

2056
B.E. (Biotechnology) Fourth Semester
BIO-413: Chemical Reaction Engineering

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section.

x-x-x

1. Attempt the following:-
 - a) What are autocatalytic reactions?
 - b) Express temperature dependency of the reaction rate constant.
 - c) What are tracer studies?
 - d) Define instantaneous fractional yield for parallel reactions.
 - e) For the equation $A \rightarrow 3R$; calculate E_A .
 - f) What are non-elementary reactions?
 - g) Define product inhibition with example.
 - h) Define Performance equation.
 - i) Deduce material balance for a reactant for a reaction in batch reactor.
 - j) Suggest a suitable ordering of reactors (small mixed, plug, large mixed) for positive order reactions.

(10)

Section-A

2.
 - i) Briefly explain the following terms: Space time, mean residence time and space velocity.
 - ii) Discuss possible causes of non-idealities in real reactors. Also, brief how various tracer inputs can be used to establish deviations from ideal behavior.
 - iii) Design and justify optimum temperature progression for reversible endothermic & reversible exothermic reactions using a given feed material.
3.
 - i) A gaseous feed of pure A (2 mol/liter, 100 mol/min.) decomposes to give a variety of products in a plug flow reactor. The kinetics of conversion is represented by
$$A \rightarrow 2.5 \text{ Products, } -r_A = (10 \text{ min}^{-1}).C_A.$$
Find the expected conversion in 22-liter reactor.
 - ii) Explain how you would determine the rate constants for a homogeneous catalyzed reaction in a constant-volume batch reactor.
4. The zero order reaction is carried out in a CSTR and in a PFR.

(3,4,3)

(5,5)



For an entering volumetric flow rate of $10 \text{ dm}^3/\text{s}$ at a concentration of 0.5 mol/dm^3 what is the space time for each reactor to achieve 90% conversion? ($k_A = 0.01 \text{ mol/dm}^3 \text{ s}$)

(10)

P.T.O.

(2)

Section-B

5. i) A reaction $A+B \rightarrow C$ takes place in a two stage CSTR, one of the volume 100 m^3 and the other is 25 m^3 . The volumetric feed rate is 20 lit/min . It is given that $C_A=C_B=1.5 \text{ gm mol/lit}$ and the overall rate constant is $0.010 \text{ lit/ gm mol min}$. Calculate the overall conversion.
- ii) Discuss how best you will arrange two unequal-sized stirred tank reactors for a given conversion and reaction order. (6,4)
6. i) For any irreversible series reaction discuss the optimum contact pattern for the favorable product distribution.
- ii) An elementary reaction $A \rightarrow R \rightarrow S$, takes place in a mixed flow reactor. Find the condition (time) when maximum concentration of intermediate is achieved. (6,4)
7. i) Discuss in details the kinetics of substrate utilization for a microbial fermentation in a batch culture. Express graphically how would you determine k_s from the given data?
- ii) With the help of the plots, compare the toxin and substrate limiting microbial growth. (6,4)

x-x-x