Reg. No. | | | | | | | | | | | | | | |

B.E. / B. TECH DEGREE EXAMINATION, MAY 2022

Fifth Semester

CH18502 - CHEMICAL REACTION ENGINEERING I

(Chemical Engineering)

(Regulation 2018)

TIME: 3 HOURS **MAX.MARKS: 100**

CO1	Attain familiarity in the fundamentals of reaction engineering and analyze the kinetic data, to determine the rate of reaction.
CO2	Perform calculations associated with design equation of reactors and determine the volume of a reactor for a given conversion and vice-versa for single reactions.
CO3	Evaluate systems and perform calculations for multiple reactions, to suggest reactor/combination of reactors for the yield of desired product.
CO4	Investigate the temperature effects associated with the reactors during reaction and determine conversion.
CO5	Explore the various non-idealities in the real reactors and modeling suitable reactors incorporating the effects of various non-idealities.

PART- A (10x2=20Marks)

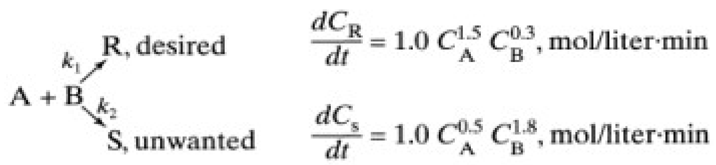
(Answer all Questions)

		CO	RBT LEVEL
1	For the reaction 2A→P, find the εA.	1	3
2	For a certain first order reaction, rate constant is 0.0022 s^{-1} . Calculate the half life of the reaction.	1	3
3	Show the CSTR's in series approximate a PFR graphically.	2	2
4	Liquid A decomposes by first order kinetics and in a batch reactor 60% of A is converted in 8 min run. Calculate the time required for it to reach 72% conversion?	2	3
5	Compare selectivity and yield in multiple reactions.	3	2
6	Give your comments on the product ratio r_R/r_S for maximising the formation of R in the P+Q → R (Desired reaction), $r_R = 14 \exp(-273/T).C_P^{0.5}. C_Q$ P+Q → S (Undesired reaction), $r_S = 200 \exp(-200/T).C_P. C_Q$	3	2
7	Relate Gibbs free energy change and Equilibrium constant.	4	2
8	Find the equilibrium constant (K_{298K}) of reaction A forming R, if $\Delta G_{0,298K}$ = -14130 J/mol.	4	3
9	Draw exit age distribution curve for nonideal flow.	5	2
10	.List the effect of earliness and lateness of mixing of fluid on kinetics of the reaction.	5	2

Q. Code: 437366

PART- B (5x 13=65Marks)

			Marks	CO	RBT LEVEL
11(a)		Derive an integrated rate expression for first order variable volume process.	**(14)**	1	3
		(OR)			
11(b)	**(i)**	Discuss constant pressure batch reactor system and derive the rate equation of variable volume system.	**(7)**	1	3
	(ii)	Describe half life period of a reaction and derive the half life of first order reaction.	**(7)**	1	3
12(a)		Using a color indicator which shows a color change when the concentration of A falls below 0.12 mol/l, the following scheme is inverted to explore the kinetics of the decomposition of A. A feed containing 0.56 mol. A/lit in introduced into the first of the two ideal CSTRs in series, each having a volume of 400 cm^3. The color changes occurs in the first reactor(a single reactor) for a feed rate of 12 cm^3 /min, and in the second reactor in series (a two reactor set up) for a feed rate of 55 cm^3 /min. Find a rate equation which satisfactorily represents the decomposition of A.	**(14)**	2	3
		(OR)			
12(b)		A plug flow reactor (2 m^3) processes an aqueous feed (100 liter/min) containing reactant A (CA0 =100 mmol/liter). This reaction is reversible and the first order rate constant k_1 and k_2 are 0.04 and 0.01 min^{-1} respectively. First find the equilibrium conversion and then find the actual conversion of A in the reactor.	**(14)**	2	3
13(a)		Assess qualitatively with examples about the product distribution for Parallel reactions.	**(14)**	3	3
		(OR)			
13(b)		Consider the aqueous reaction			



For 84% conversion of A, evaluate the concentration of R in the product stream. Equal volumetric flow rates of A and B are fed into the reactor, and each stream has a concentration of 20 mol/litre of reactant. The flow in the

		Marks	CO	RBT LEVEL
	reactor follows i. Plug flow ii. Mixed flow iii. The best set-up of Plug – Mixed Contacting schemes	(5) (5) (4)	3	3
14(a)	Explain the concept of optimum temperature progression and graphical design procedure to design the reactor.	(14)	4	3
	(OR)			
14(b)	An irreversible isomerisation reaction is carried out in the liquid phase in a MFR. Rate constant at 165ºC is 0.7 h-1 ; Activation Energy is 120000 J/mol; Heat of Reaction is -350 kJ/kg; Heat capacity of reactants and products is 1.96 kJ/ kg.K; Volumetric flow rate is 0.33 m3 /h; Feed Temperature is 20ºC; Conversion expected is 95%. Calculate the reactor size and temperature of the reaction mixture if the reactor is operated adiabatically.	(14)	4	3
15(a)	For a Non-ideal reactor described by N-Tank's in series model derive an expression for Exit age distribution, E (t) and E(θ).	(14)	5	3
	(OR)			
15(b)	Following results were obtained for a pulse test on a piece of reaction equipment. The output concentration rose linearly from zero to 0.5 µmol/dm^3 in 5 min, and then fell linearly to zero in 10 min after reaching a maximum value of 0.5 µmol/dm^3. (i) Calculate the mean residence time. (ii) (ii) Calculate the total reactor volume if the flow rate is 570 l/min	 (7) (7)	5	3

PART- C (1x 10 =10 Marks)

		Marks	CO	RBT LEVEL
16	For any reactions of positive order, tubular reactor is the best. Create a model by your own example and derive the respective performance equation.	(10)	2	5

****

Q. Code: 437366