

Note:

1. Question No. 1 is compulsory.
2. Attempt any three questions out of remaining five questions.
3. Assume suitable data wherever necessary.
4. Figures to right indicate full marks.

Q. 1 Answer the following

- a. Differentiate between elementary and non-elementary reactions. 20
- b. What is Arrhenius law? Explain how is rate of reaction is dependent on temperature?
- c. If pyrolysis of ethane proceeds with an activation energy of about 300kJ/mol how much faster is the decomposition at 650°C than at 500°C?
- d. Define rate of reaction, order and molecularity of reaction.

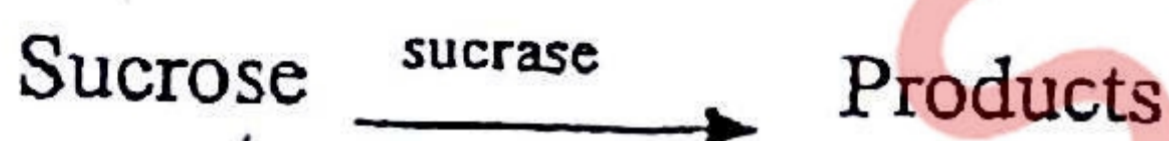
Q.2 a. Liquid A is decomposed to 50% in 10 min. Find the time required for 80% conversion when the reactor obeys; 10

- i) first order kinetics
- ii) second order kinetics.

b. Derive the equation for concentration profile of first order reaction using a spherical biocatalyst. 10

Q.3 a. Derive the model equation for cell culture for fed batch reactor. 8

b. At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows: 12



Starting with a sucrose concentration  $C_{A0} = 1.0$  millimol/lit and an enzyme concentration  $C_{E0} = 0.01$  millimol/lit, the following kinetic data are obtained in a batch reactor (Concentrations calculated from optical rotation measurements):

$C_A$ , millimol/lit	0.84	0.68	0.53	0.38	0.27	0.16	0.09	0.04	0.018	0.006	0.0025
t, hr	1	2	3	4	5	6	7	8	9	10	11

[P.T.O.]



(2)

Determine whether these data can be reasonably fitted by a kinetic equation of the Michaelis- Menten type, or  $-r_A = \frac{k_3 C_A C_{E0}}{C_A + C_M}$

Where  $C_M$  = Michaelis constant. If the fit is reasonable, evaluate the constants  $k_3$  and  $C_M$ . Solve by the integral method.

Q.4a. Explain the step by step method of differential method of interpretation of batch reaction data. 10

b. An aqueous phase reaction  $A \longrightarrow R$  proceeds as follows; 10

t (sec)	780	2080	3540	7200
$x_A$ (%)	11.2	25.7	36.7	55.2

Find the reaction rate constant and the order of reaction. Determine the time required for 50% conversion of A. Assume  $C_{A0} = 0.05 \text{ mol/lit}$ .

Q.5a.  $A + B \longrightarrow C$  takes place in a two stage CSTR one of volume  $100 \text{ m}^3$  and the other  $25 \text{ m}^3$ . The volumetric feed rate is  $20 \text{ lit/min}$ .  $C_A = C_B = 1.5 \text{ gm mol/lit}$  and the overall rate constant is  $0.010 \text{ lit/gm mol.min}$ . Calculate the overall conversion. 10

b. Derive dispersion model for non-ideal reactors. 10

Q.6 Write a note on ( Any four) 20

- Series and parallel reactions
- Effectiveness factor and Thiele modulus
- Perfusion reactor
- E curve, F curve and C curve for non-ideal reactors
- Air lift reactor