3 hrs

Maximum: 70 Marks

Answer ALL questions
(The figures in the right hand margin indicate marks)

PART – A

(2 x 5 = 10 Marks)

Q.1. Answer **ALL** questions

- | | CO # | Blooms Level |
|---|------|--------------|
| a. Given the reaction $2\text{NO}_2 + \frac{1}{2}\text{O}_2 = \text{N}_2\text{O}_5$, what is the relation between the rates of formation and disappearance of the three reaction components? | CO1 | K1 |
| b. On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order. | CO2 | K4 |
| c. Define pseudo first order reaction. | CO1 | K2 |
| d. Differentiate batch reactor and continuous reactor. | CO1 | K2 |
| e. How can you keep the concentration of the reactant high for a single reactant parallel reaction? | CO2 | K3 |

PART – B

(15 x 4 = 60 Marks)

Answer **ALL** the questions

- | | Marks | CO # | Blooms Level |
|---|-------|------|--------------|
| 2. a. The irreversible reaction $\text{A}+\text{B}=\text{AB}$ has been studied kinetically, and the rate of formation of product has been found to be well correlated by the following rate equation
$r_{\text{AB}} = k [\text{A}]^2$is independent of $[\text{B}]$.
What reaction mechanism is suggested by this rate expression if the chemistry of the reaction suggests that the intermediate consists of an association of reactant molecules and that a chain reaction does not occur? | 8 | CO1 | K1 |
| b. The data for the first order decomposition of Benzene diazonium chloride to Chlorobenzene & nitrogen are as follows. | 7 | CO2 | K3 |

K (Sec -1)	0.00043	0.00103	0.00180	0.00355	0.00717
T (K)	313	319	323	328	333

What is the activation energy & complete rate expression for this reaction?

(OR)

- | | | | |
|--|---|-----|----|
| c. For the following stoichiometry, find the overall order of the reaction
$\text{A} + \text{B} = \text{Products}$
Given | 8 | CO2 | K3 |
|--|---|-----|----|

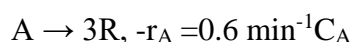
C_A (mol/lit)	4	1	1
C_B (mol/lit)	1	1	8
$-\text{r}_\text{A}$ (mol/lit.min)	2	1	4

- | | | | |
|---|---|-----|----|
| d. Describe about the different intermediates used in chemical reaction with examples | 7 | CO2 | K2 |
|---|---|-----|----|

- 3.a. Derive the performance equation of the reaction of second order $A + B \rightarrow$ Product having initial concentration C_{A0} and C_{B0} of A and B respectively for a constant volume batch reactor. Draw free hand graphs for Conc vs time. 8 CO3 K3
- 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? 7 CO2 K3

(OR)

- c. Derive the performance equation for irreversible first order reaction of variable volume batch reactor. 7 CO2 K2
- d. Calculate the first order rate constant for the disappearance of A as per the gas phase reaction $A \rightarrow 1.6 R$, if the volume of the reaction mixture, starting with pure A increases 50% in 4 minutes. The total pressure of the system remains constant at 1.2 atm and the temperature is 25°C . 8 CO2 K3
- 4.a. Derive the performance equation of ideal batch reactor from material balance expression. 8 CO3 K2
- b. Gaseous reactant A decomposes as follows. 7 CO2 K3



Find the space time and conversion of A in 50% A-50% inert feed having flow rate 180 lit/min and $C_{A0} = 300 \text{ mol/lit}$, to a 1 m^3 mixed flow reactor.

(OR)

- c. A homogeneous gas phase reaction with stoichiometry and the kinetics $A \rightarrow S, -r_A = kC_A^2$, takes place with 50% conversion in a mixed flow reactor. Find the conversion if this reactor is replaced by another MFR having volume six times the first MFR all remain unchanged. . 8 CO2 K5
- d. Write the advantages, disadvantages and application of mixed flow reactor. 7 CO1 K2
- 5.a. Discuss about the quantitative treatment of product distribution for unimolecular type first order reaction $A \rightarrow R \rightarrow S$ in a batch reactor. 7 CO3 K3
- b. The desired liquid phase reaction $A+B \longrightarrow R+T$, $-r_R = -r_T = k_1 C_A^{1.5} C_B^{0.3}$ Is accompanied by the unwanted side reaction $A+B \longrightarrow S+U, r_S = r_U = k_2 C_A^{0.5} C_B^{1.8}$ From the stand point of favourable product distribution, order the contacting pattern of continuous flow operation, from the most desirable to the least desirable. 8 CO3 K3

(OR)

- c. Derive the expression of C_A , C_R and C_S for quantitative product distribution of an unimolecular type first order reaction $A \rightarrow R \rightarrow S$ in a mixed flow reactor. Evaluate its $C_{R,\max}$ and space time for attaining $C_{R,\max}$. Draw the concentration-time graph. 12 CO2 K2
- d. What is the importance of product distribution in multiple reactions with respect to single reaction for designing? 3 CO1 K3

--- End of Paper ---