BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO/2023)

CLASS: BTECH **SEMESTER: V**
BRANCH: BIOTECH **SESSION: MO/2023**

SUBJECT: BE304 REACTION ENGINEERING

TIME: 03 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 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**

				CO	BL
Q.1(a)	I.	What is the difference between zero-order and first order reaction?	[1.5x4 =6]	1	3,4
	II.	Can the order of reaction be negative? If it can be negative, what does it signify?			
	III.	Will a reaction of first order end? If it ends, when does it end ?			
	IV.	A reaction has the stoichiometric equation A + B → 2R. What is the order of reaction?			
Q.1(b)	Concentration - Rate data for the decomposition of N_2O_5 at 67^0 K is given below:		[2x2= 4]	1	3,4

$$2\ N_2O_{5\ (g)} \rightarrow 4NO_{2\ (g)} + O_{2\ (g)}$$

Concentration, mol/l	0.113	0.080	0.056	0.040
Rate, mol/ *l*. min	0.039	0.028	0.020	0.014

Plot a graph of rate against the concentration of N_2O_5 and answer the following:
(i) What is the rate expression for the reaction?
(ii) Calculate the value of rate constant.

2(a)	A reaction with stoichiometric equation: $1/2\ A + B \rightarrow R + 1/2\ S$ has the following rate expression: $-r_A = 2C_A^{0.05} C_B$ What is the rate expression for this reaction if the stoichiometric equation is written as: $A + 2B \rightarrow 2R + S$?		[2]	1,2	3,4
Q.2(b)	Find the first-order rate constant for the disappearance of A in the gas reaction $2A \rightarrow R$ if, on holding the pressure constant, the volume of the reaction mixture, starting with 80% A, decreases by 20% in 3 min.		[4]	1,2	3, 4
Q.2(c)	When a concentrated urea solution is stored, it slowly condenses to biuret by the following elementary reaction: $2\ NH_2\text{-}CO\text{-}NH_2 \rightarrow NH_2\text{-}CO\text{-}NH\text{-}CO\text{-}NH_2 + NH_3$ To study the rate of condensation a sample of urea (C = 20 millilitre) is stored at 100°C and after 7 hr 40 min we find that 1 mol% has turned into biuret. Find the rate equation for this condensation reaction.		[4]	1,2	3,4
Q.3(a)	The following problem considers an isothermal single-phase flow reactor operating at steady-state and constant pressure. Given a gaseous feed, C_{Ao} = 100, C_{BO} = 200, $A + B \rightarrow R + S, \quad X_A = 0.8.$ Find X_B, C_A, C_B.		[4]	2,3	3,4

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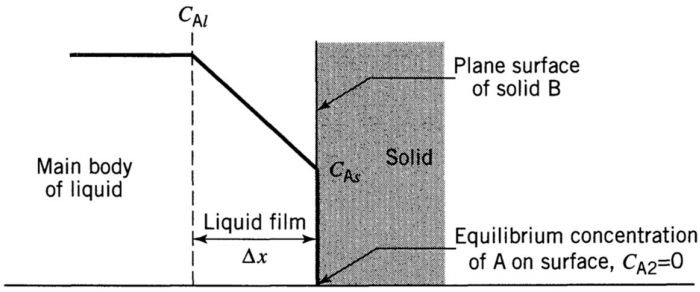
Q.3(b)	An aqueous feed of A & B (400 l /min, 100 mmol A/l, 200 mmol B /l) is to be converted to product in a mixed flow reactor. The kinetics of the reaction are represented by: $A+B \rightarrow R$, $-r_A = 200\ C_A C_B$ mol /l.min Find the volume of the reactor needed for 99.9% conversion to product.	[6]	2,3	3,4
Q.4(a)	I. Which achieves higher conversion among the flow reactors for identical conditions? Why? II. Why does rate of reaction vary in a PFR? How does it vary in a MFR?	[2x2 =4]	3,4	3,4
Q.4(b)	A gaseous feed of pure A (2 mol /l , 100 mol/min) decomposes to give a variety of products in a plug flow reactor. The kinetics of conversion is represented by: $A \rightarrow 2.5$ products ; $-r_A = (10\text{min-}1)\ C_A$ Find the expected conversion in a 22-litre reactor	[6]	3,4	3,4
Q.5(a)	Explain the steps involved when air bubbles through a tank of liquid which contains dispersed microbes and is taken up by microbes to produce products.	[5]	4	3,4
Q.5(b)	Dilute A diffuses through a stagnant liquid film onto a plane surface consisting of B reacts to produce R which diffuses back into the mainstream. Develop the overall rate expression for the liquid (l) / solid (s) reaction. A (l) + B (s) $\rightarrow$ R (l) Which takes place on this flat surface as below:  	[5]	4	3, 4

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