Register Number:……..

KUMARAGURU
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B.TECH DEGREE EXAMINATIONS: MAY 2017

(Regulation 2014)

Sixth Semester

BIOTECHNOLOGY

U14BTT604: Bioreactor Analysis and Design

COURSE OUTCOMES

CO1: The student would remember and understand the basic principles of reaction mechanism and kinetics

CO2: The students would apply non-ideal systems in bioreactors

CO3: The students would design single bioreactors for submerged fermentation

CO4: The students would design multiple bioreactors for submerged fermentation

CO5: The students would design bioreactors from mechanical aspects

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Radioactive decay follows _____ order kinetics CO1 [K_2]

   a) First b) Second

   c) Third d) Zero

2. Match the type of reactor with mixing type CO1 [K_2]

List I	List II
A. Batch reactor	i. No mixing
B. CSTR	ii. Uniform mixing
C. PFR	iii. Radial mixing
D. Packed Bed Reactor	iv. No axial mixing

   a) A-i, B-ii, C-iii, D-iv b) A-ii, B-iii, C-iv, D-i

   c) A-iii, B-iv, C-i, D-ii d) A-iv, B-i, C-ii, D-iii

3. In zeroth order reactions, reactions are ----------of the substrate concentration CO2 [K_2]

   a) More dependent b) dependent

   c) Independent d) Partially dependent

4. Which of the following statement(s) is/are true about non- ideal reactor? CO2 [K_3]

P. F- curve is drawn for step input

Q. C-curve is drawn for pulse input

R. In non-ideal system, there is no change in residence time of the particle

S. In plug flow reactor, there is no longitudinal mixing take place.

a) P,Q b) P,R

c) R,S d) Q,R

5. In a continuous flow stirred tank reactor, the composition of the exit stream is CO3 [K_3]

a) Same as that in the reactor. b) Different than that in the reactor.

c) Depends upon the flow rate of inlet stream. d) Similar to the inlet stream

6. For a reaction of the type, $V \xrightarrow{K1} x \xrightarrow{K2} y \xrightarrow{K3} Z$, the rate of reaction ($-r_x$) is given by CO3 [$K_2$]

a) $(K_1+K_1)\,C_x$ b) $(K_1+K_2+K_3)\,C_x$

c) $(K_1C_V)-(K_2C_x)$ d) $(K_1-K_2)\,C_x$

7. In steady state shell mass balance equation , the substrate partition coefficient is CO4 [K_2]

a) Zero b) Greater than 1

c) Unity d) Not equal to one

8. **Assertion (A):** The rate of a chemical reaction should be proportional to the concentration of the reactant CO L [K_4]

Reason (R): The rate of the reaction depends on the number of collisions.

a) Both A and R individually true and R is the correct explanation of A b) Both A and R individually true and R is not correct explanation of A

c) A is false but R is true d) A is true but R is false

9. External mass transfer effects are eliminated by CO4 [K_2]

a) Reducing the rate of reaction b) Decreasing the mass transfer coefficent

c) Increasing the size of the catalyst d) Decreasing the bulk concentration

10. Matching type item with multiple choice code CO2 [K_3]

List I (Dimensionless no.)	List II (Definition)
A. Damkholar No.	i. First order kinetics x time
B. Pecklet No	ii. Dispersion effect in PFR
C. Axial dispersion No	iii. (UxL)/De
D. Hatta No.	iv. Rate of diffusion through film

	A	B	C	D
a)	ii	i	iii	iv
b)	i	iv	ii	iii
c)	i	iii	ii	iv
d)	iii	ii	i	iv

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11.	Why is microbial system preferred over enzymatic system?	CO1	[K_4]
12.	Write any two performance equations of ideal batch reactor	CO1	[K_2]
13.	Distinguish between an ideal reactor and non-ideal reactor	CO2	[K_3]
14.	Define RTD.	CO2	[K_2]
15.	Analyse reasons for non-ideality in bioreactor performance.	CO3	[K_4]
16.	Draw sketch for a bioreactor and label its components	CO3	[K_3]
17.	Differentiate packed-bed reactor with fluidized bed reactor	CO4	[K_3]
18.	Define an effective factor.	CO4	[K_2]
19.	Relate the functions of a baffle with mixing.	CO5	[K_3]
20.	How is Reynolds number useful while designing a bioreactor?	CO5	[K_4]

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. Derive an expression for the search mechanism for enzyme catalyzed reaction. CO1 [K_4]

22. In studying the kinetics of degradation of synthetic dyes using microorganism, the concentration of synthetic dye were determined periodically with respect to time. The following results were obtained. CO1 [K_4]

Time (min)	0	10	20	40	100	125
Concentration of synthetic dyes (mol/lit)	0.10	0.0714	0.055	0.0385	0.02	0.0167

Determine the order and rate constant for the biochemical reaction

23. A 15-m^3 chemostat is operated with dilution rate 0.1 h^{-1}. A continuous steriliser with steam injection and flash cooling delivers sterilised medium to the fermenter. Medium in the holding section of the steriliser is maintained at 130˚C. The concentration of contaminants in the raw medium is 105 ml $^{-1}$; an acceptable contamination risk is one organism every 3 months. The Arrhenius constant and activation energy for thermal death are estimated as 7.531039 h^{-1} and 288.5 kJ $gmol^{-1}$, respectively. The inner diameter of the steriliser pipe is 12 cm. At 130˚C, the liquid density is 1000 kg m^{-3} and the viscosity is 4 kg m^{-1} h^{-1}. CO2 [K_4]

a) Assuming perfect plug flow, determine the length of the holding section.
b) What length is required if axial dispersion effects are taken into account?

24. Describe the design aspects of plug flow tubular bioreactor used for submerged fermentation. CO3 [K_3]

25. Explain the formulation of dimensionless groups and calculation of effectiveness factors for immobilized cells. CO4 [K_4]

26. The enzyme urease is immobilized in alginate beads. For this system calculate the effective factor and also determine the film and pore diffusion effect on the kinetics. CO4 [K_3]

27. Discuss the guidelines to design a typical stirred tank reactor and add note on critical factors to be considered. CO5 [K_5]

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