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

CLASS: BE **SEMESTER: V**
BRANCH: CHEM/P&P **SESSION : MO/2019**

SUBJECT : CL5005 CHEMICAL REACTION ENGINEERING

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) What do you mean by elementary and non-elementary reactions? Show example [2]
(b) What is rate constant? How do you increase rate constant of a reaction? [3]

Q2 In a gas phase reaction, the following reaction is taking place isothermally and isobarically. [5]

$$0.5N_2 + 1.5H_2 \rightarrow NH_3$$

The molar feed is 50% H_2 and 50% N_2 at pressure 8.2 atm and 227°C temperature. If the conversion is 60%, determine the final concentration of H_2 and NH_3. Assume H_2 is the limiting reactant.

Q3 (a) For the following reaction: [2]

$$aA + bB \rightarrow cC + dD$$

prove that

$$\frac{-r_A}{a} = \frac{-r_B}{b} = \frac{r_C}{c} = \frac{r_D}{d}$$

(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 time would it take to reach 75% conversion? [3]

Q4 An aqueous feed of A and B (400 litre/min, 100 mmol A/litre, 200 mmol B/litre) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by [5]

$$A + B \rightarrow R, \quad -r_A = 200\, C_A C_B \frac{\text{mol}}{\text{liter} \cdot \text{min}}$$

Find the volume of reactor needed for 99.9% conversion of A to product. Consider no density change and A is limiting reactant.

Q5 (a) To achieve same conversion for a reaction having order greater than 1, which reactor between CSTR and PFR will have minimum size? Explain graphically. [2]
(b) 6 gm of carbon is burnt with an amount of air containing 18 gm oxygen. The product contains 16.5 gm CO_2 and 2.8 gm CO besides other constituents. What is the degree of conversion on the basis of disappearance of limiting reactant? [3]

Q6 A liquid reactant stream (1mol/litre) passes through two mixed flow reactors in a series. The concentration of A in the exit of the first reactor is 0.5 mol/litre. Find the concentration in the exit stream of the second reactor. The reaction is second order with respect to A and $V_2/V_1 = 2$. [5]

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