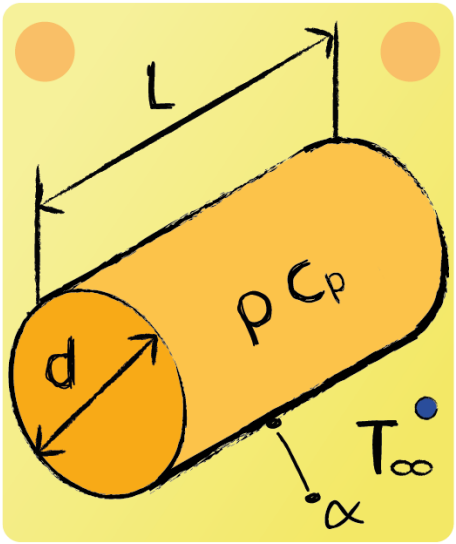
Lecture 14 Question 4

Consider the following cylinder. How long will it take for the cylinder to cool down to $2 \cdot T_\infty$?
Hint: Bi << 1 & $T_0 = 4 \cdot T_\infty$



Lumped capacity model:

$$\Theta^* = 1 - \exp\left(-\frac{\alpha \cdot A_s}{\rho \cdot c_p \cdot V} \cdot t\right)$$

Dimensionless temperature:

$$\Theta^* = \frac{T(t) - T_0}{T_\infty - T_0} = \frac{2 \cdot T_\infty - 4 \cdot T_\infty}{T_\infty - 4 \cdot T_\infty} = \frac{2}{3}$$

Surface area:

$$A_s = \pi \cdot d \cdot L$$

Volume:

$$V = \frac{1}{4} \cdot \pi \cdot d^2 \cdot L$$

Solving:

$$-\frac{\alpha \cdot A_s}{\rho \cdot c_p \cdot V} \cdot t = \ln\left(\frac{1}{3}\right)$$

$$t = -\frac{\rho \cdot c_p \cdot V}{\alpha \cdot A_s} \cdot \ln\left(\frac{1}{3}\right)$$

$$t = -\frac{\rho \cdot c_p \cdot d}{4 \cdot \alpha} \cdot \ln\left(\frac{1}{3}\right)$$