Ref. No.: Ex/FTBE/PC/B/T/225/2024

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2024
Subjects- CHEMICAL ENGINEERING KINETICS

Time: 3 Hrs **Full Marks: 100**

Use separate Answer-script for each Part.
(50 marks for each part)

Part – I (50 marks)

Answer question no 4 and any two from the following

1. An enzymatic catalytic reaction A →B exibit the following behavior
   a) A rate proportional to the concentration of enzyme introduce in to the mixture [E_o].
   b) At low reactant concentration the rate is proportional to the reactant concentration [A].
   c) At high reactant concentration the rate levels off and become independent of reactant concentration. (20)
2. In a microbial laboratory, three test tubes containing microbial cultures are placed in three hot baths, maintained at different temperatures 70^0C, 80^0C and 90^0C respectively. The following values of time-temp combination with respect to the no. of microorganisms (N) have been determined from the experiment. (20)

For 70^0C		**For 80^0C**		**For 90^0C**	
Time, t (s)	No. of microorganism, N	Time, t (s)	No. of microorganisms, N	Time, t (s)	No. of microorganisms N
0	10^7	0	10^7	0	10^7
30	10^5	30	10^5	30	$5x10^4$
60	10^4	60	$5x10^3$	60	10^3
120	10^3	120	10^2	120	550
180	500	180	50	180	150
300	10	300	1	300	1

Calculate how long it will take for the reduction of microorganisms to 1 in 1000 at 85^0C.

3. Reactant **A** decomposes in a batch reactor, A ⟶ B

The composition of A in the reactor is measured at various times with results shown in the following columns 1 and 2. Find a rate equation using the differential method to represent the data. (20)

Time (t, s)	Concentration ($C_{A,}$ mol/liter)
0	**C_{A0} =10**
30	**8**
50	**7**
70	**5**
90	**3**
110	**2**
130	**1**

4. How can you represent an elementary Reaction-explain with example? 10

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2nd Year 2nd Semester EXAMINATION **2024**

Subject: CHEMICAL ENGINEERING KINETICS (PC/B/T/225)

PART II (50 Marks)

Answer **Q.No.4(compulsory)** and any two from the following:

Q.1. **5×3= 15**

(i) In a porous cylindrical catalyst, what are the parameters that would affect the diffusion of the reactant?

(ii) For a Gas-Solid system, if the solid particle is surrounded by a gas film, which factors would affect the rate kinetics?

(iii) Estimate the ε_A for the reaction **A → 3R** containing 20% inert in the feed?

(iv) Estimate the molar feed rate of gaseous reactant A (mol/hr) if 20 lit/hr. pure A with concentration 100 mol/m^3 is fed to the reactor?

(v) Is Thiele modulus dimensionless?-justify your answer.

Q.2. Derive the concentration profile of the reactant A inside a purely single cylindrical pore of length L with initial concentration of A at the pore mouth equals to C_{As}. Also estimate the concentration of A at the midway of such cylindrical pore with Thiele modulus value equals to 0.6 **9+6 =15**

Q.3. Write short notes on the following: **3×5=15**

(i) Pore blocking (ii) Thiele modulus (iii) Performance equation of catalytic reactor

Q.4. The catalytic reaction A→ 4R is studied in a plug flow reactor using various amounts of catalyst and 20 liters/hr. of pure A feed at 3.2 atm and 117° C. The concentrations of A in the effluent stream is recorded for the various runs as follows: (Use graph paper)

Catalyst used (kg)	0.02	0.04	0.08	0.16
$C_{A,out}$ (mol/liter)	0.074	0.06	0.044	0.03

(i) Find the rate equation for this reaction (ii) Estimate the amount of the catalyst needed for 78% of A conversion? **16+4 =20**

Q.5 There are two different catalytic reactions to form the same product R as shown below: Both the reaction occurs in a PFR type fluidized reactor utilizing same catalyst but with different gaseous reactant A & B, respectively. Both the reaction was occurred at total pressure 4 atm. and at 107° C. For scheme 1, pure A is to be fed but for scheme 2, feed must contain 40% inert. For both the scheme, molar feed rate of A and B is kept constant at 2 kmol/hr. Estimate (i) the amount of catalyst to achieve 75% conversion of A & B, respectively (ii) If the catalyst cost Rs. 10,000/kg., then which scheme would be preferable for the same conversion?

A → R (scheme 1) $-r_A = 98$ (lit/kg. cat-hr) C_A

B → 2R (scheme 2) $-r_A = 96.5$ (lit/kg. cat-hr) C_A

12+3=15