16/05/2025 TE CHEMICAL SEM-VI C-SCHEME CRE-II QP CODE: 10086006

(3 Hours) **[Total: 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) Write a short note on the Shrinking core model and the Progressive conversion model..
(b) What are the first, second and third moments of RTD.
(c) What is the significance of Hatta number in fluid fluid reactions?
(d) Write a short note on the Fluidised bed reactor.

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

$$A + B \rightleftharpoons R + S$$

Where the adsorption of B is rate 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 14 % oxygen stream at 900°C and 1 atm. Assume the gas film resistance to be negligible. Surface reaction rate constant, k" = 25 cm/s. **(10)**

Q.3. (a) Develop a conversion time relationship for shrinking spherical particles when resistance through the gas film is controlling. **(10)**

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

Q.4. a) The data given below represent a continuous response to a pulse input into a closed vessel, which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel. Tabulate & construct E Curve. **(10)**

t, min	0	5	10	15	20	25	30	35
C_{Pulse} g/l (tracer output concentration)	0	3	5	5	4	2	1	0

(b) Spherical solid particles containing 'B' are roasted at a constant temperature in an oven with a constant gas composition. Solids are converted to give a firm non non-flaking product according to the Shrinking core model (SCM). From the following conversion data, determine the rate-controlling mechanism for the transformation of solid. **(10)**

Data:

d_p,mm	X_B	t,s
2	**0.875**	**1**
1	**1**	**1**

Q.5. (a) The catalytic reaction A → 3R is run in a packed bed reactor at 3.5 atm & 115^{0}C. It is desired to treat 1500 mol/hr of pure A at 3.5 atm to a 32 % conversion. the following rate concentration data are available:

C_A, Mol/l	0.04	0.06	0.075	0.09
$-r_A$, mol A/(h.kg catalyst)	3.5	5.7	7.2	8.8

Determine the amount of catalyst needed in a packed bed reactor. **(10)**

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

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

a) Write a short note on the Tanks in Series model

b) Draw the kinetic regime for i) slow reactions, no mass transfer resistance.
ii) Instantaneous reaction with low C_B

c) Differentiate between Physical adsorption & Chemical adsorption.

d) Differentiate true density, apparent density and bulk density

e) Explain the Pulse input experiment for RTD measurement
