# 314309

**24225**

**3 Hours / 70 Marks** Seat No. | | | | | | | | |

*Instructions* – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

**Marks**

**1. Attempt any FIVE of the following :** **10**

a) Define the term activation energy.

b) Give general material balance equation for a chemical reactor.

c) State any four characteristic of catalyst in catalytic reaction.

d) Draw symbollic diagram with labelling of PFR in (i) series and in (ii) parallel arrangement.

e) Derive $t_{½} = C_{Ao/2}k$ for zero order reaction.

f) Give any four name of catalyst used in catalytic reaction.

g) State the different methods to analyse the rate data to determine order of reaction.

**Marks**

**2. Attempt any THREE of the following :** **12**

a) Explain properties of catalyst :-

i) Activity

ii) Specificity

iii) Crystalline structure

iv) Kindling point

b) Derive the performance equation of constant volume mixed flow reactor/CSTR.

c) Liquid 'A' decomposes by first order kinetics and in a batch reactor 50% of A is converted in 5min, how long will it take to reach 75% conversion.

d) The rate constant of a reaction at 27ºC is $1.3 \times 10^{-3}(S^{-1})$. Determine the frequency factor. Take E = 12817 cal/mol.

**3. Attempt any THREE of the following :** **12**

a) Give the stepwise procedure of integral method of analysis of rate data.

b) Explain any two methods of preparation of catalyst.

c) At 25ºC, the rate constant for the hydrolysis of ethyl acetate by NaOH is 6.5 (l/mol).$(Min^{-1})$ starting with concentration of base and ester of 0.03 mol/l of each. What proportion of ester will be hydrolysed in 10 min?

d) State advantages and disadvantages of CSTR.

**Marks**

**4. Attempt any THREE of the following :** **12**

a) The half life for the conversion of ammonium cynate into urea at 303 k at initial concentrations of ammonium cynate of 0.1 mol/l and 0.2 mol/l are 1152 min and 568 min, respectively. What is the order of reaction.

b) Differentiate between Elementary and non elementary reaction (any four points).

c) Explain the method of feeding when plug flow rectors are connected in parallel.

d) Explain the terms space time and space velocity with their units.

e) Calculate the first order rate constant for the disappearance of A as per the gas phase reaction $A \rightarrow 1.6R$ if the volume of the reactions mixture starting with pure A increases by 50% in 4 min. The total pressure of the system remains constant at 1.2 atm and the temperature is 25ºC.

**5. Attempt any TWO of the following :** **12**

a) Explain the temperature dependency of rate constant from collision theory.

b) It is proposed to operate a batch reactor for converting A into R. This is a liquid phase reaction with the stoichiometry $A \rightarrow R$. How long must we react each batch in order to drop the concentration from $C_{A_o} = 1.3$ mol/l to $C_{A_f} = 0.3$ mol/l. The rate Vs concentration data are as given below.

| $-r_A$ (mol/l) | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.3 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $-r_A$ (mol/l.min) | 0.1 | 0.3 | 0.5 | 0.6 | 0.5 | 0.25 | 0.10 | 0.06 | 0.05 | 0.045 | 0.042 |

c) Derive equation for size comparison between CSTR and PFR.

**Marks**

**6. Attempt any TWO of the following :** **12**

a) Explain the procedure to determine the best system for achieving desired conversion for different size CSTR in series.

b) In studying the kinetics of decomposition of a reaction, the concentrations of reactants were determined analytically at different times. The following results were obtained.

| Time, min | 0 | 10 | 20 | 40 | 100 | 125 |
|---|---|---|---|---|---|---|
| conc, mol/l | 0.10 | 0.0714 | 0.0556 | 0.0385 | 0.02 | 0.0167 |

Determine the order and rate constant for the reaction.

c) A specific enzyme acts as catalyst in the fermentation of substrate A (reactant). At a given enzyme concentration in the aqueous feed stream of 25 l/min, determine the size of plug flow reactor needed to achieve 95% conversion of reactant A $C_{A_o}$ = 2 mol/l. The kinetics and stoichiometry of fermentation reaction are given by

$$A \xrightarrow{\text{enzyme}} R, \; -r_A = \frac{0.10 C_A}{1+0.5 C_A} \text{ (mol/l min)}$$