Department of Biosciences and Bioengineering
Indian Institute of Technology Guwahati
January – May, 2024

Mid Semester Examination (Closed book)

Course No.: **BT209** Course Title: **Bioreaction Engineering**
Duration: **2 hours** Full marks = **30** Dated: **25.02.2024**

Note: i) There are four questions. Answer all questions.

ii) Clearly state the assumptions whenever required. Label what part of the problem you are working on, and define the symbols that you use.

Q1. **(5×1=5 marks)**

(i) For identical feed composition, flow rate, conversion and for zero order reactions, the ratio of volume of mixed flow reactor to the volume of plug flow reactor is
(a) Zero (b) one (c) < 1 (d) >1

(ii) The half-life time ($t_{1/2}$) of a zero order reaction $A \xrightarrow{k} P$ is given by
(a) C_{A0}/k (b) 0.693/k (c) $C_{A0}/2k$ (d) none of these

(iii) If the time required to change the concentration of reactant to half of its original value is independent of the initial concentration, the order of reaction is
(a) zero (b) one (c) two (d) three

(iv) Under what condition space time and mean residence time of the flow reactor are same?
(a) constant volume system (b) varying volume system
(c) homogeneous system (d)) it will never be same

(v) For a given conversion and for reaction order $0 < n < 1$, a mixed flow reactor is always smaller than that for a plug flow reactor. (True/False)

Q2. From steady-state kinetics runs in a mixed flow reactor, we obtain the following data on the reaction $A \rightarrow R$.

τ, sec	C_{A0}, mol/liter	C_A, mol/liter
60	50	20
35	100	40
11	100	60
20	200	80
11	200	100

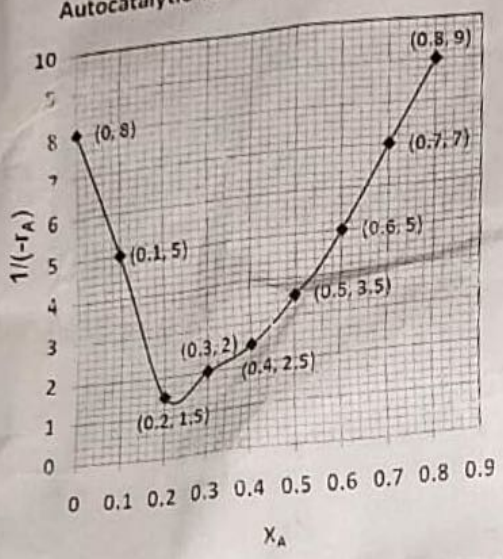
Find the space time needed to treat a feed of C_{A0} = 100 mol/liter to 80% conversion in a plug flow reactor (PFR) **(5 marks)**

Q3. A first order reaction is to be treated in a series of two mixed reactors. Show that the total volume of the two reactors is minimum when the reactors are equal in size. Assume constant density system, isothermal and steady state operation. **(10 marks)**

Q4. In the hippopotamus, digestion occurs as an autocatalytic reaction in the stomach followed by a catalytic reaction in the intestines. This system can be modeled as a series of CSTR-PFR. The volumetric flow rate of food intake into the system can be assumed to be 100 liters/day, at a concentration of 7.5 mol/liter. The volume of the stomach (modeled as CSTR) is 450 liters. Reciprocal rates (liter-day/moles) for the two types of reactions are provided below. If the total conversion of 50% is observed, what is the volume of the intestines?

(10 marks)

Autocatalytic reaction in the stomach



Catalytic reaction in the intestines