(3 Hours) **[Total Marks: 80]**

N.B. : (1) Question No. 1 is compulsory.

(2) Solve any three questions from the remaining questions.

(3) Assume suitable data wherever necessary.

Q 1. Answer the following questions: **(20)**

(a) Explain the different sorts of behaviours of reacting solid particles in heterogeneous fluid solid noncatalytic reactions.
(b) Explain Pulse input experiment for RTD measurement.
(c) What is significance of Hatta number in fluid fluid reactions?
(d) Differentiate between Physical adsorption & Chemical adsorption.

Q.2. (a) Derive Langmuir-Hinshelwood type of rate equation for the reaction –

$P+Q \leftrightarrow R+S$

Where desorption of R is rate controlling step. **(10)**

(b) Calculate the time required to burn to completion spherical particles of graphite (radius 12 mm, bulk density 2.4 g/cc) in a 12% oxygen stream at 900^{o}C and 1 atm. Assume gas film resistance to be negligible. Surface reaction rate constant - k" = 25 cm/s. **(10)**

Q.3. (a) Develop conversion time relationship for Shrinking spherical particles when Chemical reaction control. **(10)**

(b) Explain in detail the contacting patterns in fluid- fluid reactions. **(10)**

Q.4. a) The effluent concentration readings given below represent a continuous response to a pulse input into a closed vessel.

t, min	0	1	2	3	4	5	6	7	8	9	10	12	14
C_{Pulse} g/m3	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

This vessel is to be used as a reactor for decomposition of liquid A.

$A \rightarrow$ Products,

$-r_A = k C_A$, $k=0.10$ min^{-1}

Calculate the mean conversion of reactant A in the real reactor using segregation model

(10)

(b) A moving grate is continuously fed with feed consisting of 30% of 50 μm radius particles,40% of 100 μm radius particles & 30% of 200 μm radius particles. The feed is fed in the form of thin layer & moves on the grate is cross current fashion to the flow of reacting gas. The time required for complete conversion is 5,10, & 20 minutes three sizes of particles. Find the conversion of solids on the grate for residence time of 8 minutes over the moving grate. **(10)**

Q.5. (a) Gaseous A absorbs and reacts with B in liquid according to

$$A_{(g\rightarrow l)} + B_{(l)} \rightarrow R_{(l)}, \quad -r_{Al} = kC_AC_B$$

in a packed bed.

i) Calculate the rate of reaction

ii) Determine the location of the major resistance (gas film, liquid film, and bulk liquid) and behavior in the liquid film at a point in the reactor.

where p_A= 100 Pa and C_B =100 mol/m3 liquid.

k= $10^8 m^3$ liquid/mol.h

H_A= 1.0 Pa m^3liquid/mol

$k_{Ag}a$ =0.1 mol/(h.m3 of reactor. Pa)

$k_{Al}a$ = 100 m^3liquid/(m^3reactor.h)

a=100 m^2/m^3 reactor

fl= 0.01 m^3 liquid/m^3 reactor

$D_{Al} = D_{Bl}$= 10^{-6} m^2/h For $E_i < M_H/5$, consider instantaneous reaction and E≈Ei **(10)**

(b) Write short notes on Packed Bed and Slurry Reactor **(10)**

Q.6. Answer the following questions. (Any four): **(20)**

a) Write short note on Tanks in Series model

b) Sketch the concentration profile for fluid fluid reaction if it is slow reaction (Assume reaction is between gaseous A and liquid B). Show the concentration profile for 1) High C_B & 2) Low C_B

(a) Define true, apparent and bulk density for a catalyst bed.

(b) Write short note on Shrinking core model and Progressive conversion model?

(e) Define Residence Time Distribution (RTD) and explain significance of E (t) curve.
