

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FIFTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019**

**Course Code: CH305**

**Course Name: CHEMICAL REACTION ENGINEERING-I**

Max. Marks: 100

Duration: 3 Hours

Graph sheets may be provided

**PART A**

*Answer any two full questions, each carries 15 marks.*

Marks

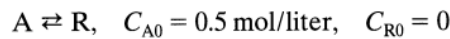
- 1 a) Define the molecularity and order of a chemical reaction. (2)
- b) The rate constants of a certain reaction are  $1.6 \times 10^{-3}$  and  $1.625 \times 10^{-2} \text{ (s)}^{-1}$  at  $10^\circ\text{C}$  and  $30^\circ\text{C}$ . Calculate the activation energy in KJ/mol. (5)
- c) For the gas phase decomposition of azo methane, develop a mechanism and from it, derive a rate law. (8)
- 2 a) Differentiate between elementary and non-elementary reaction with examples. (4)
- b) List the various factors affecting the rate of a chemical reaction. (3)
- c) Give detailed classifications of chemical reactions. Write examples for each classification (8)
- 3 a) The decomposition of nitrous oxide is found to proceed as follows: (12)
- $$\text{N}_2\text{O} \rightarrow \text{N}_2 + \frac{1}{2}\text{O}_2, \quad -r_{\text{N}_2\text{O}} = \frac{k_1[\text{N}_2\text{O}]^2}{1+k'[\text{N}_2\text{O}]}$$
- Suggest a mechanism to explain this rate. What is the order of this reaction with respect to  $\text{N}_2\text{O}$ ?
- b) Explain Pseudo Steady State Hypothesis and write its applications (3)

**PART B**

*Answer any two full questions, each carries 15 marks.*

- 4 a) Derive the integral equation for a second order reaction with equimolar concentrations of the reactants. (5)
- b) The half-life period for a certain first order reaction is  $2.5 \times 10^3 \text{ s}$ . Determine the time taken for  $\frac{1}{4}$  of the reactant to be left behind. (5)
- c) After 8 minutes in a batch reactor, reactant ( $C_{A0} = 1 \text{ mol/liter}$ ) is 80% converted; after 18 minutes, conversion is 90%. Find a rate equation to represent this reaction. (5)
- 5 a) Define an autocatalytic reaction. Give an example. (2)

- b) The first-order reversible liquid reaction (7)



takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction.

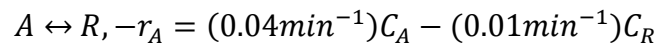
- c) Find the first order rate constant for the disappearance of A in the gas reaction (6)

$A \rightarrow 1.6R$  if the volume of the reaction mixture, starting with pure A increases by 50% in 4 minutes. The total pressure within the system stays constant at 1.2 atm and the temperature is 25°C.

- 6 a) Define space time and space velocity. (3)

- b) Derive the performance equation of a Mixed Flow Reactor. (5)

- c) A plug flow reactor (2 m<sup>3</sup>) processes an aqueous feed (100 liter/min) containing reactant A ( $C_{A0} = 100 \text{ mmol/liter}$ ). This reaction is reversible and represented by (7)



First find the equilibrium conversion and then find the actual conversion of A in the reactor.

### PART C

*Answer any two full questions, each carries 20 marks.*

- 7 a) Define recycle ratio and explain a recycle reactor. (3)

- b) Explain the graphical method of determining the conversion in the case of unequal size mixed flow reactors connected in series. (7)

- c) An aqueous reactant stream (4 mol A/liter) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at the exit of the plug flow reactor if in the mixed flow reactor  $C_A = 1 \text{ mol/liter}$ . The reaction is second-order with respect to A, and the volume of the plug flow unit is three times that of the mixed flow unit. (10)

- 8 a) Write a note on bioreactors (5)

- b) Derive the Michaelis – Menton equation for enzymatic reactions. (15)

- 9 a) With neat sketch, explain membrane Reactors. Write the different types of membrane reactors. (8)

- b) Explain the phases of bacterial cell growth. (5)

- c) Cell growth rate is expressed in terms of Monod Equation. Write the equation and specify each term on the equation. (4)

- d) Explain reactive distillation with an example. (3)

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