Ex:

After being open for a long time, the switch closes at $t = 0$.

Write a numerical expression for $i(t)$ for $t > 0$.

\[
i(t) = i(t \to \infty) + \left[ i(t = 0^+) - i(t \to \infty) \right] e^{-t/R_cC}, \quad t > 0
\]

$t = 0^-$ models: $C$ = open circuit, find $v_C(0^-)$

Switch open, 30mA disconnected

Since there is no power source and there is a resistor across $C$ to discharge it, we must have

\[
v_C(0^-) = 0 \text{V}
\]

Note: No current can flow in the single wire to the left since that would cause charge to accumulate in that part of the circuit. There is no complete circuit.
\( t=0^+ \): \( v_c(t=0^+)=v_c(t=0^-) \) since the energy variable \( v_c \) cannot change instantly. We model \( C \) as a \( v \)-src for the instant in time \( t=0^+ \).
\( v_c(0^+)=v_c(0^-)=0 \) V acts like a wire.

\[
\begin{align*}
30mA & \quad 1k\Omega \quad L(v(t)) \quad \text{wire shorts out 2k}\Omega \\
\text{\textbullet} & \quad 2k\Omega \\
\end{align*}
\]

\( \therefore \) 0 V across 2k\( \Omega \)

We have a current divider with \( R=1k\Omega \) flows in 2k\( \Omega \) by Ohm's law.

\[
\begin{align*}
\dot{i}(0^+) &= 30mA \cdot \frac{1k\Omega}{1k\Omega+1k\Omega} = 15 \text{ mA} \\
\end{align*}
\]

\( t \to \infty \): \( C \) acts like open circuit

\[
\begin{align*}
30mA & \quad 1k\Omega \quad L(i(t+\infty)) \quad 2k\Omega \\
\text{\textbullet} & \quad \text{2k}\Omega \\
\end{align*}
\]

We have a current divider with 1k\( \Omega \) on left and 1k\( \Omega \)+2k\( \Omega \)=3k\( \Omega \) on right.

\[
\begin{align*}
\therefore \ i(t+\infty) &= 30mA \cdot \frac{3k\Omega}{1k\Omega+3k\Omega} = 22.5 \text{ mA} \\
\end{align*}
\]

\( \tau = R_{Th} C \): We find \( R_{Th} \) looking into terminals where \( C \) is connected.
In this circuit, we need only turn off the independent source and look into the circuit from the terminals where the $C$ is connected to find $R_{Th}$.

We may redraw the circuit as follows:

We have

\[ R_{Th} = 2 \, k\Omega \parallel (1 \, k\Omega + 1 \, k\Omega) = 1 \, k\Omega \]

\[ R_{Th}C = 1 \, k\Omega \cdot 0.25 \, \text{ms} = 0.25 \, \text{s} \]

Combining results, we have our final answer:

\[ i(t) = 22.5 \, \text{mA} + (15 \, \text{mA} - 22.5 \, \text{mA}) e^{-t/0.25} \]