ChE 354
Quiz #1

1. Calculate the volume of a CSTR and a PFR (not in series) necessary to convert \( 2 \) \text{ mole/liter} of A to product given the following:

\[
A \rightarrow B \quad -r_A = 0.01 \frac{1}{s} C_A
\]

The volumetric flow rate is 5 liters per minute and the final concentration is \( 1.2 \) \text{ mole/liter}. Show the area that is related to the volume for each reactor. The curve can be described by:

\[
49.4674 + 67.2086 x - 61.5976 x^2 + 261.696 x^3
\]

\[
\frac{1}{(-r_A)}
\]

\[
\begin{array}{c}
\text{100} \\
\text{200} \\
\text{300} \\
\text{400} \\
\text{1} \\
\end{array}
\]

\[
X = \frac{C_{A0} - C_{Af}}{C_{A0}};
\]

\[
ra = \frac{0.01}{s} C_{A0} (1 - X);
\]

\[
V_{CSTR} = \frac{C_{A0} v_0 X}{ra};
\]

\[
V_{PFR} = \frac{C_{A0} v_0}{0.01} \int_0^x \frac{1}{(1 - x)} \, dx;
\]

\textbf{Answer}

\[
C_{A0} = 2.0 \text{ mole/liter}; \quad C_{Af} = 1.2 \text{ mole/liter}; \quad v_0 = 5 \text{ liter/min}; \quad \frac{1}{60 \, s};
\]

\[
X = \frac{C_{A0} - C_{Af}}{C_{A0}};
\]

\[
ra = \frac{0.01}{s} C_{A0} (1 - X);
\]

\[
V_{CSTR} = \frac{C_{A0} v_0 X}{ra};
\]

\[
V_{PFR} = \frac{C_{A0} v_0}{0.01} \int_0^x \frac{1}{(1 - x)} \, dx;
\]
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$X$</td>
<td>0.4</td>
</tr>
<tr>
<td>$V_{\text{CSTR}}$</td>
<td>5.56 liter</td>
</tr>
<tr>
<td>$V_{\text{PFR}}$</td>
<td>4.26 liter</td>
</tr>
</tbody>
</table>