BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B.TECH **SEMESTER : V**
BRANCH: BIOTECHNOLOGY **SESSION : MO/2022**

SUBJECT: BE304 REACTION ENGINEERING

TIME: 3:00 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Discuss the reaction rate of homogeneous reactions. [2]

Q.1(b) For a reactant A (initial concentration C_{Ao}), its C_A varies according to $(1/C_A) - (1/C_{Ao}) = k\,t$. where 't' is time and 'k' is kinetic constant. Derive an expression for the rate of reaction. [3]

Q.1(c) (i) Milk is pasteurized if it is heated to 63^0C for 30 minutes, but if it is heated to 74^0C it only needs 15 seconds for the same result. Find the activation energy for this sterilization [2x2.5=5]
(ii) The pyrolysis of ethane proceeds with an activation energy of about 300 kJ/mol. How much faster is the decomposition at 650°C than at 500^0C?

Q.2(a) (i) What is €a in variable density system [1+1=2]
(ii) Find €a on this reaction: A→3R.

Q.2(b) When a concentrated urea solution is stored, it slowly condenses to biuret by the following elementary reaction: [3]

2 NH2-CO-NH2→ NH2-CO-NH-CO-NH2 + NH3

To study the rate of condensation a sample of urea (C = 20 milliliter) is stored at 100°C and after 7 hr 40 min we find that 1 mol% has turned into biuret. Find the rate equation for this condensation reaction.

Q.2(c) In the hippopotamus, digestion occurs as an autocatalytic reaction in the stomach followed by a catalytic reaction in the intestines. This system can be modelled as a series of CSTR-PFR. The volumetric flow rate of food intake into the system can be assumed to be 100 L/day, at a concentration of 7.5 mol/L. The volume of the stomach (modelled as CSTR) is 450 L. Reciprocal rates (in moles/L-day) for the two types of reactions are provided in figures in the data sheet. If the total conversion of 50% is observed, what is the volume of the intestines? [5]
(Note: Required data is provided separately at the end of the question paper).

Q.3(a) What are the different factors to be considered for reactor design? [2]

Q.3(b) A liquid reactant stream (1 mol/L) passes through two MFR's in series. The concentration in the exit stream of the first reactor is 0.5mol/L. Find the concentration in the exit stream of the second reactor. The reaction is second order with respect to 'A' and $V_2/V_1 = 2$ [3]

Q.3(c) A gaseous feed of pure A with C_{A0} = 1 mol/L enters a mixed flow reactor of 2-liter volume and reacts to give R. The reaction kinetics and stoichiometry are given by [5]
$2A \rightarrow R$, $-r_A = 0.05C_{A2}$ mol / (L.s). Find the feed rate (L /min) that will give an outlet concentration C_A=0.5 mol/L.

Q.4(a) Define Recycle ratio and give its significance of varying it from 0 to ∞ [2]

Q.4(b) An aqueous reactant stream with CA0 = 4 mol/L passes through a mixed flow reactor followed by a plug flow reactor. Determine the concentration at the exit of the plug flow reactor if CA = 1 mol/L in the mixed reactor. The reaction is second order with respect to A and Vplug/Vmixed = 3. [3]

Q.4(c) In an isothermal batch reactor, 70% of reactant A is converted in 13 minutes. Find the space time and space velocity needed to effect this conversion [2.5 + 2.5 = 5]
(i) in a plug flow reactor and
(ii) in a mixed flow reactor

Q.5(a) (i) What do you mean by effective diffusivity? [1+1=2]
(ii) Define effectiveness factor.

Q.5(b) The general reaction stoichiometry for G/L reactions on solid catalyst is [3]
$aA(g)\ (g \rightarrow l) + b\,B\ (l) \xrightarrow{on\ catalyst\ surface} \text{Products}$.

State the sequence of steps involved in the overall reaction process for G/L reactions on solid catalyst.

PTO

Q.5(c) While being shown around Lumphead Laboratories, you stop to view a reactor used to obtain kinetic data. It consists of a 5-cm inner diameter glass column packed with a 30-cm height of active catalyst. Is this a differential or integral reactor? Explain your answer. [5]

:::::24/11/2022:::::M

DATA SHEET

Data for Q 2 (c)