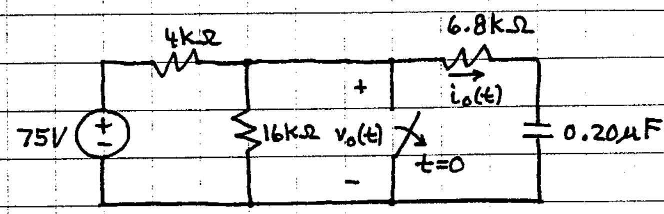
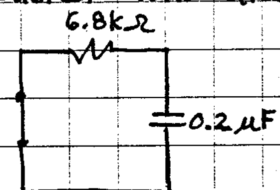
ex:



Switch has been closed for a long time before opening at time $t=0$.

a) Find initial value of $i_o(t)$.

sol'n: If switch was closed for a long time, then the capacitor will discharge through 6.8kΩ:

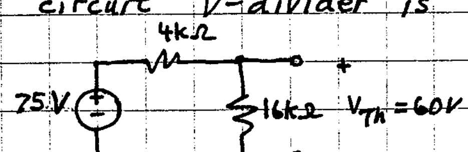


(Right side of circuit, see 'Note' below.)

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, the mesh currents on the two sides of the short do not interact.

Thus, at $t=0^-$ the C has no charge, and $v_C=0$.
∴ C acts like short at $t=0^-$. Since v_C cannot change instantly, $v_C(t=0^+)=0V$, too.

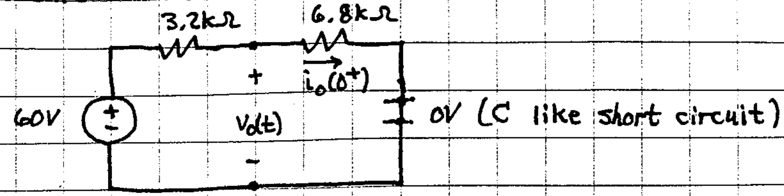
Also, we replace the 75V and 4kΩ and 16kΩ with a Thevenin equivalent. V_{Th} from open-circuit V-divider is $75V\cdot\frac{16k\Omega}{4k\Omega+16k\Omega}=60V=V_{Th}$



Turn 75V down to 0V and connect 1V source to output to get $R_{Th}=1V/[1V/(4k\Omega\|16k\Omega)]=4k\Omega\|16k\Omega$

$$R_{Th} = 4k\Omega \cdot 1 \| 4 = 4k\Omega \cdot \frac{4}{5} = 3.2k\Omega$$

∴ Circuit model for $t=0^+$ is:



$$i_o(t=0^+) = \frac{60V}{3.2k\Omega + 6.8k\Omega} = \frac{60V}{10k\Omega} = \frac{6V}{1k\Omega} = 6\ mA$$

b) Find $i_o(t \to \infty)$.

sol'n: When the C is charged, it looks like open circuit.

Note: $i_C(t\to\infty) = 0\ A$ for all C's in all switching probs.

$v_C(t=0^-) = v_C(t=0^+)$ " " " " " " "

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 $i_o(t\to\infty) = 0\ A$.

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

sol'n: $\tau = R_{eq} \cdot C$ $\quad R_{eq} = 10k\Omega = 3.2k\Omega + 6.8k\Omega$

$= 10k\Omega \cdot 0.2\mu F$ $\quad C = 0.2\mu F$

$= 2\ ms$

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

sol'n: General sol'n for $i_o(t)$ is:

$$i_o(t) = i_o(t=0^+) + [i_o(t\to\infty) - i_o(t=0^+)][1 - e^{-t/RC}]$$

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

$$= 6mA\, e^{-t/2ms} \qquad t \geq 0^+$$

e) Find expression for $v_o(t)$ when $t \geq 0^+$.

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

$= 60\text{V} - 19.2\text{V}\, e^{-t/2\text{ms}} \qquad t \geq 0^+$