

**B. TECH.**  
**(SEM IV) BACKPAPER THEORY EXAMINATION, 2017-2018**  
**CHEMICAL REACTION ENGINEERING-I**

Time: 3 Hours

Total Marks: 100

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

**SECTION-A**

**1. Attempt all questions in brief. 2 x10 = 20**

- (a) Explain transition state theory.
- (b) Differentiate between molecularity and order of reaction with suitable examples.
- (c) Define Equilibrium constant  $K_c$ .
- (d) Define Autocatalytic reaction.
- (e) Define 'Time constant'.
- (f) Define 'Non-ideal' flow.
- (g) Define Holding time.
- (h) Define CSTR.
- (i) Describe collision theory.
- (j) Explain the term 'Activation Energy'.

**SECTION-B**

**2. Attempt any three of the following: 10x3 = 30**

- (a) Discuss 'Autocatalytic' reactions with the help of typical rate concentration curve.
- (b) Explain the properties and relationships of E, C and F curves for various flows with suitable examples.
- (c) Derive the design equation for PFR.
- (d) Explain *Yield* and *Selectivity* of a chemical reaction with suitable examples.
- (e) The stoichiometry of the decomposition is  $A \rightarrow 2.5 R$ . Find a rate equation which satisfactorily represents this decomposition. The following data are obtained at  $0^\circ\text{C}$  in a constant volume batch reactor using pure gaseous *A*.

|                                   |    |    |      |    |    |      |    |      |          |
|-----------------------------------|----|----|------|----|----|------|----|------|----------|
| Time, min                         | 0  | 2  | 4    | 6  | 8  | 10   | 12 | 14   | $\alpha$ |
| Partial Pressure of <i>A</i> , cm | 76 | 60 | 47.5 | 39 | 32 | 27.5 | 24 | 21.5 | 15       |

## SECTION-C

3. Attempt any *one* part of the following: **10x1 =10**
- (a) Why “differential method for analysing kinetic data is preferred over integral method for fractional order reactions”?
- (b) Three CSTR<sup>s</sup> of different sizes are connected in series. Discuss the behaviour of the system and also explain the scheme for connecting the reactors with neat diagram.

4. Attempt any *one* part of the following: **10x1 =10**
- (a) A liquid reactant *P* converted by 2<sup>nd</sup> order kinetics. 65 % of *P* is converted in 480 sec in a batch reactor. How much time would it take to reach 90% conversion?
- (b) An aqueous reactant stream (5 mol A/ litre) passes through a PFR followed by a CSTR. Find the concentration in the CSTR, if at the exit of the PFR  $C_A = 1 \text{ mol/litre}$ . The reaction is 2<sup>nd</sup> order with respect to A, and the volume of the PFR is double that of CSTR.

5. Attempt any *one* part of the following: **10x1 =10**
- (a) Define *Recycle Reactors*. Also differentiate between reversible and Irreversible reaction.



- (b) For a series reaction  $A \rightarrow R \rightarrow S$ , obtain an expression for  $C_R$  and also prove that time taken to obtain the maximum concentration of  $R(C_{Rmax})$  equals the log mean kinetic constant difference.

6. Attempt any *one* part of the following: **10x1 =10**
- (a) Specific rate constants of the following are obtained at different times of a reaction. Find order of the reaction from the data.

|                                     |      |      |      |      |
|-------------------------------------|------|------|------|------|
| Run                                 | 1    | 2    | 3    | 4    |
| t (Sec)                             | 840  | 2100 | 3600 | 7260 |
| $k \times 10^3$ (litres/gmole. Sec) | 1.64 | 1.71 | 1.65 | 1.72 |

- (b) Derive the performance equation for ‘Tanks in series model’ with the help of suitable example.

7. Attempt any *one* part of the following: **10x1 =10**
- (a) The rate constant of a reaction at 27<sup>o</sup>C is  $1.5 \times 10^{-4} (\text{s})^{-1}$ . Determine the frequency factor for this reaction. Take Energy of Activation is equal to  $1.5 \times 10^5$  cal/mol.
- (b) For an isothermal batch reactor, 90% of a liquid is converted in 20 min. What space time and space velocity are needed to effect this conversion in a PFR?