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

CLASS: BE **SEMESTER : V**
BRANCH: BIOTECHNOLOGY **SESSION : MO/18**

SUBJECT: BT5027 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 the term 'specific reaction rate' and 'rate of reaction. [2]

Q.1(b) (i) What are the various intermediates that can be formed in a non-elementary reaction? [2+2=4]
(ii) What are the variables affecting the rate of reaction?

Q.1(c) A certain reaction has a rate given by $-r_A = 0.005C_A^2$, mol / (cm^3.min). If the concentration is expressed in mol / ***l*** and time in hours, what would be the value and units of rate constant? [6]

Q.2(a) What is activation energy? [2]

Q.2(b) At 25^0C, the rate constant for the hydrolysis of ethyl acetate by NaOH is 6.5 ***l*** mol.min^{-1} starting with concentration of base and ester of 0.03 mol / ***l*** of each. What proportion of ester will be hydrolyzed in 10 min? [4]

Q.2(c) The half life periods for decomposition of PH_3 for different initial pressures are given below: [6]

p, torr	707	79	37.5
$t_{1/2}$, min	84	84	84

Confirm order of the reaction.

Q.3(a) Define Half life of the reaction. [2]

Q.3(b) For an irreversible gas phase reaction $2A \rightarrow 3R$, determine the value of ε_A if the feed is a mixture of 50% A and 50% inert. [1+3=4]
(ii) What are ideal reactors? What are the different factors to be considered for reactor design?

Q.3(c) In an isothermal batch reactor the conversion of a liquid reactant A is 70% in 13 min. Find the space time and space velocity necessary to effect this conversion in a plug flow reactor and in mixed flow reactor. Consider first order kinetics. [6]

Q.4(a) What is a mixed flow reactor? What is a plug flow reactor? Is a plug flow reactor different from a tubular flow reactor? [2]

Q.4(b) (i) Which reactors performance is identical for constant density systems? [2+2=4]
(ii) Distinguish between Holding time and Space time for flow reactors.

Q.4(c) A homogeneous gas reaction $A \rightarrow 2R$ proceeds with $-r_A = 10^{-1} C_A$ mol / ***l*** s at $200\ ^0$C. Find the space time required to achieve 70% conversion of a 40% A and 60% inerts feed to plug flow reactor operating at 200^0C and 5 atm pressure. The initial concentration of A is 0.0625 mol / ***l*** [6]

Q.5(a) What is the basis of modelling non-ideal behaviour in reactor? [2]

Q.5(b) Explain the reasons for non-ideality of reactors? [4]

Q.5(c) Write short notes on: Residence time distribution studies [6]

Q.6(a) Explain the various steps involved in the transport of reactant to active site of catalysts and desorption of products [2]

Q.6(b) Consider a porous catalyst particle catalysing the reactant of A to product B. What are the factors affecting the rates of reactant A in the presence of the porous catalyst? [4]

Q.6(c) Analyse the intra-particle (assume spherical particles) diffusion and biochemical reaction simultaneously with the help of law of conservation of mass. [6]

Q.7(a) What is the Michaelis - Menten kinetic scheme and how does this explain generally the observed kinetics? [2]

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Q.7(b) (i) What is meant by saturation kinetics? [2+2=4]
(ii) Why is the rate of an enzyme-catalyzed reaction proportional to the amount of ES complex?

Q.7(c) The isomerisation of 5 x 10^{-2} $mol.dm^{-1}$ bulk concentration of glucose to fructose is conducted at 313K in a batch reactor using immobilised glucose isomerase. The reaction exhibits reversible M-M kinetics and is characterised by K_m value of $2x10^{-3}$ $mol.dm^{-1}$. The determined effectiveness factor η of 0.7 reveals an appreciable contribution of mass transport to the measured reaction rate. Calculate the substrate concentration at the solid- liquid interface under these conditions. (*you may neglect internal mass transfer*). [6]

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