राष्ट्रीय प्रौद्योगिकी संस्थान, हमीरपुर

National Institute of Technology, Hamirpur

Subject: CH – 312 Chemical Reaction Engineering I

Examination: End Semester (20th November, 2023)

Department: Chemical Engineering

| **Class:** B. Tech | **Semester:** V | **Full Marks:** 50 | **Time:** 3 Hours |

Instruction

- *Attempt all questions.*
- *Wherever necessary, draw diagram and label properly to explain the concept.*
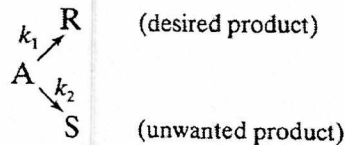- ***If any additional data/information are required kindly assume it***

Q1. Answer the following questions **(16 Marks)**
   a) Define half life time and zero order reaction
   b) Difference between elementary and non-elementary reactions
   c) Difference between integral and differential method for analysis of rate data
   d) Homogeneous and heterogeneous reactions
   e) Space time and space velocity
   f) Instantaneous fractional yield and overall fractional yield
   g) Residence time distribution
   h) Dispersion number and its impact on CSTR and PFR

Q2. Liquid A decomposes (A → Product) by first order kinetics, and in a batch reactor 50% of A is converted in 5 minutes. How long it will take to reach 75% conversion? **(5 Marks)**

Q3. Derive the performance equation for plug flow reactor (PFR) with diagram, and mention the advantages and disadvantages of batch versus continuous flow reactors **(10 Marks)**

Q4. For a reaction as shown below **(6 Marks)**

$$A \underset{k_2}{\overset{k_1}{\nearrow}} \begin{matrix} R \quad \text{(desired product)} \\ \\ S \quad \text{(unwanted product)} \end{matrix}$$

With corresponding rate equations

$$r_R = \frac{dC_R}{dt} = k_1 C_A^{a_1} \qquad \text{and} \qquad r_S = \frac{dC_S}{dt} = k_2 C_A^{a_2}$$

Determine the conditions and the nature of reactors for the formation of desired products. Also, draw the contacting pattern for various combinations of high and low concentration of reactors in continuous and non-continuous operations.

Q5. The concentration reading as given in table below represents 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 t, and tabulate and plot the exit age distribution E. (Use graph paper) **(7 Marks)**

Time t, min	0	5	10	15	20	25	30	35
Tracer Output Concentration, C_{Pulse} (gm/litre fluid)	0	3	5	5	4	2	1	0

Q6. What are the characteristics of tracer used in reactors to detect non-ideal behaviour? What are the difference between E and F curve and draw E curve and F curve for plug flow, mixed flow and arbitrary flow. **(6 Marks)**