

Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - VII EXAMINATION - WINTER 2025

Subject Code: 2170501

Date: 24-11-2025

Subject Name: Chemical Reaction Engineering - II

Time: 10:30 AM TO 01:00 PM

Total Marks: 70

Instructions

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

Q.1 (a) Define & explain: RTD, C-curve, E-curve, F-curve. **Marks 03**

(b) Derive RTD expression for ideal PFR & ideal CSTR. **04**

(c)

t (min)	0	2	4	6	8	10	12	14
C (g/m ³)	0	2	6	9	8	5	3	0

07

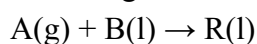
Q.2 (a) Discuss various contacting patterns for fluid–fluid reactions with diagrams. **03**

(b) Define Hatta modulus and enhancement factor. **04**

(c) Derive rate equation for fast pseudo-first-order fluid–fluid reaction when B is in large excess. **07**

OR

(c) A dilute gas A absorbs into a liquid containing B and reacts: **07**



Given: $k_{Ag} = 0.01 \text{ mol}/(\text{m}^3 \cdot \text{hr} \cdot \text{Pa})$,

$k_{Al} = 20 \text{ hr}^{-1}$.

$H = 10^5 \text{ Pa} \cdot \text{m}^3/\text{mol}$,

$C_B = 50 \text{ mol}/\text{m}^3$,

$p_A = 2000 \text{ Pa}$,

(i) Locate resistance distribution(ii) Rate of reaction

Q.3 (a) State limitations of shrinking core model. **03**

(b) Discuss progressive conversion model for fluid–particle reactions. **04**

(c) Derive the expression for spherical particle (unchanging size) when ash layer diffusion controls. **07**

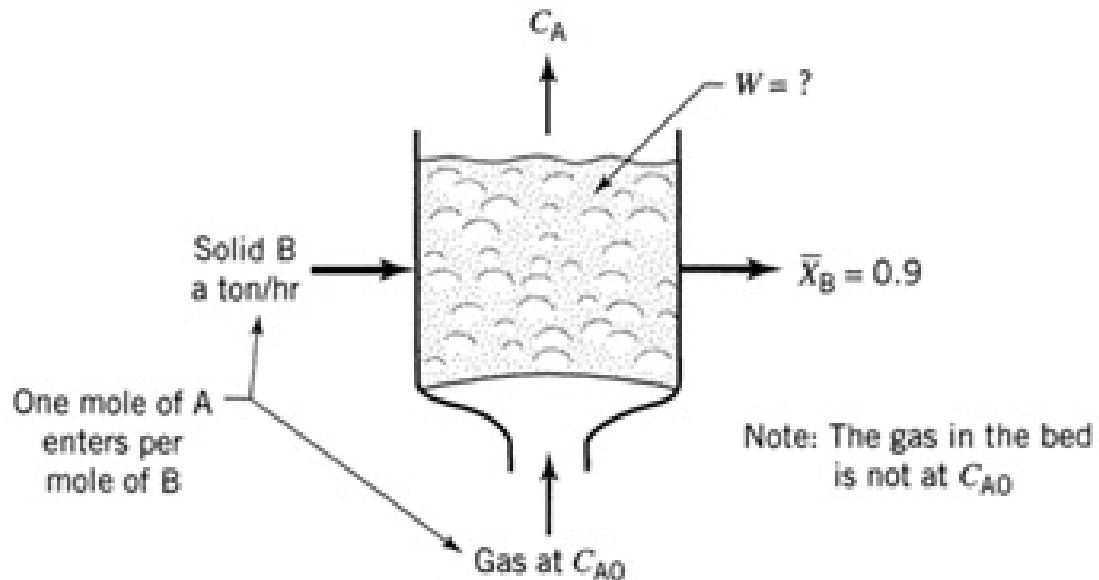
OR

(a) Write examples of industrial fluid–particle reactions. **03**

(b) Physical meaning of Thiele modulus. **04**

- (c) In a gas-phase environment, particles of B are converted to solid product as follows: $A(\text{gas}) + B(\text{solid}) \rightarrow R(\text{gas}) + S(\text{solid})$. Reaction proceeds according to the shrinking core model with reaction control and with time for complete conversion of particles of 1 hr. A fluidized bed is to be designed to treat 1 ton/hr of solids to 90% conversion using a stoichiometric feed rate of A, fed at C_{A0} . Find the weight of solids in the reactor if gas is assumed to be in mixed flow. Note that the gas in the reactor is not at C_{A0} . Below Figure sketches this problem.

07



Q.4 (a) Classify catalysts.

03

(b) Describe catalyst promoters, inhibitors, poisons.

04

(c) Explain Langmuir–Hinshelwood–Hougen–Watson (LHHW) model for solid-catalyzed gas phase reaction.

07

OR

(a) Discuss BET adsorption isotherm.

03

(b) Different methods of catalyst deactivation.

04

(c) Compare fluidized-bed reactor vs fixed-bed reactor.

07

Q.5 (a) Define: (i) Turnover frequency(ii) Activity(iii) Selectivity

03

(b) Discuss trickle-bed reactor.

04

- (c) The experimental data for the gas-phase, catalytic, irreversible reaction $A + B \rightarrow C$ is given in the table. Suggest a rate law & mechanism consistent with the data. 07

Run	Rate(mol/g s)	P_A (atm)	P_B (atm)	P_C (atm)
1	0.073	0.1	1	2
2	3.42	1	10	2
3	0.54	10	1	2
4	6.80	1	20	2
5	2.88	1	20	10
6	0.56	20	1	2
7	0.34	1	1	2
8	4.5	1	20	5

OR

- (a) Write importance of effectiveness factor. 03
- (b) Describe slurry reactor with schematic. 04
- (c) Derive design equation for packed-bed catalytic reactor considering deactivation. 07
