Ex:

After being open for a long time, the switch closes at $t = 0$. Write an expression for $v_c(t \geq 0)$ in terms of $R_1$, $R_2$, $R_3$, $i_s$, and $C$.

Solt'n: At $t = 0^-$ the switch is open and $C = \text{open}$.

$t = 0^-:$

- $i_s$ flows thru $R_2$ producing $v$-drop $i_s R_2$.

Since there is no current in $R_1$, this voltage appears across $C$.

$$v_c(0^-) = i_s R_2$$

Note that $+$ sign of $i_s R_2$ $v$-drop connects to $+$ sign of $v_c$ thru $R_1$ ($0v$ drop $\approx$ wire) and $-$ sign of $i_s R_2$ $v$-drop connects to $-$ sign of $v_c$ thru wire.
At \( t=0^+ \), we treat \( C \) as \( v \)-source with value \( v_c(0^+) = v_c(0^-) \). Switch is closed.

\[
v_c(0^+) = v_c(0^-) = i_S R_2
\]

Since the value we need is \( v_c(0^+) \), there is nothing further to solve.

For \( t \to \infty \), we treat \( C \) as open, switch closed.

Now we have \( v_c = i_S \cdot R_2//R_3 \). This is the same as \( t=0^- \) except that we have \( R_2//R_3 \) instead of \( R_2 \).

\[
v_c(t \to \infty) = i_S \cdot R_2//R_3
\]

The time constant is \( R_{TH} C \).

We remove \( C \) and look into the circuit from terminals where \( C \) attaches. We also turn off \( i_S \). What we see is \( R_{TH} \).
we have \( R_{Th} = R_1 + R_2 \parallel R_3 \)

Now plug terms into general soln:

\[
v_c(t>0) = v_c(t \to \infty) + [v_c(0^+) - v_c(t \to \infty)] e^{-t/R_{Th}C}
\]

Here, we have:

\[
v_c(t>0) = i_s \cdot R_2 \parallel R_3 + (i_s R_2 - i_s R_2 \parallel R_3) \frac{-t}{(R_1 + R_2 \parallel R_3)C}
\]