Register No : _____

THE KAVERY ENGINEERING COLLEGE

(An Autonomous Institution)

B.E/B.TECH DEGREE END SEMESTER THEORY EXAMINATIONS, NOV /DEC 2024

Seventh Semester

Chemical Engineering

CH3701 – Chemical Reaction Engineering II

Regulations - 2021

Duration : 3 Hrs *Maximum : 100 Marks*

*PART – A (ANSWER ALL QUESTIONS) (Marks 10*2=20)*

Q.No	*Questions*	*BLT*	*CO*	*Marks*
1.	Give two examples of fluid-solid reaction in which the particles do not change their size on reaction.	RE	1	2
2.	In a gas-solid non-catalytic reaction, a 4 mm solid is 7/8th converted. What is the diameter of the shrinking core?	AP	1	2
3.	Does a catalyst alter equilibrium conversion of a chemical reaction? Explain.	UN	2	2
4.	Tell the general characteristics of catalysis.	RE	2	2
5.	List the advantages of the Langmuir-Hinshelwood method in developing rate equations.	RE	3	2
6.	What do you mean by rate controlling step in heterogeneous reactions?	RE	3	2
7.	Recall the significance of effectiveness factor.	RE	4	2
8.	Define thiele modulus and give its significance.	RE	4	2
9.	"Enhancement factor is always greater than or equal to one". Justify this statement.	EV	5	2
10.	Define Hatta number.	RE	5	2

*PART – B (ANSWER ALL QUESTIONS) (Marks 5*13 = 65)*

Q.No		*Questions*	*BLT*	*CO*	*Marks*
11.	a	Develop the relationship between time and conversion when diffusion through ash layer controls a fluid-solid reaction as per the shrinking core model. Also, show that the time 'τ' required for complete burning of the solid particle is proportional to the square of the radius 'R'.	AP	1	13
		Or			
	b	Spherical particles of an ore of size R = 2 mm are roasted isothermally in an air stream. Time conversion data obtained are as follows:	AP	1	13

Time, min	15	30	60
Conversion	0.334	0.584	0.88

Assume that the reaction follows SCM:
(i) Find the rate controlling mechanism.
(ii) Determine the time needed for complete conversion of spherical particles of size R= 0.5mm, all other parameters are unchanged.

12.	a	i	Explain the methods for the determination of surface area of catalyst.	UN	2	7
		ii	Explain the steps involved in the preparation of a catalyst which is impregnated on a carrier.	UN	2	6
			Or			
	b		Explain in detail about Langmuir and Freundlich isotherm.	EV	2	13
13.	a		Construct the rate equation for the reaction M + N ⟶ R. The reaction mechanism is M + X = M.X. The reaction is between Adsorbed M and unabsorbed species is M.X + N = R.X & R.X = R + X. (i) Adsorption of M is the rate controlling step. (ii) Desorption of R is controlling the rate of equation.	AP	3	13
			Or			
	b	i	Give all the necessary assumptions and develop the expression for Langmuir Hinshelwood kinetics.	AP	3	8
		ii	Discuss the physical adsorption and chemisorption.	AP	3	5
14.	a		Develop an expression for the effectiveness factor for a first order reaction of the type A ⟶ Products of a single cylindrical pore of length L with a neat sketch.	CR	4	13
			Or			
	b		A first order catalytic reaction A → R is carried out in a packed bed reactor. The molal feed rate of the reactant is 12.5 kmol/hr. The following data is available;	EV	4	13

W (kg cat)	0.625	1.87	3.125	4.375	6.25	7.5	8.75
X_A	0.058	0.139	0.213	0.288	0.381	0.440	0.493

Design the packed bed reactor with weight of catalyst for 40% conversion if the model feed rate is increased to 125Kmol/hr.

15.	a		Formulate a rate equation for an instantaneous reaction of any order between A and B, fluid-fluid reaction A (gas) + bB (liquid) → Product. Sketch the concentration profiles assuming a two-film theory.	CR	5	13
			Or			
	b		Solids of unchanging size R = 0.5 mm, are reacted with gas in a steadily flow bench scale fluidized reactor with the following result. F = 15 gm/sec; W = 1150 gm; XB = 0.78 Also the conversion is strongly temperature sensitive suggesting that the reaction step is rate controlling. Design a commercial sized fluidized bed reactor (find W) to treat 5 metric tones/hr of solid feed of size R = 0.5 mm to 95% conversion.	CR	5	13

*PART – C (Marks 1*15 = 15)*

Q.No			*Questions*	*BLT*	*CO*	*Marks*
16.	a		A first order irreversible reaction takes place in a solid catalyst. Considering a single spherical pore in the catalyst particle, develop an expression for concentration profile of the reactant in the pore and derive the expression for effectiveness factor for the same. State all assumptions made.	AP	4	15
			Or			
	b	i	Develop an expression for effectiveness factor for a flat plate with a neat sketch.	AP	4	9
		ii	Explain Effectiveness factor under Non-isothermal conditions.	UN	4	6