U.S.N.										

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

Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

Programme: B.E. | **Semester: V**
Branch: Chemical Engineering | **Duration: 3 hrs.**
Course Code: 22CH5PCCR1 | **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.

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	***CO***	***PO***	**Marks**
1	a)	A rocket engine burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen). The combustion chamber is cylindrical, 75 cm long and 60 cm in diameter and the combustion process produces 108 kg/s of exhaust gases. If combustion is complete, find the rate of reaction of hydrogen and oxygen.	***CO1***	***PO2***	**08**
	b)	For the hydrolysis of a reactant '*A*' as per Arrhenius theory, the rate constant at 60°C is 6.698×10^{-3} L/min and the activation energy is 16,200 Cal/mol. Calculate the rate constant at 80°C by collision and transition state theories. What is the percentage difference in rate constants predicted by these two methods?	***CO1***	***PO2***	**08**
	c)	Differentiate between the order and molecularity of reactions.	***CO1***	***PO2***	**04**
		UNIT - II			
2	a)	The thermal decomposition of C_2H_6 to ethane, methane, butane, and hydrogen is believed to follow the sequence of reactions as shown below. $C_2H_6 \xrightarrow{k_1} 2CH_3^*$ $CH_3^* + C_2H_6 \xrightarrow{k_2} CH_4 + C_2H_5^*$ $C_2H_5^* \xrightarrow{k_3} C_2H_4 + H^*$ $H^* + C_2H_6 \xrightarrow{k_4} H_2 + C_2H_5^*$ $2C_2H_5^* \xrightarrow{k_5} C_4H_{10}$ Derive the rate equation for the formation of C_2H_4.	***CO2***	***PO2***	**14**
	b)	What are the differences between the elementary and non-elementary reactions? Mention suitable examples.	***CO2***	***PO2***	**06**
		OR			

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<tr><td></td><td>3</td><td>a)</td><td>For an irreversible, bimolecular type II order reaction, $A + B \rightarrow P$, derive an expression in terms of conversion for the rate equation assuming M = 2.</td><td>CO2</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Explain the different methods used to analyze the kinetic data.</td><td>CO2</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - III</td><td></td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>a)</td><td>Derive the design equation for the plug flow reactor.</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>The liquid phase isomerization of butane was carried out in three reactors connected in series. Conversion achieved in the first reactor MFR is 20%, conversion achieved in the second reactor PFR is 40% and final conversion achieved in the third MFR reactor is 65%. The experimental data is given for your reference.
<table>
<tr><td>$-r_A \; \frac{kmol}{m^3.h}$</td><td>30</td><td>53</td><td>59</td><td>38</td><td>25</td></tr>
<tr><td>X_A</td><td>0</td><td>0.2</td><td>0.4</td><td>0.6</td><td>0.65</td></tr>
</table>
Estimate the volume of each reactor connected in series for the entry flow rate of 50 kmol/h.</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td>a)</td><td>Elucidate the graphical procedure for finding the outlet composition from a series of mixed-flow reactors of various sizes.</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>An aqueous reactant stream (4 mol of A/liter) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at the exit of the plug flow reactor, if in the mixed flow reactor, C_A = 1 mol/liter. The reaction is second order with respect to ‘A’ and the volume of the plug flow unit is three times of the mixed flow reactor.</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - IV</td><td></td><td></td><td></td></tr>
<tr><td></td><td>6</td><td>a)</td><td>Formulate equations for instantaneous fractional yield, overall fractional yield, and selectivity in the case of parallel reaction schemes.</td><td>CO4</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td>b)</td><td>Consider the irreversible unimolecular type first-order reaction in series $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ occurring in an MFR. For this reaction, develop the concentration-time relationship. Assume that the feed contains no R and S, and show that $\tau_{m,\,opt} = \sqrt{\frac{1}{k_1 k_2}}$.</td><td>CO4</td><td>PO2</td><td>12</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - V</td><td></td><td></td><td></td></tr>
<tr><td></td><td>7</td><td>a)</td><td>Define optimum temperature progression. Discuss the optimum temperature progression for an exothermic reversible reaction.</td><td>CO4</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Explain with a neat graph the step-by-step design procedure for an adiabatic operation of a batch reactor.</td><td>CO4</td><td>PO2</td><td>10</td></tr>
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