Ref. No. EX/MET/BS/B/T/315/2024

B.E. OF METALLURGICAL AND MATERIAL ENGINEERING 3RD YEAR FIRST SEMESTER , SESSION 2024

CHEMICAL KINETICS AND MASS TRANSFER

Assume any missing data

Notations have usual significance

Time : 3 hours **Full Marks : 100**

Q. No.	PART A (answer question 1 and any two from the rest)	Marks
	CHEMICAL KINETICS	
Q1	**Identify the correct answer**	2x10=20
1(a)	Limiting reactant of a chemical reaction decides **(i)** Conversion (ii) rate constant (iii) time of reaction (iv) equilibrium constant	
1(b)	A space velocity of $4h^{-1}$ means (i) 4 reactor volume of feed is processed per hour (ii) After every 4 hour reactor is filled with feed (iii) Hundred percent conversion takes place after 4 hours (iv) none of the above	
1(c)	If rate of a reaction A →B is doubled when the reactant concentration is doubled. Order of reaction is (i) 0 (ii) 1 (iii) 2 (iv) 3	
1(d)	For a first order reaction, if 50% of the initial concentration is consumed in 23 minutes, rate constant of the reaction is (i) 0.03 s (ii) 0.03 m (iii) 0.03 h (iv) infinite	
1(e)	A plug flow reactor is characterised by (i) Eddy motion (ii) Length of the reactor (iii) Flat velocity profile (iv) Laminar flow	
1(f)	For a first order reaction, if 50% of the initial concentration is consumed in 23 minutes, rate constant of the reaction is (i) $0.03\ s^{-1}$ (ii) $0.03\ m^{-1}$ (iii) $0.03\ h^{-1}$ (iv) infinite	
1(g)	If order and molecularity are same, the reaction must be (i) Nonelementary (ii) Liquid phase (iii) Gas phase (iv) elementary	

Q. No.	PART A (continued)	Marks
Q1	**Identify the correct answer (continued)**	2x10=20
1(h)	The time derivative of rate equation is written in terms of (i) Most reactive Reactant (ii) Stoichiometrically present reactant (iii) Most costly reactant	
1(i)	The rate equation $-\frac{dC_A}{dt} = kC_A^{1.2}C_B^{0.8}$ represents (i) The Chemical reaction reaction is of order of 2 and elementary (ii) The chemical reaction is of order of two and non elementary (iii) The chemical reaction is of order of two and reversible	
1(j)	The rate equation $-\frac{dC_A}{dt} = kC_A^{1.2}C_B^{0.8}$ represents a chemical reaction of stoichiometry aA+bB = Product where a, and b are (i) 1.2 and 0.8 respectively (ii) 1 and 1 respectively (iii) a and b can have any value	
2	Derive working formula for a CSTR carrying out second order liquid phase reaction. Give schematic diagram. If an elementary liquid phase reaction 2A→B is carried out in the reactor having k=10 s^{-1}, F_{A0}=2 mole/s , C_{A0}=1 mol/cc, final conversion = 80%, Calculate the volume of the reactor.	10+10
3	A constant density first order reaction is carried out in a batch reactor and data obtained as follows	5+15
	Time (s) 0 30 60 90 120 150 180 600	
	C_A mol/ cc 1.0 0.74 0.55 0.42 0.29 0.24 0.16 0.0025 Calculate the rate constant and time required for 50% conversion. **Use differential method of analysis.**	
4(a)	Derive the volume ratio of CSTR and PFR for same degree of conversion For liquid phase 1st order reaction.	5
4(b)	Write the procedure for designing an isothermal CSTR Cascade to achieve certain final conversion. The procedure to be explained with proper diagram.	15
5	Define selectivity and yield for parallel reaction. Consider the following type of parallel reaction A +B → P (DESIRED) (rate const k1) A + B→ S (UNDESIRED) (rate const k2) Show the different situations in tabular form with proper explanation to obtain high selectivity.	4+16

Q. NO.	PART B (ANSWER TWO QUESTIONS)	MARKS
	MASS TRANSFER	
6.	In a binary system derive the expression for molar flux of A in X direction . Consider two rectangular chambers of same volume are connected by a one meter long tube. one chamber contains Gas A And the other chamber contain gas B. Both gases Start to diffuse Into each other. The gasses are at 60 degrees centigrade, And one atmospheric pressure. The binary diffusivity is $1x10^{-5}$ m^2/s. Universal gas law constant is $82.057x10^{-3}$. Calculate molar flux of A.	10 +10
7.	Gaseous reactant A is reacting on the solid surface B to produce gaseous product C and D according to the Following reaction. 2A(g) + B(s) = 3C(g) + D(g) + E(s) Derive an expression for molar flux of a at the solid surface. Draw suitable schematic Necessary to solve the problem.	20
8. (a)	Explain molecular diffusion and convective diffusion.	5
8. (b)	What are the advantages and Limitation of film theory	5
8. (c)	Imagine a cube of dimension one meter in a multi component flow system containing three moles of A and 5 moles of B and 10 moles of C at Steady state. Molecular weight of A, B and C are one, two, and three respectively. Diffusion rate of A and B in X direction are one mole per second and minus two moles per second respectively. The cube is convicted at a velocity one meter per second in X direction. Calculate molar average velocity and fluxes relative to molar average velocity. Draw schematic necessary for the problem.	10