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CHEMICAL ENGINEERING DEPARTMENT
Motilal Nehru National Institute of Technology, Allahabad
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End Semester (Odd) Examination 2020-21

Programme Name: B.Tech. **Semester: V**

Course Code: CH 15101 **Course Name: CHEMICAL REACTION ENGINEERING-I**

Branch: CHEMICAL ENGINEERING **Max. Marks: 40**

Duration: 2 hours (additional 20 minutes for creating pdf file and uploading) **Student Reg. No.:** | | | | | | | | |

Instructions: (Related to Questions)

1. *Figures to the right indicate the full marks.*
2. *Attempt all the questions*
3. *Assume any data if necessary.*

			Marks
Q1	a	A lion weighing 150 kg (density = 950 kg/m^3) consumes 5 kg of meat per day. Each kg of meat provides 2000 kJ of energy. Assuming that the meat is 50% glucose and the overall reaction is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$, -ΔH_r = 4000 kJ Find the metabolic rate of lion in terms of the moles of oxygen used per m^3 of lion per second.	2
	b	For a given elementary reaction, $2A \xrightarrow{k_1} 2R$ Write the rate expression and find out the molecularity and order of the reaction.	2
Q2	a	The rate expression for a certain reaction is given by, $-r_A = 0.05C_A^2$, (mol/cm^3.min). If the concentration is to be expressed in mol/liter and time in hours, what would be the value and units of the rate constant?	1

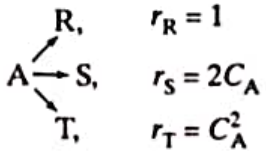
b For the reaction $A \rightarrow R$, second order kinetics and C_{A0} = 1 mol/liter, we get 50% conversion after 1 hour in a batch reactor. What will be the conversion and concentration of A after 1 hour if C_{A0} = 10 mol/liter? 2

c A gaseous feed of pure A (1 mol/liter) enters a mixed flow reactor (3 liters) and reacts as follows: $2A \rightarrow R$, $-r_A = 0.05C_A^2$ (mol/(liter.sec)) 2

Find what volumetric feed rate will give an outlet concentration C_A = 0.5 mol/liter.

Q3 a At present the elementary liquid phase reaction $A + B \rightarrow R + S$ takes place in a plug flow reactor using equimolar quantities of A and B. Conversion is 96%, $C_{A0} = C_{B0}$ = 1 mol/liter. If a mixed flow reactor ten times as large as the plug flow reactor were hooked up in series with the existing unit, which unit should come first and by what fraction could production be increased for that setup? 5

b Consider the parallel decomposition of A (C_{A0} = 5) of different orders 4



Determine the maximum concentration of "S" obtainable in a plug flow and mixed flow reactor.

Q4 a The compound A decomposes as follows, $A \rightarrow P + R$ 5

Find the complete rate equation for this reaction. Given the following data

T, °C	508	427	393	356	283
k, cm^3/mol. s	0.1059	0.00310	0.000588	80.9 X 10^{-6}	0.942 X 10^{-6}

Where T represents the temperature and k are the rate constants. Use units of joules, moles, cm^3 and seconds.

b For a gas phase reaction $A + B \rightarrow 5R$, the standard heat of reaction at 50 °C is -75000 J. Calculate the heat of reaction at 1000 °C. Given that the specific heats for the various reaction components A, B and R are 35, 45 and 70 J/mol.K, respectively. 3

Q5 a Define optimum temperature progression, and show it qualitatively for irreversible, reversible endothermic and reversible exothermic reactions. 2

b Discuss about the exothermic reactions in mixed flow reactors with respect to the point of ignition in conversion verses temperature plot. 2

Q6 A sample of the tracer is injected as a pulse to a reactor and the effluent concentrations measured are as follows:

t(min)	0	2.5	5.0	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30
$C(g/cm^3)$	0	1.5	3.0	4.5	5.0	5.2	5.0	4.5	4.0	4.0	2.0	1.0	0.5

The reactor is to be used to run the following reaction: $A \xrightarrow{k_1} R$

$-r_A = 0.2\ C_A$ mol/(liter.min)

Calculate the following:

a Mean and variance of the E curve. 5

b Conversion of A assuming the Segregation Model. 5