Printed Pages: 02   **Sub Code: ECH403**
Paper Id: **151221**   **Roll No.** [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

B TECH
(SEM-V) THEORY EXAMINATION 2018-2019
CHEMICAL REACTION ENGINEERING-I

Time: 3 Hours   *Max. Marks: 100*
Note: Attempt all sections. If require any missing data; then choose suitably.

SECTION - A
1. **Attempt *all* questions in brief.**   **2 x 10 = 20**
    a. Activation Energy.
    b. Elementary and Non-elementary reactions.
    c. Dispersion number.
    d. Autocatalytic reaction.
    e. Homogeneous and Non homogeneous reactions.
    f. Differentiate between Ideal and Real reactors.
    g. Explain the dispersed plug flow model.
    h. Define recycle ratio R and Selectivity.
    i. Instantaneous fractional yield and overall fractional yield.
    j. E and F curve.

SECTION – B
2. **Attempt any *three* of the following.**   **10 x 3 = 30**

    a. Calculate the ratio of rate constants of two reactions which have same value of Arrhenius factor and a difference of 5 k mol^{-1} in E_{act} at 25°C.
    b. Prove that for *n*th order reaction, the plot of ln $t_{1/2}$ versus $1/T$ is a straight line and slope of the line is equal to E_{act}.
    c. Discuss the various techniques that can be used in determination of the rate of a reaction.
    d. For the reactions in series $A \xrightarrow{k_1} R \xrightarrow{k_2} S$, $k_1=k_2$ find the maximum concentration of R and when it is reached.
    e. We wish to produce 90% conversion in the reaction $A \rightarrow B$, $r = kC_A C_B$ with $k = 1/4$ (units of minutes, moles, and liters).
        (i)   Find τ and C_{B0} where PFTR and CSTR give equal τ for $C_{A0} = 2 - C_{B0}$.
        (ii)   (ii) What are the best two-reactor combination and optimum C_{BO} for minimum t?
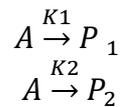
SECTION - C
3. **Attempt any *one* part of the following:**   **10 x 1 = 10**

    a. A reactant reacts 30% in 30 min. If the reaction follows a second order kinetics, find rate constant and remaining concentration of reactant after 60 min.
    b. At 100°C pure gaseous A reacts away with stoichiometry $2A \rightarrow R + S$ in a constant volume batch reactor as follows:

t, sec	0	20	40	60	80	100	120	140	160
p_A, atm	1.00	0.96	0.80	0.56	0.32	0.18	0.08	0.04	0.02

What size of plug flow reactor operating at 100°C and 1 atm can treat 100 moles A/hr in a feed consisting of 20% inerts to obtain 95% conversion of A?
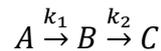
4. **Attempt any one part of the following:** 10 x 1 = 10

    a. For a side reaction

    $$A \xrightarrow{K1} P_1$$
    $$A \xrightarrow{K2} P_2$$

    Prove that [P1] : [P2] = k1 : k2.

    b. If the initial concentration of A is 2.0 mol dm^{-3} and k_1 and k_2 are 0.30 and 0.15 min^{-1}, respectively, at what time the concentration of B in the following reaction will be maximum:

    $$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

    Also calculate the maximum concentration of B.

5. **Attempt any one part of the following:** 10 x 1 = 10

    a. What is meant by an autocatalytic reaction? Derive an expression for rate constant of a simple autocatalytic reaction.
    b. Explain the dispersed plug flow model and fit the model for small extent of dispersion. A 12-m length of pipe is packed with 1 m of 2-mm material, 9 m of 1-cm material, and 2 m of 4-mm material. Estimate the variance in the output C curve for a pulse input into this packed bed if the fluid takes 2 min to flow through the bed. Assume a constant bed voidage and a constant intensity of dispersion given by D/ud_p = 2.

6. **Attempt any one part of the following:** 10 x 1 = 10

    a. Derive the performance equation of recycle plug flow reactor.
    b. Develop a relationship between equilibrium constant K and temperature T for the ammonia synthesis reaction.

    $$\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$$
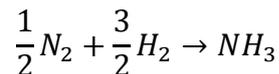
    Data: ΔH_R at 298 K = - 46190 J/mol ΔG^0 at 298 K = - 16635 J/mol
    CP is in J/(mol.K) and T is in K.

7. **Attempt any one part of the following:** 10 x 1 = 10

    a. The liquid phase reaction $A + B \underset{k_2}{\overset{k_1}{\rightleftharpoons}} R + S$ k$_1$ = 7liter/mol.min, k$_2$ = 3liter/mol.min is to take place in a 120 liter steady state mixed reactor. Two feed stream, one containing 2.8 mol A/liter and other containing 1.6 mol B/liter, are to be introduced in equal volume into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream? Assume a constant density throughout.

    b. A company has two mixed reactors of unequal size for producing a specified product that forms by homogeneous first-order reaction. How these reactors should be connected to achieve a maximum production rate.