QP Code: RA22BTECH412 Reg. No | | | | | | | | | | AR 21/22

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

B. Tech (Sixth Semester – Regular/Supplementary) Examinations, April 2025

21BCHPC36003/22BCHPC36003 – Chemical Reaction Engineering-II

(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

		CO #	Blooms Level
a.	What is the purpose of evaluating the Residence Time Distribution (RTD) in a chemical reactor?	CO1	K1
b.	Compare the advantages of heterogeneous catalysis over homogeneous catalysis.	CO2	K2
c.	Explain the function of a catalyst in a chemical reaction.	CO2	K2
d.	Identify the reasons for catalyst deactivation in catalytic reactions.	CO1	K3
e.	List two examples of fluid-particle reactions without change in particle size.	CO1	K1

PART – B **(15 x 4 = 60 Marks)**

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

		Marks	CO #	Blooms Level
2. a.	Define Dirac-delta function. What is the value of $\int_2^4 \delta(t-3)\, t^3 dt$	3	CO1	K1
b.	A pulse of tracer was injected into a reactor and the effluent concentration was measured as a function of time. The resulting data are given in the table below:	12	CO2	K4

t, min	0	1	2	3	4	5	6	7	8	9	10	12	14
C, g/ m^3	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

Construct C-curve and E-curve and calculate the following:

(a) Fraction of material leaving the reactor that has spent between 3 and 6 minutes in the reactor

(b) Mean residence time of the reactor.

(c) Fraction of material leaving the reactor that has spent 3 min or less in the reactor.

(OR)

c.	Calculate the mean residence time and variance of the tracer. A sample of tracer hytane was injected as a pulse to a tracer and the effluent concentration measured as a function of time, resulting the following data:	10	CO2	K4

t, min	0	1	2	3	4	5	6	7	8	9	10	12	14
C, g/m^3	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

d.	Write the advantages and disadvantages of step input method for calculating RTD.	5	CO1	K2
3.a.	Find the rate expression for coal combustion process $C + O_2(g) \rightarrow CO_2(g)$ assuming first order irreversible reaction	8	CO3	K4
b.	Write the steps of mechanism of solid catalysed reaction by showing in a diagram.	7	CO1	K1

(OR)

c.	The decomposition of Cumin results Benzene and Propylene in the presence of Pt as catalyst. Write the mechanism steps for non-diffusion-limited reaction. Develop the rate law for the above reaction assuming surface reaction rate controlling.	10	CO2	K3
d.	Describe the mechanisms of surface reaction in solid catalysed reaction.	5	CO3	K3
4.a.	Derive the expression for the concentration profile inside the porous catalyst considering cylindrical pore and first order reaction	10	CO2	K3
b.	Explain the non-isothermal condition developed during the reaction in a porous catalyst. Write the expression for temperature difference in film and within particle.	5	CO1	K2

(OR)

c. Consider a catalytic reaction $A \rightarrow 4R$ is studied in PFR using various amount of catalyst and 20 lit/ hr of pure A feed at 3.2 atm and 117 ^{0}C. The concentration of A in the effluent stream is recorded for the various work as follows — 10 — CO2 — K4

Run	1	2	3	4
C_{Ain}, mol/lit	0.02	0.04	0.08	0.16
C_{Aout}, mol/lit	0.074	0.060	0.044	0.029

Find the rate equation to represent this reaction using integral method of analysis

d.	Differentiate differential reactor and integral reactors for finding the rates from experimental data of solid catalysed reaction.	5	CO1	K2
5.a.	What are the different types of models considered for fluid-particle reaction? How will it be selected?	8	CO1	K3
b.	Derive the performance equation relating time with radius and conversion, considering diffusion through gas film control in shrinking core model of unchanging size for spherical particle	7	CO3	K4

(OR)

c.	What are the steps of succession during reaction in shrinking core model for spherical particles of unchanging size?	5	CO1	K1
d.	Derive the performance equation relating time with radius and conversion, considering chemical reaction control in shrinking core model of unchanging size for spherical particle	10	CO3	K4

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