Switch has been closed for a long time before opening at time \( t=0 \).

a) Find initial value of \( i_c(t) \).

**Solved:** If switch was closed for a long time, then the capacitor will discharge through 6.8kΩ:

\[
\begin{align*}
6.8kΩ & \quad \text{(right side of circuit)} \\
0.2\mu F & \quad \text{(see `note` below.)}
\end{align*}
\]

**Note:** The closed switch creates a short circuit. The left and right sides of the circuit may then be treated as though they are totally independent. Why? Because the currents flowing through the short create no V drop. Thus, two mesh currents on the sides of the short do not interact.

Thus, at \( t=0^- \) the \( C \) has no charge, and \( v_c = 0 \).

\[\therefore \text{ } C \text{ acts like short at } t=0^- \] Since \( v_c \) cannot change instantly, \( v_c(t=0^+) = 0V \), too.

Also, we replace the 75V and 4kΩ and 16kΩ with a Thévenin equivalent, \( V_{Th} \) from open-circuit V-divider is 75V \( \cdot \frac{4kΩ}{4kΩ+16kΩ} = 60V = V_{Th} \)

Turn 75V down to 0V and connect 1V source to output to get \( R_{Th} = \frac{1V}{\sqrt{1V/4kΩ(16kΩ)}} = 4kΩ || 16kΩ \)
\[ R_{TH} = 4k\Omega \cdot \frac{1/4}{1} = 4k\Omega \cdot \frac{4}{5} = 3.2k\Omega \]

Circuit model for \( t = 0^+ \) is:

\[ \begin{array}{c}
\begin{array}{c}
60V \\
\downarrow
\end{array}
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\downarrow
\end{array}
\end{array} \quad \begin{array}{c}
\begin{array}{c}
0V
\end{array}
\end{array} \]

\[ i_0(t=0^+) = \frac{60V}{3.2k\Omega + 6.8k\Omega} = \frac{60V}{10k\Omega} = 6mA \]

b) Find \( i_0(t \to \infty) \).

**Sol'n:** When the \( C \) is charged, it looks like open circuit.

Note: \( i_0(t \to \infty) = 0A \) for all \( C \)'s in all switching problems.

But \( V_C(t=0^-) = 0V \) only if circuit discharges \( C \) completely for \( t < 0 \), otherwise, \( V_C(t=0^-) \) is some nonzero value.

If \( C \) is open circuit, then \( i_0(t \to \infty) = 0A \).

c) Find time constant for \( t \geq 0 \).

**Sol'n:**

\[ \tau = R_{eq} \cdot C = \frac{10k\Omega}{3.2k\Omega + 6.8k\Omega} \cdot 0.2\mu F = 2ms \]

d) Find expression for \( i_0(t) \) when \( t \geq 0^+ \)

**Sol'n:** General sol'n for \( i_0(t) \) is:

\[ i_0(t) = i_0(t=0^+) + \left[ i_0(t=\infty) - i_0(t=0^+) \right] \left[ 1 - e^{-t/\tau} \right] \]

\[ = 6mA + \left[ 0 - 6mA \right] \left[ 1 - e^{-t/2ms} \right] \]

\[ = 6mA e^{-t/2ms} \quad t \geq 0^+ \]
e) Find expression for $v_o(t)$ when $t \geq 0^+$.

$$
\text{Sol'n: } v_o(t) = 60V - i_o(t) \cdot 3.2k \Omega = 60V - 6mA \cdot e^{-t/2ms} \cdot 3.2k \Omega
$$
$$
= 60V - 19.2V e^{-t/2ms} \quad t \geq 0^+
$$