QP Code: SN23BTECH207 | Reg. No | | | | | | | | | | | AY 23

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur (GIET University)

B. Tech (Fifth Semester - Regular) Examinations, November 2025

23BCHPC35002 – Chemical Reaction Engineering-I

(Chemical Engineering)

Time: 3 hrs | Maximum: 70 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

	Question	CO #	Blooms Level
a.	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?	CO2	K3
b.	Differentiate elementary and non-elementary reaction.	CO1	K2
c.	What is pseudo first order reaction?	CO1	K2
d.	Which is the most favorable contacting pattern to get maximum R in $A \overset{k_1}{\rightarrow} R \overset{k_2}{\rightarrow} S$ among PFR and MFR? Justify the answer.	CO3	K4
e.	What should be the objective of designing the multiple reactions system?	CO2	K3

PART – B **(10 x 5 = 50 Marks)**

<u>Answer ***ALL*** the questions</u>

	Question	Marks	CO #	Blooms Level
2. a.	Discuss about the classification of reactions with examples.	4	CO1	K1
b.	A rocket mixture burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen). The combustion chamber is cylindrical, 75cm long and 60 cm in diameter and the combustion process produces 108 kg /sec of exhaust gases. If the combustion is complete, find the rate of reaction of hydrogen and of oxygen.	6	CO3	K4
	(OR)			
c.	Classify the different types of intermediates with examples considered in homogeneous chemical reactions.	4	CO1	K2
d.	In a certain Kinetic study, the rate constants were found to vary with temperature in the following manner. K x 10^3 (min^{-1}): 4.15 26.8 114 246 T (K) : 573 600 623.5 635 Evaluate the activation energy & Arrhenius constant.	6	CO2	K3
3.a.	Derive the performance equation for a constant volume batch reactor following first order rate kinetics of the type $A \rightarrow Products$ with concentration vs time grapgh	5	CO2	K4
b.	A parallel liquid phase reaction $A \rightarrow R \; and \; A \rightarrow S$ having rate constants k_1 = 5 h^{-1} and k_2 =0.8 h^{-1} respectively. Find moles of R produced in 15 min. Data: $C_{A_0} = 8.5 \frac{mol}{lit}$, $C_{R_0} = 0 \; and \; C_{S_0} = 0$	5	CO2	K3
	(OR)			

c. Derive the performance equation for a variable volume batch reactor following 1st order rate kinetics — 5 CO2 K4

d. In a batch reactor, reactant is 70% converted after 8 min and 90% converted after 18%. Find the rate expression to represent this reaction of C_{A0}= 1 mol/l. — 5 CO2 K3

4.a. Derive the design equation of plug flow reactor from its material balance equation. — 5 CO2 K4

b. Gaseous reactant A decomposes as follows.

$$A \rightarrow 3R, \; -r_A = 0.6 \text{ min}^{-1} C_A$$

Find the space time and conversion of A in 50% A-50% inert feed having flow rate 180 lit/min and C_{A0}=300 mol/lit, to a 1 m^3 mixed flow reactor — 5 CO2 K3

(OR)

c. Derive an expression relating the volume of mixed flow reactor and conversion from material balance and draw $1/(-r_A)$ vs. X_A plot. — 5 CO3 K4

d. A zero order reaction (A → R) with rate constant 10 occurs in a plug flow reactor. Find the volume required to achieve 90 % conversion with initial concentration of reactant 100 mol/lit and volumetric flow rate of reactant 25 lit/min. — 5 CO2 K3

5.a. Do the qualitative discussion of product distribution for the parallel reaction of a single reactant of the type, — 10 CO3 K4

$$A \rightarrow R(desired) \qquad \frac{dC_R}{dT} = k_1 C_A^a$$

$$and \;\; A \rightarrow S\;(undesired).\frac{dC_S}{dT} = k_1 C_A^b$$

(OR)

b. Consider the aq. phase reactions

A+B ⟶ R (desired), $-r_R = k_1 C_A^{1.5}\, C_B^{0.3}$ mol/ (lit.min)

A+B ⟶ S (undesired) $r_S = k_2\, C_A^{0.5}\, C_B^{1.8}$ mol/ (lit.min)

For 90% conversion of A find the concentration of R in the product stream. Equal volumetric flow rates of A and B streams are fed to the reactor, and each stream has a concentration of 20 mol/lit of reactant. The flow in the reactor follows (a) plug flow (b) mixed flow.. — 10 CO3 K4

6.a. Reactant A in a liquid produces R and S by the following reactions:

$$A \longrightarrow R$$
$$A \longrightarrow S$$

Both these reactions are first order. — 10 CO3 K4

A feed with C_{A0} =1 C_{R0} = 0 and C_{S0} = 0 enters in two mixed flow reactors in series (τ_1=2 min, τ_2 =5 min). The composition in the first reactor is C_{A1} =0.4 C_{R1} = 0.4 and C_{S1} = 0.2. Find the composition leaving the second reactor

(OR)

b. Discus quantitatively the product distribution for the unimolecular first order reaction of the type $A \rightarrow R \rightarrow S,$ having k_1 and k_2 as rate constants respectively for PFR and MFR. Also compare the distribution of C_R in the two reactors. — 10 CO2 K4

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