Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3170501 Date: 27/06/2023

Subject Name: Chemical Reactions Engineering II

Time: 10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** Enlist three examples for both catalytic heterogeneous reactions & non-catalytic heterogeneous reactions **03**

(b) Discuss with neat sketch about the solid particle and concentration. profile of solid reactant-unchanging size-shrinking model of unreacted core. **04**

(c) Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first-order rate, **07**

$$-r_A'' = k''(C_{As} - C_{Ae}) \qquad \text{mol/m}^2\text{.sec}$$

Where C_{Ae}, is the concentration of A in equilibrium with the solid surface. Develop an expression for the rate of reaction of A accounting for both the mass transfer and reaction steps.

Q.2 **(a)** Define: Catalyst Promoters, Catalyst Inhibitors, Catalyst Poisons **03**

(b) (i) If $\tau/t=1/3$,Find out average conversion for a particle B of constant size in a mixed flow reactor for chemical reaction controlling. **04**

(ii) Which of the following constants is a type of equilibrium constant?

a) Association constant b) Solubility

c) Decay constant d) Dissociation constant

(c) Calculate the time needed to burn to completion the particles of graphite (diameter of particle=12 mm, ρ_B= 2.2 gm/cm3, ks= 25 cm/sec) in a 10% oxygen stream. For the higher gas velocity used assume that film diffusion does not offer any resistance to transfer and reaction. The reaction temperature is 900^{o}C. **07**

OR

(c) In a uniform environment 4 mm solid particles are 87.5% converted to product in 5 min. The solids are unchanged in size during reaction and ash diffusion step is known to be rate controlling. What mean conversion is obtainable in a fluidized bed reactor operating with **07**

same environment but using feed consisting of equal mass of 2 mm and 1 mm particles? The mean residence time of solids in this reactor is 30 minutes.

Q.3 **(a)** What are the carriers or support used and why they are used with catalyst? Name the three categories of Industrial catalysts. **03**

(b) Name the methods of preparing solid catalyst. Discuss any one method in detail. **04**

(c) For kinetics of fluid-solid catalytic reaction, write about "Adsorption isotherm". **07**

OR

Q.3 **(a)** Discuss the spectrum of kinetic regimes for porous catalyst surrounded by a reactant. **03**

(b) Develop the overall rate expression for gas phase heterogeneous reaction : $A \longrightarrow M+N$, considering the following steps: **04**
(i) Adsorption of A (ii) Surface reactions between adsorbed A and adjacent sites to produced adsorbed M & N.(iii) Desorption of M & N.
Assume step (ii) is rate controlling step.

(c) Discuss about the surface area determination of catalysts by nitrogen desorption method. **07**

Q.4 **(a)** Give the significance of Hatta modulus in fluid – fluid reaction. **03**

(b) Derive the rate equation for fast reaction with low concentration of liquid reactant in fluid – fluid reaction. **04**

(c) What is film conversion parameter? State various criteria of it which is used in the study of fluid-fluid reactions. **07**

OR

Q.4 **(a)** Discuss the importance of solubility data for determination of kinetic regime for fluid – fluid reaction. **03**

(b) Sketch the concentration profile for the gas-solid non-catalytic reaction in which the resistance through the ash layer is rate controlling. **04**

(c) Gaseous A absorbs and reacts with B in liquid according to **07**
$A(g \rightarrow l) + B(l) \longrightarrow R(l)$, $-r_{Al} = kC_AC_B$ in packed bed.
(i) Calculate the rate of reaction. (ii) Determine location of major resistance (gas film, liquid film, bulk liquid) and behavior in liquid film at a point in the reactor where P_A = 100 Pa and C_B=100 mol/m^3 liquid.
Data: k=10^8 m^3 liquid/mol.h, H_A=1.0 pa.m^3/mol,

k_{Aga}=0.10 mol/h.m^3.pa, $k_{Al\ a}$=100 m^3liquid/m^3reactor.h

f_l=0.01 m^3liquid/m^3, a=100 m^2liquid/m^3reactor

D_{Al}= D_{Bl}=10^{-6} m^2/h.

Q.5	**(a)**	List out steps involved in solid catalyzed fluid phase reactions in converting reactants to products.	**03**
	(b)	Write a short note on Slurry reactors.	**04**
	(c)	Justify: For given treatment rate, the conversion of a reacting fluid, flowing through a batch of deactivating catalyst, decreases with time during the run.	**07**

OR

Q.5	**(a)**	Answer the following in brief. (i) Effectiveness factor (ii) Pore diffusion Resistance (iii) Thiele modulus	**03**
	(b)	Write a short note on Langmuir-Hinshelwood-Hougen-Watson kinetic model.	**04**
	(c)	Derive the Performance Equations for Plug flow Reactor containing porous catalysts.	**07**