1. An isothermal 100 lt CSTR is fed with an aqueous solution containing reactant A at \( C_A^0 = 3 \text{ mole/lt} \) and flowrate \( V_0 = 25 \text{ lt/min} \). The reactions:

\[
\begin{align*}
\text{Br} & \quad (\text{moles/lt-min}) = 0.3 \ C_A \\
\text{C} & \quad (\text{moles/lt-min}) = 0.2 \ C_A \\
B + C & \quad \rightarrow \ D \\
\text{Dr} & \quad (\text{moles/lt-min}) = 0.05 \ C_B C_C
\end{align*}
\]

(all concentrations in moles/lt)

take place. Find the product distribution leaving the reactor (\( C_A^F, C_B^F, C_C^F, \text{ and } C_D^F \)), if \( C_B^0 = C_C^0 = C_D^0 = 0 \).

2. A constant volume batch reactor was used to measure kinetic data for the reaction:

\[ \text{A} \rightarrow \text{B} \]

at constant temperature. The following data were obtained:

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Run 1, ( C_A ) (moles/lt)</th>
<th>Run 2, ( C_A ) (moles/lt)</th>
<th>Run 3, ( C_A ) (moles/lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
</tr>
<tr>
<td>20</td>
<td>0.41</td>
<td>0.86</td>
<td>1.33</td>
</tr>
<tr>
<td>40</td>
<td>0.32</td>
<td>0.74</td>
<td>1.18</td>
</tr>
<tr>
<td>60</td>
<td>0.25</td>
<td>0.62</td>
<td>1.03</td>
</tr>
<tr>
<td>80</td>
<td>0.18</td>
<td>0.52</td>
<td>0.89</td>
</tr>
<tr>
<td>100</td>
<td>0.13</td>
<td>0.42</td>
<td>0.77</td>
</tr>
<tr>
<td>120</td>
<td>0.08</td>
<td>0.34</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Assuming power law kinetics, find the reaction order and rate constant. Predict the concentration which would exist in the reactor after 10 minutes if the initial concentration was 2.0 moles/lt.

3. The parallel reactions:

\[
\begin{align*}
\text{A + B} & \quad \rightarrow \text{C} \quad \text{r}_1 = k_1 C_A C_B \\
\text{A} & \quad \rightarrow \text{D} \quad \text{r}_2 = k_2 C_A
\end{align*}
\]

take place in a constant volume reactor at constant temperature. \( C_{A0} = C_{B0} = 1 \text{ mole/lt} \), \( k_1 = 2.0 \text{ lt/mole-min} \), \( k_2 = 0.5 \text{ min}^{-1} \).

Write out rate expressions for all four species (\( r_A, r_B, r_C, \text{ and } r_D \)) and write the equations in terms of the time derivatives (\( dC_A/dt, dC_B/dt, dC_C/dt, \text{ and } dC_D/dt \)). (Don’t solve the equations in this part.) If the reaction proceeds until \( C_C = 0.6 \text{ moles/lt} \), what is \( C_D \)? How long is required to produce 0.6 moles/lt of C?

4. An autocatalytic reaction:
A → B + C  \quad r = k C_A C_B

takes place in a CSTR-PFR series. Each reactor has a volume of 0.1 m³, the reaction takes place in the liquid phase so that constant density may be assumed, and the rate constant is 500 m³/kmole-ksec. The initial concentration of A entering the reactor is 2.0 kmoles/m³ with no B or C present in the feed stream.

If the flowrate of reactant to the CSTR is 150 kmoles/ksec, what is the fractional conversion of A leaving the CSTR, and what is the fractional conversion of A leaving the PFR?

What are the production rates of A, B, and C leaving the PFR in kmoles/ksec for conditions given in part A?