

# B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

## September / October 2023 Supplementary Examinations

**Programme: B.E.**

**Branch: Chemical Engineering**

**Course Code: 19CH5DCCR1**

**Course: Chemical Reaction Engineering-1**

**Semester: V**

**Duration: 3 hrs.**

**Max Marks: 100**

**Date: 20.09.2023**

**Instructions:** 1. Answer any FIVE full questions, choosing one full question from each unit.  
2. Missing data, if any, may be suitably assumed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

### UNIT - I

1. a) List the various forms by which rate of reaction can be expressed. **05**
- b) State the factors affecting the rate of reaction. **05**
- c) A reaction  $2HI(g) \rightarrow H_2(g) + I_2(g)$ , studies over a range of temperatures. Results obtained are below. **10**

Temperature (K)	633	666	697	715	781
Rate constant $k \times 10^4$ (L/mole.s)	0.17	1.07	5.01	10.5	15.1

  - a. Find out the values of activation energy graphically
  - b. Determine by what factor the rate increases when temperature rises from 300 K to 310 K.

### UNIT - II

2. a) With an example explain the difference between elementary and non-elementary reactions. **06**
- b) List the different kinetic models for non-elementary reactions. **04**
- c) Experiments shows that the reaction between  $H_2(g)$  and  $I_2(g)$  to produce  $HI(g)$  proceeds with rate  $\frac{1}{2} \frac{d[HI]}{dt} = k[H_2][I_2]$ . Suggest a two-step mechanism which is consistent with this rate. **10**

### UNIT - III

3. a) Derive the integrated performance equation for plug flow reactor for first order reaction for changing density. **10**
- b) The laboratory measurements of rate v/s concentration for reactant A are given below. Compare the volumes of mixed flow reactor and plug flow reactor required to achieve 60% conversion. The feed conditions are the same in both the cases and molar flow rate of A entering the reactor is 10 m/s. **10**

$X_A$	0	0.2	0.4	0.6	0.8
$-r_A$ mol/(L s)	0.182	0.143	0.1	0.0667	0.0357

**OR**

4. a) Reactant A decomposes as follows:  $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ , where  $k_1 = 0.1 \text{ min}^{-1}$  and  $k_2 = 0.1 \text{ min}^{-1}$ . It is desired to produce R from 1000 L/h of feed ( $C_{A0}=1 \text{ mol/L}$ ,  $C_{R0} = C_{S0}=0$ ). Find the volume of plug flow reactor to maximize concentration of R. 10

b) Determine the integrated rate expression for a second order irreversible bimolecular reaction in terms of concentration and conversion where  $C_{A0} \neq C_{B0}$ . 10

**UNIT - IV**

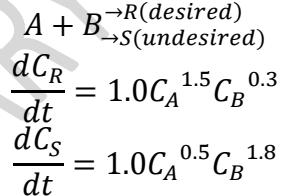
5. a) Derive an expression for space time  $\tau_N$  for a series of equal size and N number of mixed reactors assuming first order reaction. 10

b) A first order reaction is carried out in a plug flow reactor with initial reactant concentration of 0.9 mol/L. The conversion of the reaction found to be 90%. If a CSTR, 10 times as large as the plug flow reactor, were arranged in series with the existing unit. Which unit needs to be arranged first (in series) to enhance the production rate. 10

**OR**

6. a) Explain the contacting patterns for various combinations of high and low concentrations of the reactants in flow operations. 08

b) Consider the aqueous reactions in plug flow reactor. 12



For 90% conversion of A, find the concentration of R in the product stream. Equal volumetric flow rates of A and B streams are fed to the reactor, and each stream has a concentration of 20 mol/L of reactant.

**UNIT - V**

7. a) Derive the energy balance equation for a mixed flow reactor under non-adiabatic condition. 10

b) Explain optimum temperature progression of non-isothermal reaction. 10

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