Paper / Subject Code: 31723 / Chemical Reaction Engineering-I

17 NOV 2025 TE CHEMICAL SEM-V C SCHEME CRE-I QP CODE: 10095961

Time: 3 Hours **Total Marks: 80**

N.B.:

(i) Question No.1. is compulsory.
(ii) Attempt any three questions out of the remaining five questions.
(iii) Assume suitable data and justify the same.
(iv) Figures to the right indicate full marks

Q 1	(a)	Differentiate between Elementary & Non-elementary reactions.	**05**
	(b)	On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order.	**05**
	(c)	What do you understand by Damkohler Number? Write the Damkohler number for first and second-order reactions.	**05**
	(d)	In the case of a first-order reaction, show that the time required for 75% conversion is double the time required for 50% conversion.	**05**
Q 2	(a)	Show that the following scheme: $N_2O_5 \rightleftharpoons NO_2 + NO_3^*$ $NO_2 + NO_3^* \rightarrow NO_2 + O_2 + NO^*$ $NO^* + NO_3^* \rightarrow 2NO_2$ is consistent with the observed first order decomposition of N_2O_5	**05**
	(b)	Derive integrated rate expressions in terms of concentration & conversion for First order reaction.	**05**
	(c)	A specific enzyme E acts as a catalyst in the fermentation of substrate A (the reactant). At a given enzyme concentration in the aqueous feed stream of 25 l/min. Find the volume of plug flow reactor required to achieve 95 % conversion of reactant A (C_{A0} = 2 mol/l).The kinetics and stoichiometry of the fermentation reaction are given by $A \xrightarrow{enzyme} R \; (-r_A) = \frac{0.1C_A}{1+0.5C_A} \; \frac{mol}{l\ min}$	**10**
Q 3	(a)	An aqueous solution of ethyl acetate is to be saponified with NaOH. The initial concentration of ethyl acetate is 5 gm/lit and that of caustic is 0.1 normal. The values of second order rate constant at 0°C and 20°C are k = 0.235 and 0.924 (lit/mol) min^{-1} respectively. The reaction is irreversible. Calculate the time required to saponify 95% of ester at 40°C.	**10**
	(b)	Nitrous oxide decomposes according to the second order rate equation $2N_2O \rightarrow 2N_2 + O_2$ The reaction rate constant is 977 cm^3/(mol.s) at 895°C. Calculate the fraction decomposed at 1 s, 10 s & 10 min in a constant volume batch reactor. The initial pressure is 1 atm.	**10**
Q4	(a)	Assuming a stoichiometry A → R for a first order gas phase reaction, the size (volume) of plug flow reactor required to achieve 99% conversion of a pure A is 32 lit. In fact, however, the stoichiometry of the reaction is A → 3R. For this corrected stoichiometry, find the required size of the same type reactor.	**10**
	(b)	400 lit/min of an aqueous feed of A & B with C_{Ao} = 100 mmol/lit and C_{Bo} = 200 mmol/lit is to be converted into product in a mixed flow reactor. The kinetics and stoichiometry of the reaction are given by A + B → R, $-r_A = 200\ C_AC_B$, mol/lit.min Estimate the volume of reactor required to achieve 99% conversion of A to product.	**10**

Q 5 (a) 100 lit/hr of radioactive fluid having a half-life of 20 hr is to be processed by passing it through two MFRs in series. The volume of each MFR in series is 40000 lit. Find the decay in activity in passing the fluid through this reactor system. The reaction follows first order kinetics. **10**

(b) An aqueous reactant stream with C_{Ao} = 4 mol/lit passes through a mixed flow reactor (MFR) followed by plug flow reactor (PFR). The reaction is second order with respect to A. The volume of the PFR is three times that of the MFR. Find the concentration of A at the exit of PFR if the concentration of A in the MFR is 1 mol/lit. **10**

Q 6 (a) Determine the equilibrium conversion for the following elementary reaction between 273 K and 373 K **15**

$$A \longleftrightarrow R$$

At 298 K: $\Delta G^o = -14130$ J/mol, $\Delta H_R^o = \Delta H_{RT=298} = -75300$ J/mol, $C_{PA} = C_{PR}$ = constant.

(i) Construct a plot of temperature v/s conversion

(ii) What restrictions should be placed on the reactor operating isothermally if 75% or higher conversion is desired?

(b) Discuss Optimum Temperature Progression for various types of reactions. **05**
