

**Tribhuvan University**  
**Institute of Engineering**  
**Examination Control Division**  
**2082 Chaitra**

Examination	Model Question		
Level	Bachelor	Full Marks	60
Program	BCH	Pass Marks	24
Year/Part	III/I	Time	3 Hrs.

**Subject:- Chemical Reaction Engineering I**

**Course Code:- (ENCH 305)**

√Candidates are required to give their answers in their own words as far as practicable.

√Attempt all questions

√The figures in the margin indicate **Full Marks**.

√Necessary figure(s) are/is attached herewith.

√Assume suitable data if necessary

QN	Description	Marks	Chapter No.																
1	a) Develop mole balance equation for the PFR. b) The reaction $A \rightarrow B$ is to be carried out isothermally in a continuous-flow reactor. The entering volumetric flow rate $v_0$ is $10 \text{ dm}^3/\text{h}$ . Calculate the CSTR reactor volumes necessary to consume 99 % of $A$ (i.e., $C_A = 0.01 C_{A0}$ ) when the entering molar flow rate is $5 \text{ mol/h}$ , assuming the reaction rate $-r_A = k$ with $k = 0.05 \text{ mol}/(\text{h}\cdot\text{dm}^3)$ .	2 + 2	1																
2	The exothermic reaction $A + B \rightarrow C$ was carried out adiabatically and the following data recorded: <table border="1" style="margin: 10px auto; width: 80%;"> <tbody> <tr> <td style="text-align: center;"><math>-r_A</math> (mol/dm<sup>3</sup>.min)</td> <td style="text-align: center;">10</td> <td style="text-align: center;">16.7</td> <td style="text-align: center;">50</td> <td style="text-align: center;">50</td> <td style="text-align: center;">50</td> <td style="text-align: center;">12.5</td> <td style="text-align: center;">9.09</td> </tr> <tr> <td style="text-align: center;">X</td> <td style="text-align: center;">0.0</td> <td style="text-align: center;">0.2</td> <td style="text-align: center;">0.4</td> <td style="text-align: center;">0.5</td> <td style="text-align: center;">0.6</td> <td style="text-align: center;">0.8</td> <td style="text-align: center;">0.9</td> </tr> </tbody> </table> The entering molar flow rate was $300 \text{ mol}/\text{dm}^3$ . a) What are the PFR and CSTR volumes necessary to achieve 50% conversion? b) What conversion can be achieved if a $24\text{-dm}^3$ CSTR is followed in a series by a $72\text{-dm}^3$ PFR?	$-r_A$ (mol/dm <sup>3</sup> .min)	10	16.7	50	50	50	12.5	9.09	X	0.0	0.2	0.4	0.5	0.6	0.8	0.9	4 + 4	2
$-r_A$ (mol/dm <sup>3</sup> .min)	10	16.7	50	50	50	12.5	9.09												
X	0.0	0.2	0.4	0.5	0.6	0.8	0.9												
3	a) Develop an equation for the rate of disappearance of a reactant for the reversible reaction given below: $aA + bB \leftrightarrow cC + dD$ the rate constant for the forward reaction is $k_B$ and for the backward reaction is $k_{-B}$ . b) A mixture of 28 % and 72 % air is charged to a flow reactor in which is oxidized. $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ i) Set up a stoichiometric table for flow system of each species. ii) Prepare a second table evaluating the species concentrations as a function of conversion for the case when the total pressure is $1485 \text{ kPa}$ ( $14.7 \text{ atm}$ ) and the temperature is constant at $227 \text{ }^\circ\text{C}$ .	2 + 2 + 8	3																

4	<p>a) Write short notes on</p> <ol style="list-style-type: none"> <li>i. DamKöhler number and its significance</li> <li>ii. Types of membrane reactor</li> </ol> <p>b) Determine the plug-flow reactor volume necessary to produce 200 million pounds of ethylene a year by cracking a feed stream of pure ethane. The reaction is irreversible and follows an elementary rate law.</p> $\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_4 + \text{H}_2$ <p>We want to achieve 80 % conversion of ethane, operating the reactor isothermally at 1100 K and at a pressure of 6 atm. The specific reaction rate at 1,000 K is <math>0.072 \text{ s}^{-1}</math> and the activation energy is 82,000 cal/mol.</p>	2 + 2 + 8	4																
5	<p>a) Describe integral method for determining the reaction order.</p> <p>b) In a constant volume batch reactor following concentration measurement are recorded. Find the rate of the reaction using differential approach.</p> <table border="1" data-bbox="391 751 1128 898" style="margin-left: auto; margin-right: auto;"> <tr> <td>t (min)</td> <td>0</td> <td>10</td> <td>20</td> <td>30</td> <td>40</td> <td>50</td> <td>60</td> </tr> <tr> <td><math>C_A</math> (mol/m<sup>3</sup>)</td> <td>100</td> <td>85</td> <td>70</td> <td>59</td> <td>49</td> <td>41</td> <td>35</td> </tr> </table>	t (min)	0	10	20	30	40	50	60	$C_A$ (mol/m <sup>3</sup> )	100	85	70	59	49	41	35	4 + 8	5
t (min)	0	10	20	30	40	50	60												
$C_A$ (mol/m <sup>3</sup> )	100	85	70	59	49	41	35												
6	<p>a) For the parallel reactions for single reactant and single product, consider all possible combinations of reaction orders and select the reaction scheme that will maximize <math>S_{DU}</math>.</p> <p>b) Describe yield with equations.</p> <p>c) How to maximize the undesired product <math>B</math> in a series reaction <math>A \rightarrow B \rightarrow C</math>?</p>	6 + 3 + 3	6																

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