B. TECH
(SEM VI) THEORY EXAMINATION 2018-19
CHEMICAL REACTION ENGINEERING II

Time: 3 Hours   *Total Marks: 100*

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. **Attempt *all* questions in brief.**   2 x 10 = 20

   a. What is Thiele Modulus?
   b. What is effectiveness factor?
   c. Define Hatta Modulus and enhancement factor.
   d. Differentiate space time and mean residence time.
   e. Briefly describe the differential and integral reactors.
   f. What is catalyst promoter?
   g. Define solid density and particle density.
   h. What is void fraction?
   i. Define catalyst deactivation.
   j. What do you mean by enhancement factor?

SECTION B

2. **Attempt any *three* of the following:**   10 x 3 = 30

   a. Differentiate between physical and chemical adsorption and describe Langmuir adsorption with suitable example.
   b. Discuss and sketch the ideal contacting patterns for to flowing fluids.

   c. Explain continuous reaction model for porous catalysts and give electrical analog of a pore.
   d. Derive Michaclis-Menten equation and explain under which conditions it is valid. What is its importance?
   e. Show that the selectivity of two concurrent first order reactions occurring in flat shaped porous catalysts is independent of the effect of either heat or mass transfer if the activation energies of both reactions are equal.

SECTION C

3. **Attempt any *one* of the following:**   10 x 1 = 10

   (a) Spherical solid practicalcontaining B are roasted isothermally in oven with gas of constant composition solid are converted to a firm non flaking product according to the SCM as follow.

   $$A(g) + B(s) \rightarrow R(g) + S(s) \qquad C_A = 0.01 \text{ kmol/m}^3 \quad \rho_B = 20 \text{ kmol/m}^3$$
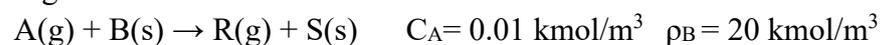
   from the above following conversion data or core size data determine the rate controlling mechanism for the transformation of solid.

Dp mm	x_b	T min
1	1	4
1.5	1	6

(b)   Derive the performance equation for a cylindrical catalyst pore and define the effectiveness factor.

4.   **Attempt any *one* of the following:**   **10 x 1 = 10**

(a)   Describe the polymerization and their classification how you prepare polystyrene in batch reactor explains with flow diagram.

(b)   Calculate the time needed to burn to completion particles of graphite (R_0= 5 mm ρ_B= 2.2 gm/cm^3 k''= 20 cm/sec) in a 8 % oxygen stream for high gas velocity used assume that film diffusion does not offer any resistance to transfer and reaction. Reaction temperature 900^{0}C

5.   **Attempt any *one* of the following:**   **10 x 1 = 10**

(a)   Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first order rate.

$$-r''_A = k''(C_{AS}-C_{Ae})$$

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

(b)   A catalytic reaction takes place A→4R at 3.2 atm and 110°C in a plug flow reactor. The reactor contains 0.01 kg of catalyst and uses a feed consisting partially converted product of 20 litre/hr of pure unreacted A. The results are as follows :

Run	1	2	3	4
$C_{A,in}$ **mole /liter**	0.100	0.080	0.060	0.040
$C_{A, out}$ **mole/liter**	0.084	0.070	0.055	0.038

Find a rate equation to represent this reaction.

6.   **Attempt any *one* of the following:**   **10 x 1 = 10**

(a)   Differentiate between physical and chemical adsorption and describe Langmuir adsorption with suitable example.

(b)   Derive the performance equation for a cylindrical catalyst pore and define the effectiveness factor.

7.   **Attempt any *one* of the following:**   **10 x 1 = 10**

(a)   Write notes on the mechanism of catalysis with particular emphasis on the factors which determine the rate of reaction.

(b)   For the reaction A→4R, find the size of packed bed required to treat 2000 mol/hr of pure A at 117^{0}C to 35% conversion at pressure 3.2 atm using the following data:

C_A **mol/liter**	0.039	0.575	0.075	0.092
$-r_A$ **molA/hr.kg Catalyst**	3.4	5.4	7.6	9.1