U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 23BT5PCREN / 22BT5PCREN **Max Marks: 100**
Course: Reaction Engineering

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Derive an expression for conversion as a function of time for a reaction A→R in a constant volume batch reactor following $-r_A = kC_A^2$	CO2	PO 1	**4**
	b)	Distinguish between (i) molecularity and order of reaction (ii) Elementary and non-elementary reaction with examples.	CO2	PO 1	**6**
	c)	Calculate the activation energy for the Benzene diazonium chloride to give chlorobenzene and nitrogen using Arrhenius equation from the following data:	CO2	PO1	**10**
		OR			
2	a)	Distinguish between integral and differential method of analysis. Also give the steps for each of these methods.	CO2	PO1	**6**
	b)	Show that decomposition of N_2O_5 at 67 °C is a first order reaction. Calculate the value of the rate constant.	CO2	PO1	**10**
	c)	At 1100k n-nonane thermally cracks 20 times as rapidly as at 1000K.Find the activation energy for this decomposition using Arrhenius equation.	CO2	PO1	**4**
		UNIT - II			
3	a)	An aqueous feed of A and B (400 lit/min,100mmolA /lit,200mmol B/lit) is to be converted to product in a mixed flow reactor. The kinetics of the reaction is represented by A+B→R, $-r_A = 200C_AC_B$	3	2	**6**

Data for 1 c):

$k(Sec^{-1})$	0.00043	0.00103	0.0018	0.00355	0.00717
T(°C)	313	319	323	328	333

Data for 2 b):

Time (min)	0	1	2	3	4
$C_{N_2O_5}$ (mol/L)	0.16	0.13	0.08	0.056	0.04

		mol/L.min. Find the volume of reactor needed for 99% conversion of A to product.			
	b)	Compare batch reactor and continuous flow reactor with neat diagrams. Discuss in terms of cost, size comparison and application.	*CO2*	*PO1*	**7**
	c)	Derive performance equation for plug flow reactor. Give graphical representation of equation.	*CO2*	*PO1*	**7**
		OR			
4	a)	The kinetics of the aqueous phase decomposition of A is investigated in two mixed flow reactors in series, the second having twice the volume of the first reactor. At steady state with a feed concentration of 1 mol A/L and mean residence time of 96 sec in the first reactor, the concentration in the first reactor is 0.5 mol A/L and the second is 0.25 mol A/L. Find the kinetic equation of decomposition.	3	2	**8**
	b)	Draw and give description for a recycle reactor.	*CO2*	*PO1*	**6**
	c)	Compare mixed flow reactor with plug flow reactor with suitable diagrams and list their characteristics.	*CO2*	*PO1*	**6**
		UNIT - III			
5	a)	The concentration reading in the following table represent a continuous response to a pulse input into a closed vessel. Rate equation is given by $-r_A = kC_A$ where $k=0.307\ min^{-1}$. Plot E curve. Determine conversion in a real reactor.	3	2	**12**
	b)	Discuss conditions for non-ideality in flow reactors with neat illustrations.	*CO2*	*PO1*	**8**
		OR			
6	a)	List characteristics of tracer used. Explain RTD studies with pulse input and step input.	*CO2*	*PO1*	**8**
	b)	A reactor with a number of dividing baffles is to be used to run the reaction A →R with $-r_A=0.05\ C_A$ mol/L.min A pulse tracer test gives the following output curve Plot E curve and determine mean residence time.	3	2	**12**

Table for Q5 a):

t (min)	0	5	10	15	20	25	30	35
C (g/lit)	0	3	5	5	4	2	1	0

Table for Q6 b):

Time, min	0	10	20	30	40	50	60	70
C (g/L)	35	38	40	40	39	37	36	35

			UNIT - IV			
	7	a)	Briefly explain phases of cell growth in a batch bioreactor with the help of a suitable diagram.	*CO2*	*PO1*	**8**
		b)	Explain different models for growth inhibitors.	*CO2*	*PO1*	**6**
		c)	The specific growth rate for inhibited growth in a chemostat is given by $$\mu = \frac{\mu_{max} S}{k_s + S + I k_s / k_I}$$ where S_0 =10g/l, k_s =1 g/l I=0.05 g/l $Y_{X/S}$=0.1 g cells/g sub X_0=0 K_I= 0.01 g/l μ_m =0.5 h^{-1} (i) Determine X and S as a function of D when I =0 With inhibitor added to a chemostat, determine X and S as a function of D	3	2	**6**
			OR			
	8	a)	Explain the working of a chemostat with a neat labeled diagram. Derive the performance equation for cell concentration and substrate concentration in the absence of endogenous metabolism.	*CO2*	*PO1*	**10**
		b)	Ethanol formation from glucose is accomplished in a batch culture of *Saccharomyces cerevisiae* and the following data were obtained	*CO3*	*PO2*	**10**

Time (h)	Biomass (X) g/L	Glucose (S) g/L
0	0.5	100
2	1	95
5	2.1	85
10	4.8	58
15	7.7	30
20	9.6	12
25	10.4	5
30	10.7	2

Calculate (i) Maximum growth rate (ii) yield on substrate (iii) Mass doubling time

			UNIT - V			
	9	a)	Sketch and explain different bioreactor configurations used commonly in fermentation.	*CO2*	*PO1*	**10**
		b)	Explain different scale up methods used in bioprocesses.	*CO2*	*PO1*	**10**
			OR			
	10	a)	Explain construction and operation of a typical air-lift fermenter with a neat labeled diagram.	*CO2*	*PO1*	**10**
		b)	Discuss various scale-up criteria based on stirred tank bioreactors.	*CO2*	*PO1*	**10**

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