U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 19BT5DCREN **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.

UNIT - I

1 a) Distinguish between integral method and differential method of analysis. **05**

b) The rate of reaction at 40°C is three times the rate at 20°C. determine the activation energy of reaction. **05**

c) Derive the integral form of rate equation for irreversible bimolecular type, second order reaction. Represent the rate equation in the form of linear plot by marking slope and intercept. **10**

UNIT - II

2 a) Derive design equation for ideal mixed flow reactor stating the conditions and suitable diagram. Also deduce the performance equation for a first order reaction in a mixed flow reactor. **10**

b) One litre per minute of liquid containing A and B (C_{A0} = 0.1 mol/L, C_{B0} = 0.01 mol/L) flow into a mixed reactor of volume V =1 L. The material react in a complex manner for which the stoichiometry is not known. The outlet stream from the reactor contains A, B, and C (C_{Af} = 0.02 mol/L, C_{Bf} = 0.03 mol/L, C_{Cf} = 0.04 mol/L). Determine the rate of reaction of A, B, and C for the conditions within the reactor. **06**

c) Define space time and space velocity. **04**

OR

3 a) Derive the performance of recycle reactor with recycle ratio R. Show that reactor approaches plug flow when R is zero and reactor approaches mixed flow when R is infinity. **10**

b) Pure gaseous reactant A (C_{Ao} = 100 mmol/L) is fed at a steady rate into a mixed flow reactor (V = 0.1 L) where it dimerizes (2A→ R). For different **10**

gas feed rates the following data are obtained:

Run number	1	2	3	4
v_o, L/h	10.0	3.0	1.2	0.5
C_{Af}, mmol/L	85.7	66.7	50	33.4

Determine the rate equation for this reaction.

UNIT - III

4 a) A sample of the tracer at 320K was injected as a pulse to a reactor and the effluent concentration measured as a function of time, resulting in the following data: **10**

t (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

The measurements represent the exact concentrations at the times listed and not average values between the various sampling tests.

1. Construct figures showing C(t) and E(t) as function of time.
2. Determine both the fraction of material leaving the reactor that has spent between 3 and 6 min in the reactor and 3 min or less

b) Derive the equation for Tanks-in-series model. What is the significance of this model? **10**

UNIT - IV

5 a) Draw a diagram depicting the various stages in microbial batch growth phase. Explain and give the kinetic equations with respect to exponential and stationary phases. **06**

b) Derive the equation to determine the dilution rate, cell mass concentration and substrate concentration with endogenous metabolism and without endogenous metabolism for cell growth in ideal chemostat. **10**

c) Differentiate between growth associated and non-growth associated product formation. **04**

UNIT - V

6 a) Draw fed batch bioreactor and explain its working principle. Give advantages and disadvantages. **10**

b) Describe the various strategies need to be used for stability of the bioreactors. **10**

OR

7 a) Mention any four criteria for selection of bioreactors with respect to physic-chemical properties. **06**

b) Explain the working principle of fluidized bed bioreactors with a neat diagram. **08**

c) How the bioreactor is can be scaled up for fermentation process based on oxygen mass transfer rate? Explain. **06**

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