Ref. No. Ex/FTBE/T/326/2019

B.FTBE (3RD YEAR 2ND SEM) EXAMINATION, 2019

CHEMICAL ENGINEERING KINETICS

Time: Three hours **Full Marks: 100**

Use separate Answer Script for each Part

PART-I (50 Marks)

1. Answer the following questions very specifically and to the point: (Any Four) (2.5 x 4 =10)

(a) What do you mean by the order of a reaction ?

(b) Express the reaction rates for the equation x A+ y B → zD.

(c) What is called instantaneous rate ?

(d) What is the temperature dependence of reaction rate ?

(e) What is the role of a catalyst in determining the reaction order?

(f) What is the relationship between half-life and zero order reactions ?

(g) A reaction is represented by A $\xrightarrow{k1}$ R and R+B $\xrightarrow{k2}$ S.

What is the rate equation for the disappearance of B ?

2. Answer any two from the following questions: (2 x 5=10)

a) How would you conveniently represent the characteristics of a plug flow reactor ?

b) What is the significance of the Dispersion Number in a model reactor design system ?

c) For an irreversible unimolecular type 1st order reaction , determine the rate equation in terms of fraction conversion

3. Answer any one from the following questions: (15)

a) Show that the equation $\frac{1}{CA} - \frac{1}{CAo} = \frac{1}{CAo}\left(\frac{XA}{1-XA}\right)$) = **2kt**

Where the ratio $= \frac{CBo}{CAo} = 2$ is valid for a 2nd order irreversible reaction.

b) For irreversible reaction in series of type A $\xrightarrow{k1}$ R $\xrightarrow{k2}$ S determine the ratio of the concentrations of C_R / C_A in terms of the reaction constants k 1 and k 2 .

c) For a variable – volume batch reactor having the reaction type of A→4R, with 30% inert present of at the start, 3 volumes of reactant mixture yield on complete conversion 6 volumes product mixture, determine the rate equation assuming the term of volume expansion ratio.

[Turn over

4. Answer any One from the following questions : (15)

(a) A homogeneous gas phase reaction A $\rightarrow$3R has a reported rate at 215C, $-r_A = 13^{-2} C_A^{1/2}$ **(mol/litre.sec).**

Find the space-time needed for 60% conversion of a 40% A + 60% inert feed to a plug flow reactor operating at 215C and 5 atm **(C = 0.0532mol/litre).**

(b) The concentration reading in the given Table represent a continuous response to a delta-function input into a closed vessel which is to be used as a chemical reactor for a liquid decomposing with rate $-r_A = kC_A$ **where K=0. 421 min-1.**

Find the fraction of reactant unconverted in the real reactor and compare this with fraction unconverted in a plug flow reactor of same size.

Time $^{t(min)}$	Tracer Output concentration (gm/lit of fluid)
0	2
5	5
10	7
15	9
20	9
25	6
30	3
35	1

(c) Calculate the vessel dispersion number $(\frac{D}{uL})$ for a closed vessel represented by the Dispersion Model and having the following concentration reading :

Time, t(min)	0	5	10	15	20	25	30	35
Tracer Output concentration (gm/lit of fluid)	0	2	4	6	4	3	2	1

Ref. No. : Ex/FTBE/T/326/2019

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR SECOND SEMESTER EXAM 2019
CHEMICAL ENGINEERING KINETICS
PART-II

Time -3hr FM: 100

Group-1
Answer any one from the followings

1. How plug flow reactor depends on the Axial dispersion model – discuss with $D/\mu L < 0.01$ and $D/\mu L > 0.01$ 10

2. Develop an overall rate expression for the following situation
Air bubbles through a tank of liquid which contains dispersed microbes and is taken up by the microbes to produce product material. 10

Group-II
Answer any one from the followings

3. Derive an equation for calculating reactor for plug Flow reactor and Mixed flow reactor. When this equation will be the same for plug flow and batch reactor. 15+5=20

4. Develop a performance equation for reactor containing porous catalytic particles For both plug plow and mixed flow reactor. 20

Group-III
Answer any one from the followings

5. In a dairy industry how can you get the value of processing time when processing temperature varies during operation using Arrhenius kinetic model. Assume a experimental value for thermal destruction of microorganism to explain the application of kinetic model. 20

6. A experimental rate measurement on the decomposition of A is made with a particular catalyst
a) Is it likely that film resistance to mass transfer influence the rate?
b) Could this run have been made in the regime of strong pore diffusion?
c) Would you expect to have temperature variations with in the pallet or across the gas film?
Data: for spherical particle d_p = 2.4 mm, effective mass conductivity=5×10^{-5} m^3/hr.m cat, k_{eff}=1.6 kJ/hr. m cat.K
For gas film, h=160kJ/hr.m^2 cat.K, k_g=300 m^3/hr.m^2 cat
For the reaction, ΔH_r= -160 kJ/mol A, C_{Ag}=20 mol/m^3, $-r'''_{A.obs}$=10^5 mol/hr.m^3cat
Assume the reaction is first order. 20