

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

**CLASS: B.TECH  
BRANCH: BIOTECHNOLOGY**

**SEMESTER : V  
SESSION : MO/2025**

**SUBJECT: BE304 REACTION ENGINEERING**

**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

Q.NO	QUESTIONS	MARKS	CO	BL
Q.1(a)	State a condition under which a bimolecular reaction with two reactants is kinetically a first-order reaction.	[1]	1,2	3,4
Q.1(b)	Concentration vs Rate data for the decomposition of N <sub>2</sub> O <sub>5</sub> at 67° K is given below:	[4]	1,2	3,4



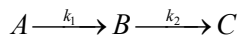
<b>Conc, mol/l</b>	0.113	0.080	0.056	0.040
<b>Rate mol/ lmin</b>	0.039	0.028	0.020	0.014

- a. What is the rate expression for the reaction?
  - b. Calculate the value of rate constant.
- Q.2(a) Why does the rate of the reaction not remain constant throughout the reaction process? [1] 1,2 3,4
- Q.2(b) The reaction  $\text{NO}_2 + \text{CO} \rightarrow \text{NO} + \text{CO}_2$  occurs in two steps. Write the rate law. What is the order of the reaction? [1.5] 1,2 3,4
- $2\text{NO}_2 \rightarrow \text{NO} + \text{NO}_3$  ( $k_1$ ) - slow  
 $\text{NO}_3 + \text{CO} \rightarrow \text{CO}_2 + \text{NO}_2$  ( $k_2$ ) - fast
- Q.2(c) For the reaction,  $\text{A} \rightarrow \text{products}$ , a graph of  $[\text{C}_\text{A}]$  versus time  $[t]$  is a curve. What can be concluded about the order of this reaction? Justify your answer by referring to all the integrated rate expressions you considered for analysis. [2.5] 1,2 3,4
- Q.3(a) Show that the decomposition of N<sub>2</sub>O<sub>5</sub> at 67 °C is a first-order reaction. Calculate the value of the rate constant. [2.5] 1,2 3,4

**Data:**

Time, min	0	1	2	3	4
C <sub>N<sub>2</sub>O<sub>5</sub></sub> , mol / l	0.16	0.113	0.08	0.056	0.040

- Q.3(b) In the case of a first-order reaction, show that the time required for 75% conversion is double the time required for 50 % conversion. [2.5] 1,2 3,4
- Q.4(a) A polymerization reaction occurs at constant temperature in a homogeneous phase. For initial monomer concentration of 0.3, 0.5 & 0.9 mol / l , 30% of the monomer reacts in 40 minutes. Find the reaction rate. [2.5] 1,2 3,4
- Q.4(b) The following liquid-phase series reaction is taking place in a constant volume batch reactor. [2.5] 1,2 3,4



The first reaction is first order, and the second reaction is zero order. Determine the concentrations of A, B and C as functions of time.

- Q.5(a) Why is drug metabolism preferred to follow zero-order kinetics? [2.5] 1,2 3,4
- Q.5(b) The concentrations of a compound undergoing chemical change were 5.72, 3.23, and 1.96 at times 0, 20 and 50 minutes from the commencement of the reaction. Find the order of the reaction. [2.5] 1,2 3,4