CBCS SCHEME

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18BT52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Chemical Reaction Engineering

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15s for the same result. Find the activation energy of this sterilization process. **(05 Marks)**

b. Derive the expression for calculating rate. Constant (K) for an Irreversible Bimolecular. Type Second – order reactions. **(15 Marks)**

OR

2 a. Derive the expression Irreversible reaction in series for calculating residual concentration of C_A, C_R and C_S. $A \xrightarrow{K_1} R \xrightarrow{K_2} S$ **(10 Marks)**

b. Evaluate the value of Rate constant 'K' and 'N' – order of the reaction for the given data by using differential method.

t : (sec)	0	20	40	60	120	180	800
Concentration C_A, mol/ℓt	10	8	6	5	3	2	1

(10 Marks)

Module-2

3 a. Consider a feed $C_{A0} = 100$, $C_{B0} = 200$, $G_0 = 100$ to a steady – flow reactor. The isothermal gas phase reaction. $A + 3B \rightarrow 6R$.
If $C_A = 40$ at the reactor exit, what is C_B , X_A and X_B there? **(10 Marks)**

b. Derive the performance equation for ideal batch and CSTR reactor. **(10 Marks)**

OR

4 a. Pure gas reactant A(C_{A0} =100 millimol/ℓt) is fed at a steady rate into a mixed flow reactor (V = 0.1 ℓt) where it dimerizes ($2A \rightarrow R$). For different gas feed rates the following data are obtained.

Run number :	1	2	3	4
V_0 (ℓt/hr)	10	3	1.2	0.5
C_{Af} , millimol/ℓt	85.7	66.7	50	33.4

Find the rate equation for this reaction. **(10 Marks)**

b. The homogenous gas decomposition of phosphine $4PH_{3(g)} \rightarrow P_{4(g)} + 6H_2$. Proceeds at 649°C with the first order rate

$$-r_{PH_3} = (10/h_2)\ C_{PH_3}$$

What size of plug flow reactor operating at 649°C and 460 kPa can produce 80% conversion of a feed consisting of 40 mol of pure phosphine per hour? **(10 Marks)**

Module-3

5 a. Explain about the three interrelated factors make up the contacting (or) flow pattern in non – ideal flow. **(10 Marks)**

b. Explain the Mathematical and Graphical explanation between the
i) F and E curves ii) C_{step} to an F curves iii) C_{step} to an F – curve. **(10 Marks)**

OR

6 a. Explain about the properties of the E and F curves for various flow in i) Plug flow ii) Mixed flow iii) Arbitary flow. **(10 Marks)**

b. The concentration readings represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel 't' and tabulate and plot the exit age distribution E.

Time (t), min	0	5	10	15	20	25	30	35
Tracer Ouput concentration, C_{pulse} gm/ℓt fluid	0	3	5	5	4	2	1	0

(10 Marks)

Module-4

7 a. Explain about the Single – Substrate – Enzyme Interaction mechanism for a biological process. **(10 Marks)**

b. The following data have been obtained for two different initial enzyme concentration for an Enzyme – Catalyzed reaction.

V[E0] = 0.015g/ℓ g/ℓ - min	1.14	0.87	0.70	0.59	0.50	0.44	0.39	0.35
[S] g/ℓ	20.0	10.0	6.7	5.0	4.0	3.3	2.9	2.5
C[Eo] = 0.00875g/ℓ g/ℓ - min	0.67	0.51	0.41	0.34	0.29			

i) Find K_m ii) Find V_m for $[E_o] = 0.015g/\ell$ iii) Find V_m for $[E_o] = 0.00875$ g/ℓ iv) Find K_2. **(10 Marks)**

OR

8 a. Explain about the mechanism involved in competitive and uncompetitive inhibition enzyme kinetics on single substrate reaction. **(15 Marks)**

b. Give the Mathematical and Graphical representation of i) Line weaver – Burk plot ii) Eadie – Hofstee plot. **(05 Marks)**

Module-5

9 a. i) Explain about the Growth models for filamentous organisms. **(05 Marks)**

ii) Give the Graphical representation on growth and non – growth associated product formation kinetics. **(05 Marks)**

b. Explain about the mathematical explanation on substrate and product inhibition on cell growth and product formation. **(10 Marks)**

OR

10 a. Glucose is being used for the production of K – Coli in a $1200m^3$ bioreactor. 60g/L of glucose is being fed into the system with a substrate conversion of 95% in the process. The Biomass yield from the substrate is 0.55g/g. Assume that the specific growth rate is approximately equal to μ_{max} which is given as $0.5h^{-1}$. For this batch mode of operation, the initial cell concentration is 0.1g/L and the downtime between batches is 20 hours.

i) Calculate the batch time (in terms of h)

ii) Total mass of cells produced per batch (in kg) is.

iii) Total number of batches in a year. **(12 Marks)**

b. Calculate i) Total mass of cells produced annually during the batch culture (tons/year) ii) If the derived annual biomass production is to be 15,000 tons/year, what should be the volume of the reactor (in m^3) . Evaluate both the problems by using above problem Q.No. 10(a). **(08 Marks)**

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