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

CLASS: BE **SEMESTER : V**
BRANCH: CHEM/P&P **SESSION : MO/19**

SUBJECT: CL5005 CHEMICAL REACTION ENGINEERING

TIME: 3 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
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) Define order and molecularity of a reaction. [2]

Q.1(b) What is activation energy? How does a catalyst affect the activation energy of a chemical reaction? [4]

Q.1(c) The first-order reversible liquid phase reaction ($\varepsilon_A = 0$) [6]

$$A \underset{k_2}{\overset{k_1}{\rightleftarrows}} R, \quad C_{A0} = 0.5 \text{ mol/liter}, \quad C_{R0} = 0$$

takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate constants of this reaction.

Q.2(a) Write down the general mole balance equation for batch and plug flow reactors. [2]

Q.2(b) A second order liquid phase reaction ($2A \rightarrow$ Product) is carried out in a CSTR. Derive an expression for conversion of A in terms of τ, k, and C_{Ao}. The notations have their usual meaning. [4]

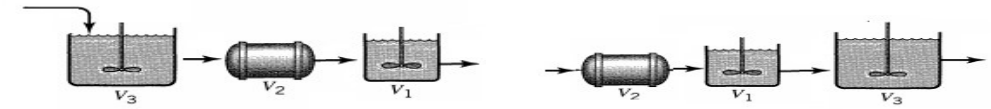
Q.2(c) The following table represents the kinetic data of a reaction A → B + C. [6]

X_A	0	0.1	0.2	0.4	0.6	0.7	0.8
$-r_A$	0.45	0.37	0.3003	0.195	0.113	0.0787	0.05

Find the volume of a CSTR to achieve 90% conversion. The initial molar concentration and volumetric flow rate are 0.09 mol/liter and 5 liter/s respectively.

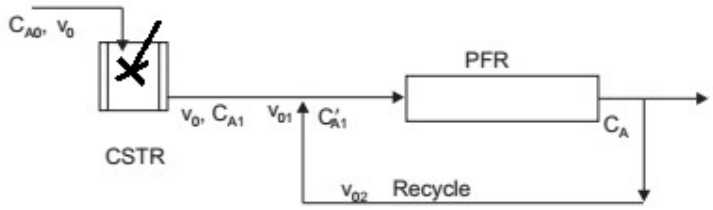
Q.3(a) What is Damköhler no. How does it related to conversion of a chemical reaction? [2]

Q.3(b) Which combination from the following figure should be preferred to achieve highest conversion for 2nd order and first order reactions? Explain graphically. Here V1<V2<V3 [4]



Why is recycle reactor best for autocatalytic reaction?

Q.3(c) A liquid phase reaction $A \rightarrow R + S$ takes place in a system consisting of a CSTR and a PFR reactor with recycle. One introduces1 kmol/m^3 of reagent A into the first reactor. Both CSTR and PFR operate isothermally at 300°C and atmospheric pressure. The volume of the first reactor is 0.086 m^3 and the inlet flow is 0.0016 m^3/s. The conversion at the outlet of the PFR is 90%. [6]
It is a first-order reaction and the rate is $(-r_A) = 8\,C_A$ kmol/(m^3 h). Calculate the PFR volume considering a recycle ratio of $R = 1$.



Q.4(a) What is meant by active site? What are the interactive forces acting in chemisorption? [2]

Q.4(b) Discuses and derive the expression for Langmuir adsorption isotherm [4]

Q.4(c) Derive the rate expression in terms of gas phase concentration for the following reaction [6]

$$A(g) + B(g) \overset{Catalyst}{\rightleftharpoons} C(g)$$

where surface reaction is the rate controlling step.

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Q.5(a) Discuss various factors that causes non-ideality of reactors. [2]

Q.5(b) List the differences between E(t) and F(t) functions. Derive E(t) function for pulse input in a CSTR. Also find the variance. [4]

Q.5(c) A sample of tracer was injected as pulse to a reactor and the effluent concentration measured as a function of time. The results are [6]

T (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (mol/m3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

Calculate the mean residence time.

Q.6(a) Write the names of the parameters in tanks in series model and dispersion model. [2]

Q.6(b) Discuss the different boundary conditions in dispersion model. [4]

Q.6(c) For tanks in series model, Prove that [6]

$$\sigma_\theta^2 = \frac{1}{N}$$

The notations have their usual meaning.

Q.7(a) Define homopolymer and copolymer. [2]

Q.7(b) Show the structure of linear, branched and crosslinked polymers. Cite the differences between addition polymerization and condensation polymerization. [4]

Q.7(c) Compare between emulsion polymerization and suspension polymerization. Mention the disadvantages of emulsion polymerization with respect to other polymerization techniques. [6]

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