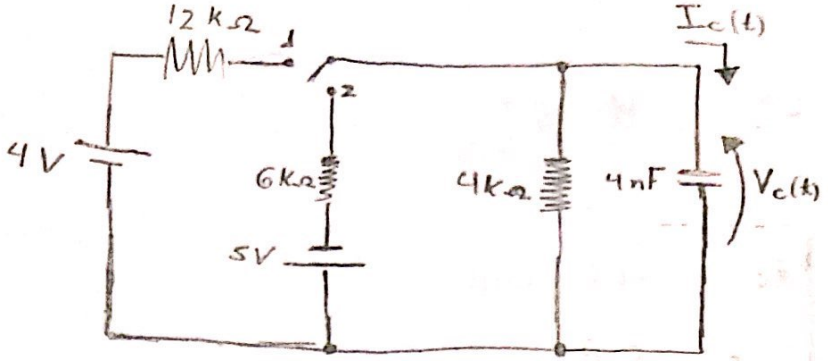
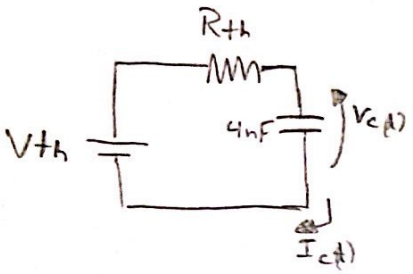
④ a-)



Chave em 1:



$R_{th} = 12 // 4 = 3\,k\Omega$

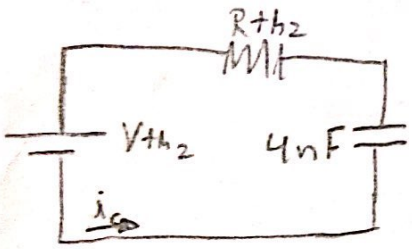
$\frac{4}{16k} = \frac{V_{th}}{4k}$ $\quad V_{th} = \frac{4}{16} = 1,0\,V$

$V_{th} = V_c$

$\boxed{V_c = 1,0\,V}$

$\tau_1 = R_{th} \cdot C$

$= 3k \cdot 4 = 12\,\mu s \rightarrow 5\tau_1 = 60\,\mu s$



$\frac{-5}{10k} = \frac{V_{th_2}}{4k} \rightarrow \boxed{V_{th_2} = -2,0\,V}$

$R_{th_2} = 6 // 4 \Rightarrow \boxed{R_{th_2} = 2,4\,k\Omega}$

$\tau_2 = R_{th_2} \cdot C$

$\tau_2 = 2,4 \cdot 4,0$

$\boxed{\tau_2 = 9,6\,\mu s}$

$5\tau_2 = 48\,\mu s$

Em $t = 0$; $t = 100\,\mu s$; $V_{th_2} = -2,0\,V$; $V_c(t) = 1,0\,V$

$t = 100 + 48 = 148\,\mu s$

$i_{c(t)} = \frac{-2 - 1}{2,4k} = \frac{-3}{2,4k}$ $\boxed{= -1,25\,mA}$

$V_c(t) = 1 + (-2-1)(1 - e^{-t/\tau_2}) = 1 - 3(1 - e^{-t/\tau_2})$

$\boxed{V_c(t) = -2 + 3e^{-t/\tau_2}}$

$t = 0$ $\quad \boxed{V_c(0) = 1,0\,V}$

$t = \infty$ $\quad \boxed{V_c(\infty) = -2,0\,V}$

$$I_{c(t)} = \frac{V_{th_2} - V_{c(t)}}{R_{th_2}} = \frac{-2-(-2+3e^{-t/\tau_2})}{2,4} \Rightarrow \frac{-2+2-3e^{-t/\tau_2}}{2,4}$$

$$\boxed{I_{c(t)} = \frac{-3e^{-t/\tau_2}}{2,4}} \rightsquigarrow \begin{matrix} t=0 \\ t=\infty \end{matrix} \quad \boxed{\begin{matrix} i_{c(0)} = -1,25\ mA \\ i_{c(\infty)} = 0\ A \end{matrix}}$$

b-) $V_{c(t)} = -2 + 3e^{-t/\tau_2}$ $\quad \frac{-7,0461}{9,6}$

$t = 7,0461\ s \rightsquigarrow V_{c(7,0461)} = -2 + 3e$

$$\boxed{V_{c(7,0461)} = -0,5560\ V}$$

$$I_{c(t)} = \frac{-3e^{-t/\tau_2}}{2,4} \rightarrow t = 7,0461 \rightarrow I_{c(7,0461)} = \frac{-3e^{\frac{-7,0461}{9,6}}}{2,4}$$

$$\boxed{I_{c(7,0461)} = -0,6000\ mA}$$