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

**Autonomous Institute Affiliated to VTU**

## August 2024 Supplementary Examinations

**Programme: B.E.** **Semester: V**
**Branch: Chemical Engineering** **Duration: 3 hrs.**
**Course Code: 19CH5DCCR1** **Max Marks: 100**
**Course: Chemical Reaction Engineering -I**

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





### UNIT - I

1 a) Explain the molecularity and order of reactions. **05**

b) A person weighing 75 kg consumes about 6000 kJ of food per day. Assume that the food is all glucose and that the overall reaction is given as follows. **05**

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$; $-\Delta H_r = 2816$ kJ/mol glucose

Find person's metabolic rate of daily activity in terms of moles of oxygen used per $m^3$ of person per second. Assume density as 1000 kg/$m^3$ for calculation.

c) Explain the theories used to describe the temperature dependence of rate equation of homogeneous reactions. **10**

### UNIT - II

2 a) What are the differences between the elementary and non-elementary reactions? Explain with examples. **08**

b) Discuss the types of reactors with figures. **07**

c) Pasteurization of milk is carried out by heating to 53°C for 35 min. In comparison with this, pasteurization at 80°C needs only 17s. Find the activation energy of the second sterilization process. **05**

### UNIT - III

3 a) What are the advantages and disadvantages of batch reactors? Derive the performance equation for batch reactor in terms of conversion. **10**

b) The rate constant for the first-order decomposition of cyclobutene at 500°C is $9.2\times10^{-3}$ $s^{-1}$. How long will it take for 50% of the sample to decompose? The reaction is given by: $C_4H_8 \rightarrow 2C_2H_4$. **10**

**OR**

4 a) Describe the step by step procedure of integral and differential methods of analysis of reactor data. **10**

b) The following kinetic data are obtained in a constant volume batch reactor at 273 K using pure gaseous reactant A. The stoichiometry of the decomposition of A is: A → 2.5 P. Find a rate equation that will satisfactorily fit the data. **10**

| Time (min) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | ∞ |
|---|---|---|---|---|---|---|---|---|---|
| Partial pressure of A (mmHg) | 760 | 600 | 475 | 390 | 320 | 275 | 240 | 215 | 150 |

**UNIT - IV**

5 a) The elementary reaction A + B→R + S is carried out in a set up consisting of a mixed flow reactor followed by a plug flow reactor. An excess of B is used so that the reaction is first order with respect to A. Various ways of increasing production have been suggested, one of which is to reverse the order of the two reactors. How would this change affect the conversion? **10**

b) Prove by a derivation that the performance of N equal sized mixed flow reactors with a total volume V in series approaches the performance of a single plug flow reactor of same volume. **10**

**OR**

6 a) The elementary reaction A + B → R, R + B → S, occur in a tubular reactor with the rate constants $k_1 = 2k_2$. Find the concentration of R and S leaving the reactor for 50% conversion of A, when A is introduced at 1 mol/lit and no R and S present in the feed. **10**

b) Under appropriate conditions, A decomposes as follows. **10**

$$A \xrightarrow{k_1 = 0.1/\text{min}} R \xrightarrow{k_2 = 0.1/\text{min}} S .$$

R is produced from 1000 L/h of feed in which $C_{A0}$ = 1 mol/L, $C_{R0} = C_{S0} = 0$.

i) What size of PFR will maximize the yield of R and what is the concentration of R in the effluent stream from this reactor?

ii) What size MFR will maximize the yield of R and what is the concentration of R in the effluent stream from this reactor?

**UNIT –V**

7 a) Elucidate the optimum temperature progression for reversible and irreversible reactions. **10**

b) Explain the step by step design procedure for an adiabatic operation of a batch reactor. **10**

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