\[ D = 5.5 \text{ cm}, \quad K = 0.6 \frac{W}{\text{m-K}}, \quad \alpha = 0.14 \times 10^{-6} \frac{\text{m}^2}{\text{s}}, \quad T_i = 4^\circ \text{C} \]

\[ T_o = 97^\circ \text{C}, \quad h = 1400 \frac{W}{\text{m}^2-\text{K}}, \quad T_0 = 70^\circ \text{C}, \quad \text{Find } A_i \]

\[ B_i = \frac{h \nu_a}{K} = \frac{(1400 \frac{W}{\text{m}^2-\text{K}})(0.45)(0.055 \text{ m})}{(0.6 \frac{W}{\text{m-K}})} = 64.17 > 0.2 \quad \text{ONE-TERM APPROX. VALID} \]

**TABLE 4-2:**

<table>
<thead>
<tr>
<th>B_i</th>
<th>A_i</th>
<th>\lambda_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3.0788</td>
<td>1.9962</td>
</tr>
<tr>
<td>100</td>
<td>3.1102</td>
<td>1.9990</td>
</tr>
</tbody>
</table>

\[ \lambda = \lambda_1 + \left( \frac{\lambda_2 - \lambda_1}{B_i - B_{i,1}} \right) \cdot (B_i - B_{i,1}) \]

\[ \lambda_1 = (3.0788) + \frac{(3.1102 - 3.0788)}{(100 - 50)} \cdot (64.17 - 50) = 3.088 \]

\[ A = A_1 + \left( \frac{A_2 - A_1}{B_i - B_{i,1}} \right) \cdot (B_i - B_{i,1}) \]

\[ A_1 = (1.9962) + \frac{(1.999 - 1.9962)}{(100 - 50)} \cdot (64.17 - 50) = 1.997 \]

\[ \frac{T_0 - T_{\infty}}{T_i - T_{\infty}} = A_i \cdot e^{-\frac{\alpha x}{c_i}} \]

\[ I = \frac{x \cdot \xi}{c_i} \]
\[ e^{-\chi_1 t} = \frac{1}{A_1} \left( \frac{T_0 - T_{\infty}}{T_c - T_{\infty}} \right) \]

\[-\chi_1 t = \ln \left( \frac{T_0 - T_{\infty}}{A_1 \left( \frac{T_0 - T_{\infty}}{T_c - T_{\infty}} \right)} \right) \]

\[ t = \frac{\chi_1^{-2}}{\nu_0^2} = -\frac{1}{\chi_1^2} \ln \left( \frac{T_0 - T_{\infty}}{A_1 \left( \frac{T_0 - T_{\infty}}{T_c - T_{\infty}} \right)} \right) \]

\[ t = -\frac{\nu_0^2}{\chi_1^2} \ln \left( \frac{T_0 - T_{\infty}}{A_1 \left( \frac{T_0 - T_{\infty}}{T_c - T_{\infty}} \right)} \right) \]

\[ t = -\frac{(0.0275 \text{ m})^2}{(0.14 \times 10^{-6} \text{ m}^2/\text{s}) \times (3.088)^2} \ln \left( \frac{(70 - 97^\circ \text{C})}{(1.997) \left(4 - 97^\circ \text{C}) \right)} \right) \]

\[ t = 1092^3 = 18.21 \text{ min} \]