Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) • EXAMINATION – WINTER 2016

Subject Code:2170501 Date:18/11/2016

Subject Name:Chemical Reaction Engineering - II

Time:10.30 AM to 1.00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive the equation for a first order reaction using the segregation model when the RTD is equivalent to an ideal PFR and ideal CSTR. **07**

(b) Define E, F and C curve and discuss their inter relationship with schematic diagrams. **07**

Q.2 **(a)** A sample of trace hytane at 320 k was injected as a pulse to a reactor, and the effluent concentration was measured as a function of time as shown in table: **07**

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

i) Construct E(t) curve

ii) Determine both the fraction of material leaving the reactor that has spent between 3 and 6 min in the reactor.

(b) Discuss various kinetic regimes of mass transfer and reaction for fluid-fluid reactions. **07**

OR

(b) Derive the rate equation for fluid – fluid reaction in the case of instantaneous irreversible reaction with lower concentration of constituent B. **07**

Q.3 **(a)** In slurry reactor pure reactant gas is bubbled through liquid containing suspended catalyst particles. Initially the reactant gas which enters the liquid must diffuse through the liquid film into the main body of liquid, and then through the film surrounding the catalyst particle. At the surface of particle reactant yields product according to first order kinetics. Derive an expression for the rate of reaction in terms of resistances encountered in the reactor. **07**

(b) Reduction of iron ore of density ρ_B = 4.6 gm/cm^3 and size R = 5 mm by hydrogen can be approximated by the unreacted core model. With no water vapor present the stoichiometry of reaction is: $4H_2 + Fe_3O_4 \rightarrow 4H_2O + 3Fe$ with rate approximately proportional to the concentration of hydrogen in the gas stream. The first order rate has been measured by Otake et al. (1967) to be **07**

$$k_s = 1.93 \times 10^5 e^{\frac{-24000}{RT}} \text{ cm/sec}$$

Taking De=0.03 cm^2/sec as the average value of the diffusion coefficient for hydrogen penetration of the product layer. Calculate the time necessary for complete conversion of a particle from oxide to metal at 600 ^{o}C and 1 atm. pressure.

OR

Q.3 **(a)** Heterogeneous reaction in which a gas reacts with solid and solid particles remains unchanged in size during reaction. Establish relationship between time and conversion for shrinking core model of unchanging size in case diffusion through ash layer controls. **07**

(b) Uniform-sized spherical particles UO_3, are reduced to UO_2, in a uniform environment with the following results: **07**

Time (hr)	0.18	0.347	0.453	0.567	0.733
Conversion X_B	0.45	0.68	0.80	0.95	0.98

If reaction follows the SCM, find the controlling mechanism and rate equation to represent this reduction.

Q.4 **(a)** Gaseous A absorbs and reacts with B in liquid according to: $A_{(g)} + B_{(l)} \rightarrow R_{(l)}$ in a packed bed reactor. By assuming infinitely fast reaction, calculate enhancement factor and Hatta modulus. Also calculate the rate of reaction for the above reaction at p_A = 100 Pa and C_B = 100 mol/m^3 liquid. **07**

Data: k = 108 m^3 liquid/mol. hour, H_A = 1 Pa m^3 liquid/mol, K_{Al}, a = 100 m^3 liquid/(m^3 reactor. Hour), K_{Ag}, a = 0.10 mol/(hour. m^3 liquid. Pa), f_l = 0.01 m^3 liquid/m^3 reactor, a = 100 m^2/m^3 reactor, $D_{Al} = D_{Bl} = 10^{-6}$ m^2/hour.

(b) Derive the performance equation for plug flow reactor containing porous catalysts. **07**

OR

Q.4 **(a)** Discuss classification and preparation of catalyst. **07**

(b) Discuss the experimental methods for finding rate law consistent with experimental data with suitable example. **07**

Q.5	**(a)**	Describe with neat sketch the fixed bed reactor and fluidized bed reactor.	**07**
	(b)	Discuss in brief about nature and mechanism of catalytic reactions.	**07**

OR

Q.5	**(a)**	Define the following with suitable examples. (i) Catalyst (ii) Promoter (iii) Inhibitor (iv) Carrier (v) Accelerator (vi) Activity (vii) Coking	**07**
	(b)	State and explain the steps in heterogeneous catalytic reaction with schematic diagram.	**07**

****