Ex:

Write a numerical expression for \( v(t) \) for \( t > 0 \).

**Sol'n:** We use general form of solution for RC circuits.

\[
v(t > 0) = v(t \to \infty) + \left[ v(0^+) - v(t \to \infty) \right] e^{-\frac{t}{R_T C}}
\]

We find \( v(0^+) \), \( v(t \to \infty) \), and \( R_T \).

We start at \( t = 0^- \) to find voltage on \( C \) at \( t = 0^+ \).

\( t = 0^- \): \( C \) acts like open circuit. Switch is closed.

Switch creates a short circuit, and \( v_c(0^-) = 0V \).
$t = 0^+$: $v_c(0^+) = v_c(0^-) = 0\text{V}$ since $v_c$ can't change instantly.

We model $C$ as voltage source of $0\text{V}$. Thus, it acts like a wire.

This is a current-divider circuit with $20\text{k}\Omega + 240\text{k}\Omega = 260\text{k}\Omega$ on one side and $120\text{k}\Omega$ on the other side.

The current thru the $240\text{k}\Omega$ is

$$i(0^+) = \frac{50\mu\text{A} \cdot 120\text{k}\Omega}{20\text{k}\Omega + 240\text{k}\Omega + 120\text{k}\Omega}$$

$$i(0^+) = \frac{50\mu\text{A} \cdot 120\text{k}\Omega}{380\text{k}\Omega}$$

$v(0^+)$ from Ohm's Law is

$$v(0^+) = \frac{50\mu\text{A} \cdot 120\text{k}\Omega \cdot 240\text{k}\Omega}{380\text{k}\Omega}$$
\[ v(0^+) = \frac{6V \cdot 12}{19} \]

For \( t \to \infty \): switch is open, \( C = \text{open circuit} \).

No current can flow through the 240 k\( \Omega \) resistor.

\[ v(t \to \infty) = 0V \]

**R_{Th}**: We look in from the terminals where \( C \) is connected, and we turn off the current source.

\[ R_{Th} = 20k\Omega + 120k\Omega + 240k\Omega = 380k\Omega \]
The time constant is $R \times C$:

$$\tau = 380 \text{ k} \Omega \cdot 0.05 \mu \text{F} = 19 \text{ ms}$$

Putting results together:

$$v(t>0) = 0V + \left( \frac{6V \cdot 12}{19} - 0V \right) e^{-t/19 \text{ ms}}$$

or

$$v(t>0) = \frac{6V \cdot 12}{19} e^{-t/19 \text{ ms}} \equiv 3.8V e^{-t/19 \text{ ms}}$$