

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VI (NEW) EXAMINATION – SUMMER 2023****Subject Code:3163612****Date:06-07-2023****Subject Name:Fundamentals of Reaction Engineering****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.

**MARKS**

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|------------|--|-----------|
| <b>Q.1</b> | (a) Define and Explain, Rate and Molecularity of the reaction.   | <b>03</b> |
|            | (b) What are the different types of ideal reactors?  | <b>04</b> |
|            | (c) Discuss Differential method for analysis of rate data.   | <b>07</b> |
| <b>Q.2</b> | (a) What is a constant volume batch reactor?   | <b>03</b> |
|            | (b) The saponification reaction:<br>$NaOH + CH_3COOC_2H_5 \rightarrow CH_3COONa + C_2H_5OH$ is 2 <sup>nd</sup> order irreversible reaction. A laboratory well stirred tank reactor is charged with an aqueous solution containing NaOH & ethyl acetate, both of initial concentration of 0.1 molar. After 15 min the conversion of ethyl acetate is 18%. For the initial charge containing NaOH & ethyl acetate in equal concentration of 0.2 molar, what time is required to obtain a conversion of 30% in a batch reactor? | <b>04</b> |
|            | (c) What do you understand by instantaneous fractional yield and overall fraction yield of a product? Give different contacting patterns for different concentration of reactant.  | <b>07</b> |
| <b>OR</b>  |  |           |
|            | (c) Derive the $C_{Rmax}$ for the reaction first order followed by zero order reaction for $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ .   | <b>07</b> |
| <b>Q.3</b> | (a) Explain the significance of space time and space velocity.   | <b>03</b> |
|            | (b) Explain the types of multiple reaction with example.   | <b>04</b> |
|            | (c) In case of 1 <sup>st</sup> order reaction, show that time required for 75% conversion is double the time required for 50% conversion.  | <b>07</b> |
| <b>OR</b>  |  |           |
| <b>Q.3</b> | (a) How will you compare the performance of single batch reactor with the flow reactor and mixed versus plug flow reactor for a first order reaction?  | <b>03</b> |
|            | (b) Differentiate overall fractional yield and selectivity.  | <b>04</b> |
|            | (c) An aqueous solution of ethyl acetate is to be react with sodium hydroxide. The initial concentration of ethyl acetate is 5 gm/lit and that of caustic is 0.1 normal. The values of 2 <sup>nd</sup> order rate constant at 0 °C and 20 °C are 0.235 and 0.924 lit/mol*min respectively. The reaction is irreversible. Calculate the time required to react 95% of ester at 40 °C.   | <b>07</b> |
| <b>Q.4</b> | (a) Explain adiabatic operation.   | <b>03</b> |
|            | (b) Explain standard heat of formation, standard heat of combustion and standard heat of reaction.   | <b>04</b> |
|            | (c) Explain the effect of temperature on equilibrium conversion as predicted by thermodynamics by keeping pressure fixed.  | <b>07</b> |

**OR**

- Q.4** (a) Mention the characteristics of Chemical Equilibrium. **03**  
(b) Write a short note on Optimum temperature progression. **04**  
(c) What is equilibrium conversion? How is it related to equilibrium constant and temperature for case of a first order reversible reaction? **07**

- Q.5** (a) Write a short note on catalyst. **03**  
(b) Mention the essential properties of a catalyst and its classification. **04**  
(c) With the help of a sketch mention the seven steps involved in a catalytic reaction. **07**

**OR**

- Q.5** (a) Explain the role of modifier, promoter and inhibitor in a catalytic reaction. **03**  
(b) Write a short note on catalyst deactivation. **04**  
(c) Synthesize a rate law for the decomposition of Cumene to form benzene and propylene considering that surface reaction is rate limiting. **07**

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