1. An isothermal 100 lt CSTR is fed with an aqueous solution containing reactant A at \( C_{A_0} = 3 \) mole/lt and flowrate \( V_0 = 25 \) lt/min. The reactions:

\[ \begin{align*}
A & \xrightarrow{r_1 \text{ (moles/lt-min) = 0.3 } C_A} B \\
A & \xrightarrow{r_2 \text{ (moles/lt-min) = 0.2 } C_A} C \\
B + C & \rightarrow D \quad \text{r}_3 \text{ (moles/lt-min) = 0.05 } C_B C_C
\end{align*} \]

(all concentrations in moles/lt)

take place. Find the product distribution leaving the reactor (\( C_{A_F}, C_{B_F}, C_{C_F}, \) 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:

\[ A \rightarrow B \]

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:

\[ \begin{align*}
A + B & \rightarrow C \quad r_1 = k_1 C_A C_B \\
A & \rightarrow D \quad r_2 = k_2 C_A
\end{align*} \]

take place in a constant volume reactor at constant temperature. \( C_{A_0} = C_{B_0} = 1 \) mole/lt, \( k_1 = 2.0 \) lt/mole-min, \( k_2 = 0.5 \) min\(^{-1}\).

Write out rate expressions for all four species (\( r_A, r_B, r_C, \) and \( r_D \)) and write the equations in terms of the time derivatives (\( dC_A/dt, dC_B/dt, dC_C/dt, \) and \( dC_D/dt \)). If the reaction proceeds until \( C_C = 0.6 \) moles/lt, what is \( C_D \)? How long is required to produce 0.6 moles/lt of \( C \)?
4. An autocatalytic reaction:

\[ A \rightarrow B + C \quad r = k C_A C_B \]

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 kmole/m³ with no B or C present in the feed stream.

If the flowrate of reactant to the CSTR is 150 kmole/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 kmole/ksec for conditions given in part A?