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:

\[
\begin{align*}
A & \rightarrow B & r_1 &= 0.3 C_A \\
A & \rightarrow C & r_2 &= 0.2 C_A \\
B + C & \rightarrow D & r_3 &= 0.05 C_B C_C
\end{align*}
\]

(all concentrations in moles/lt)

Take place. Find the product distribution leaving the reactor ($C_A$, $C_B$, $C_C$, and $C_D$), 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:

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

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 m\(^3\), the reaction takes place in the liquid phase so that constant density may be assumed, and the rate constant is 500 m\(^3\)/kmole-ksec. The initial concentration of A entering the reactor is 2.0 kmoles/m\(^3\) 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?