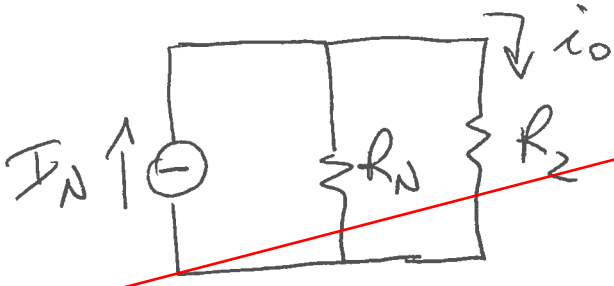
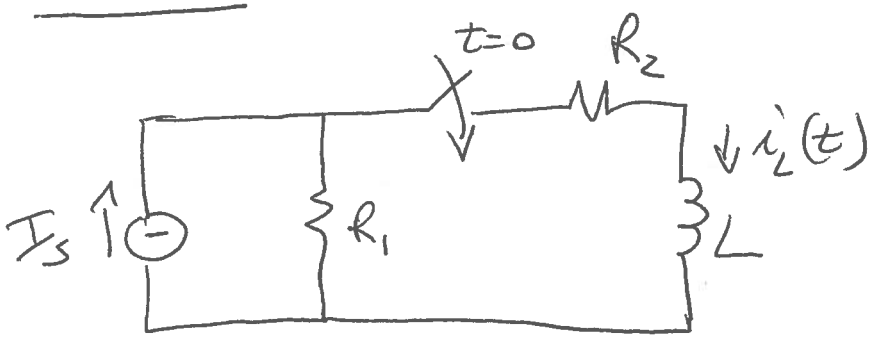


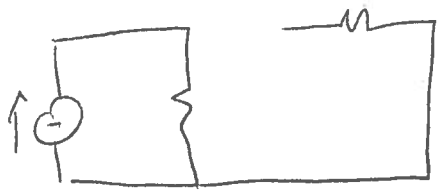
$$i_0 = \frac{R_N}{R_2+R_N} I_N = \frac{6}{5}\,mA$$

ES 22



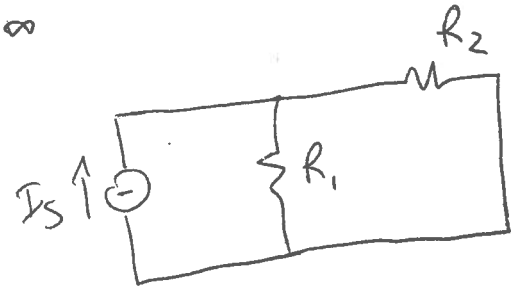
$I_S = 6A$
$R_1 = 2\Omega$
$R_2 = 4\Omega$
$L = 3H$

$t<0$



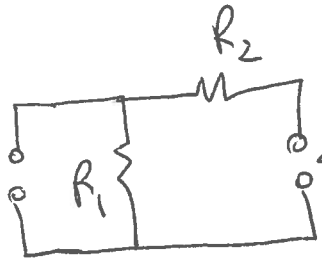
$$i_L(0^-) = 0\,A = i_L(0^+)$$

$t=\infty$



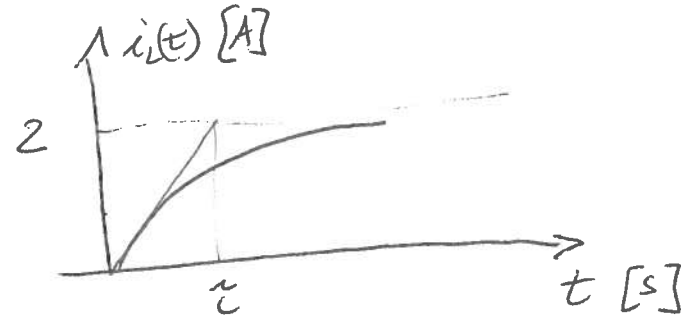
$$i_L(\infty) = \frac{R_1}{R_1+R_2} I_S = 2\,A$$

R_{eq}



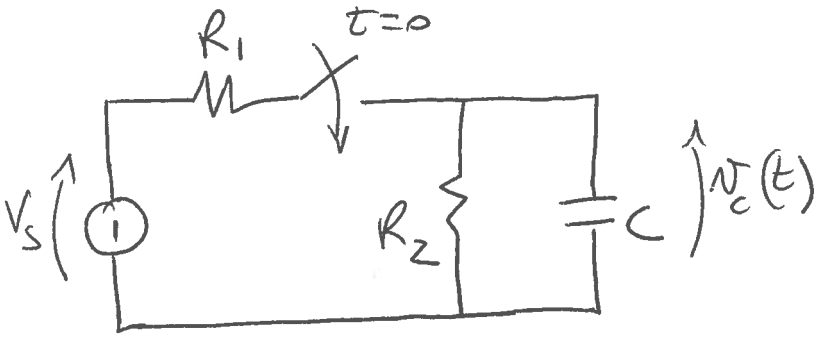
$$R_{eq} = R_1+R_2 = 6\Omega$$

$$\tau = \frac{L}{R_{eq}} = \frac{1}{2}\,s$$



$$i_L(t) = \left[i_L(0)-i_L(\infty)\right]\exp\left(-\frac{t}{\tau}\right)+i_L(\infty)$$

ES 23



$V_s = 12\,V$

$R_1 = 3\,\Omega$

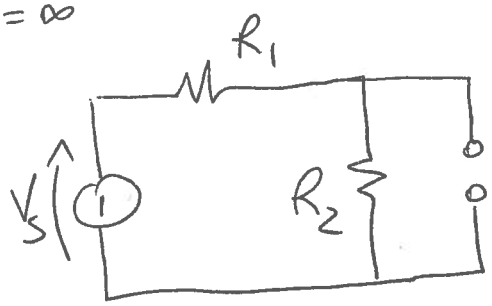
$R_2 = 6\,\Omega$

$C = \frac{1}{2}\,F$

$t<0$

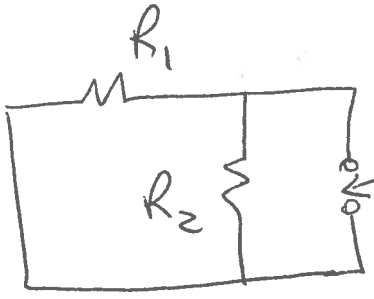
$v_c(0^-) = 0\,V = v_c(0^+)$

$t=\infty$



$v_c(\infty) = \frac{R_2}{R_1+R_2} V_s = 8\,V$

R_{eq}

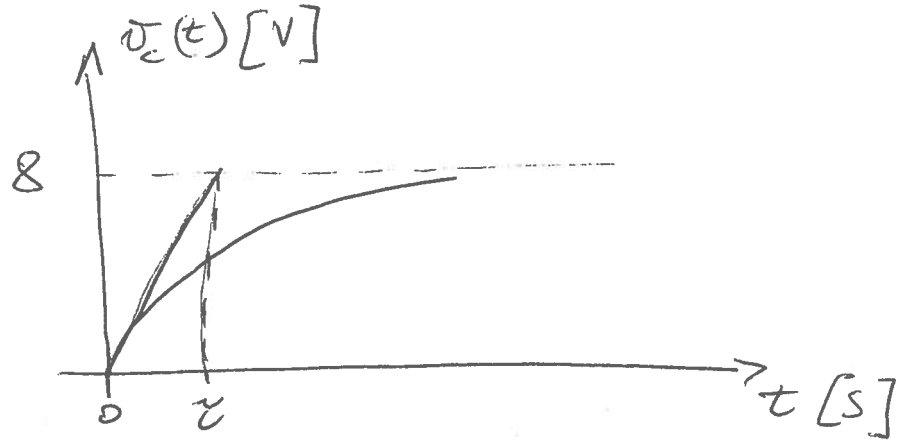


$R_{eq} = \frac{R_1 R_2}{R_1+R_2} = 2\,\Omega$

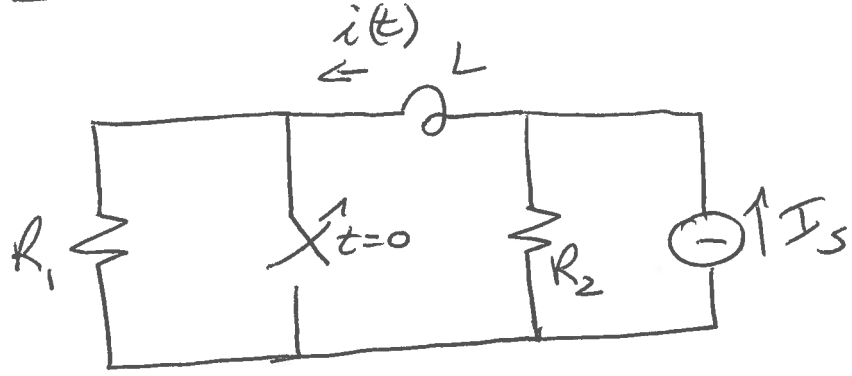
$\tau = R_{eq} C = 1\,s$

$$v_c(t) = \left[v_c(0) - v_c(\infty)\right] \exp\left(-\frac{t}{\tau}\right) + v_c(\infty)$$

$$= \frac{R_2}{R_1+R_2} V_s \left(1 - \exp\left(-t\,\frac{R_1+R_2}{R_1 R_2 C}\right)\right)$$


$v_c(t)$ [V]
8
0
τ
t [s]

ES 24



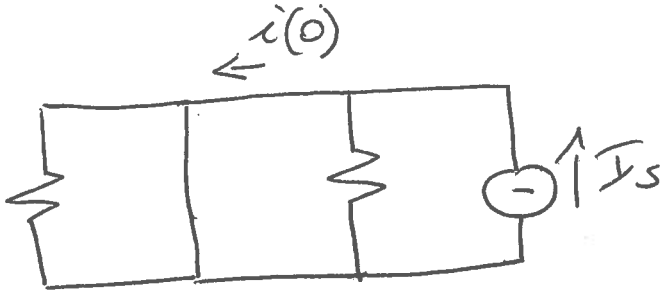
$I_S = 3\,A$

$R_1 = 5\,\Omega$

$R_2 = 10\,\Omega$

$L = 1{,}5\,H$

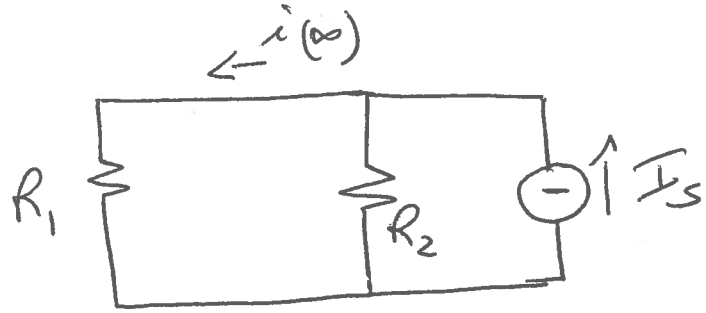
$t < 0$



$i(0) = I_S = 3\,A$

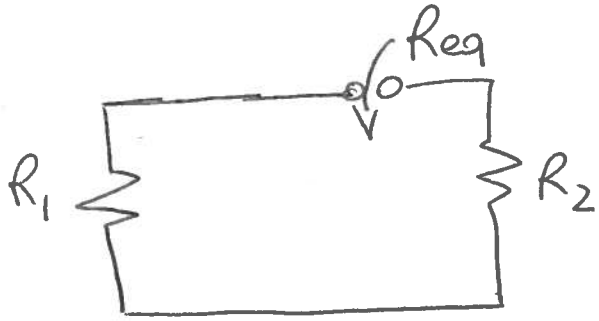
$i(0^+) = i(0^-)$

$t = \infty$



$$i(\infty) = I_S \frac{R_2}{R_1 + R_2} = 2\,A$$

τ

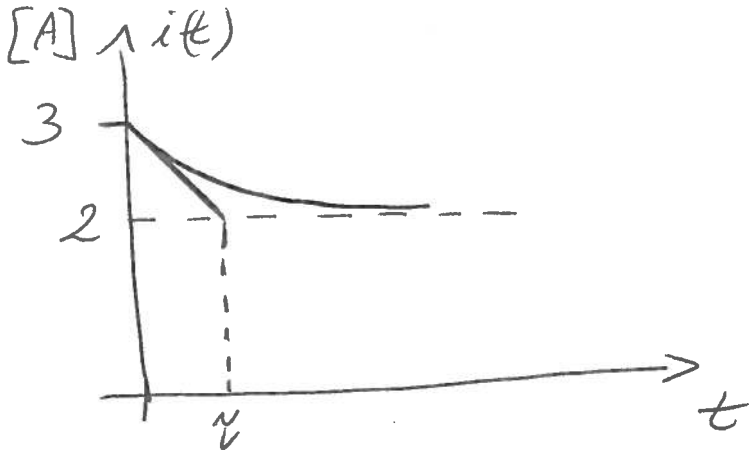


$R_{eq} = R_1 + R_2 = 15\,\Omega$

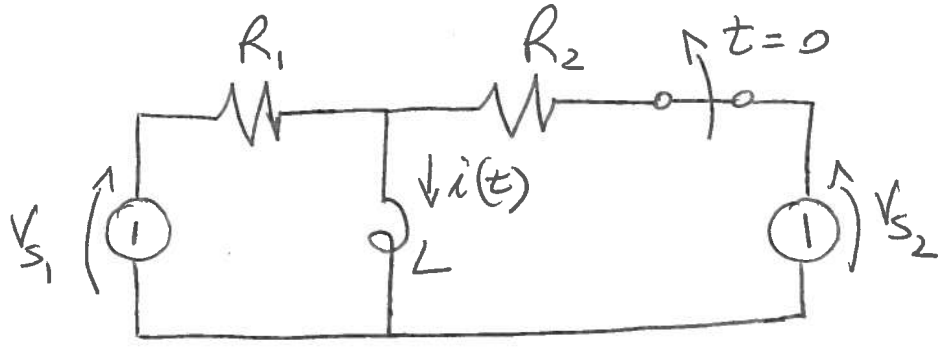
$$\tau = \frac{L}{R_{eq}} = 0{,}1\,s$$

$$i(t) = I_S \left[1 - \frac{R_2}{R_1 + R_2} \right] \exp\left(- \frac{(R_1 + R_2)t}{L} \right) + I_S \frac{R_2}{R_1 + R_2}$$

$$= \exp(-10t) + 2\ A$$



ES 25



$V_{S_1} = 20V$

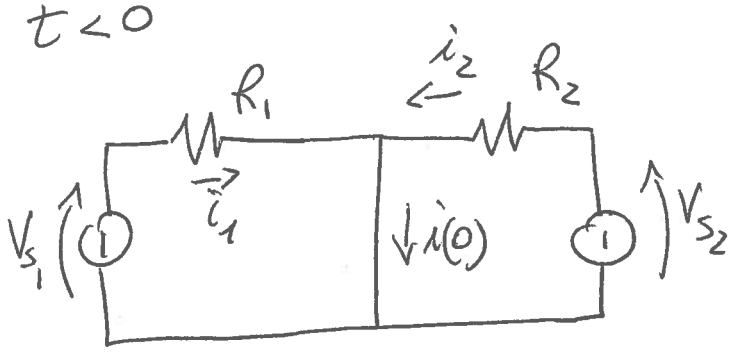
$V_{S_2} = 3V$

$R_1 = 4\Omega$

$R_2 = 3\Omega$

$L = 2H$

$t < 0$



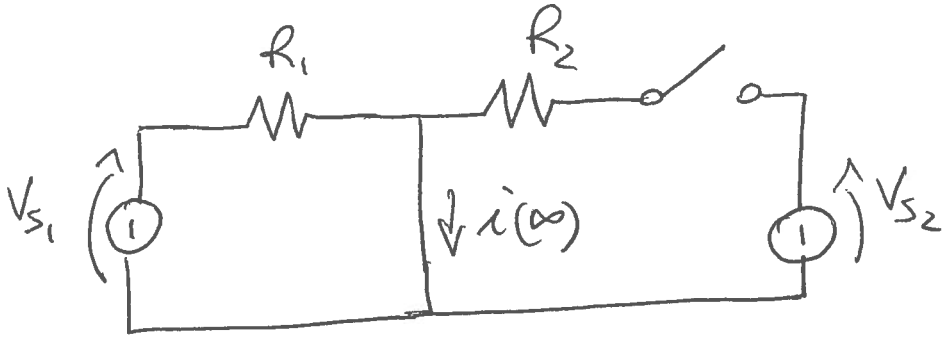
$i(0) = i_1 + i_2$

$i_1 = \frac{V_{S_1}}{R_1} \quad | \quad i_2 = \frac{V_{S_2}}{R_2}$

$i(0) = \frac{V_{S_1}}{R_1} + \frac{V_{S_2}}{R_2} = 6A$

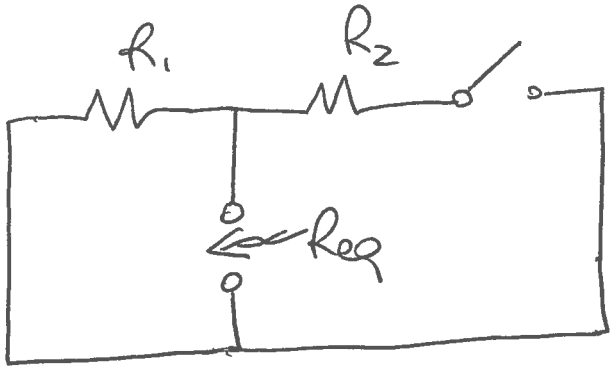
$i(0^+) = i(0^-)$

$t = \infty$



$$i(\infty) = \frac{V_{s1}}{R_1} = 5\,A$$

τ

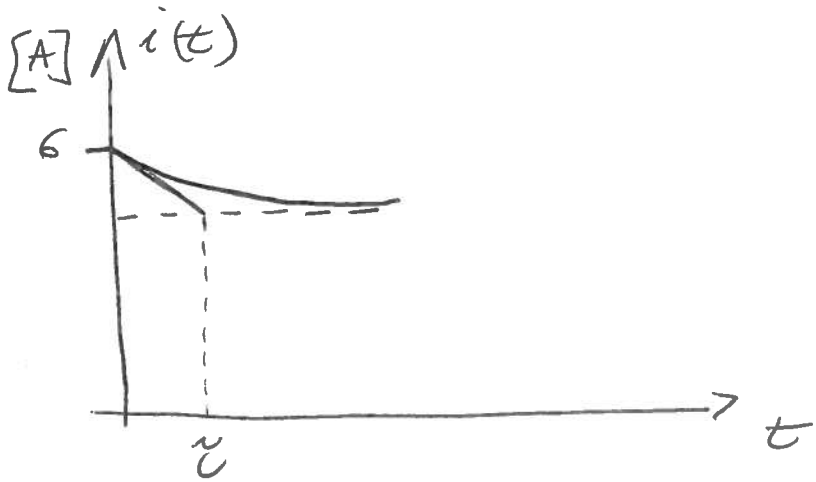


$$R_{eq} = R_1 = 4\,\Omega$$

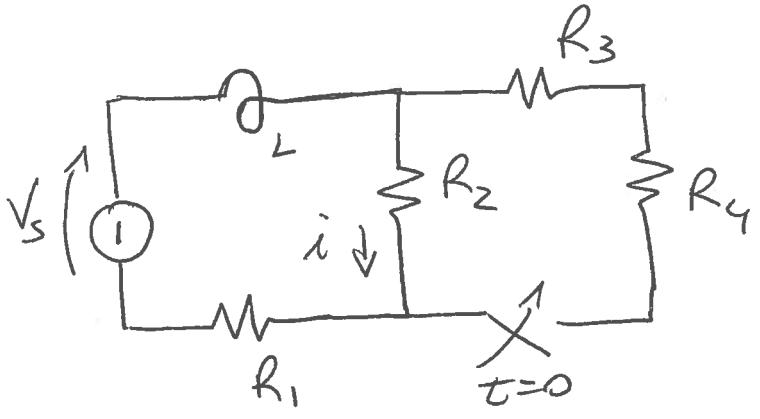
$$\tau = \frac{L}{R_{eq}} = \frac{L}{R_1} = 0{,}5\,s$$

$$i(t) = \frac{V_{s2}}{R_2} \exp\left(-\frac{R_1 t}{L}\right) + \frac{V_{s1}}{R_1}$$

$$= \exp(-2t) + 5\ A$$



ES 26



$V_s = 10\,V$

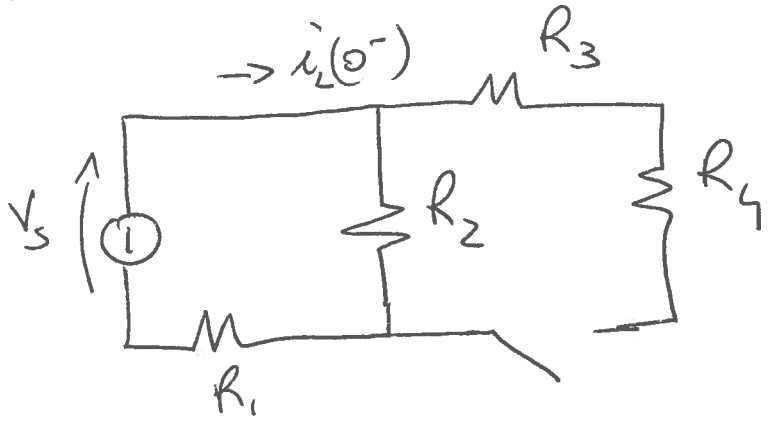
$R_1 = R_4 = 3\,\Omega$

$R_2 = 1\,\Omega$

$R_3 = 2\,\Omega$

$L = 1\,H$

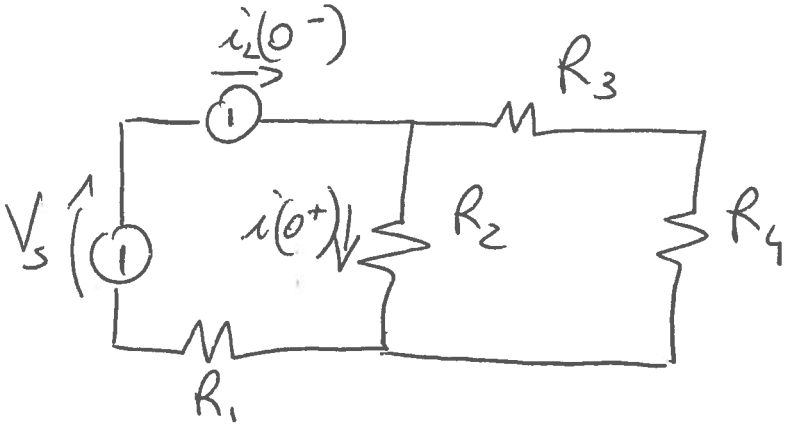
$t = 0^-$



$$i_L(0^-) = i(0^-) = \frac{V_s}{R_1 + R_2}$$

$$= 2{,}5\,A$$

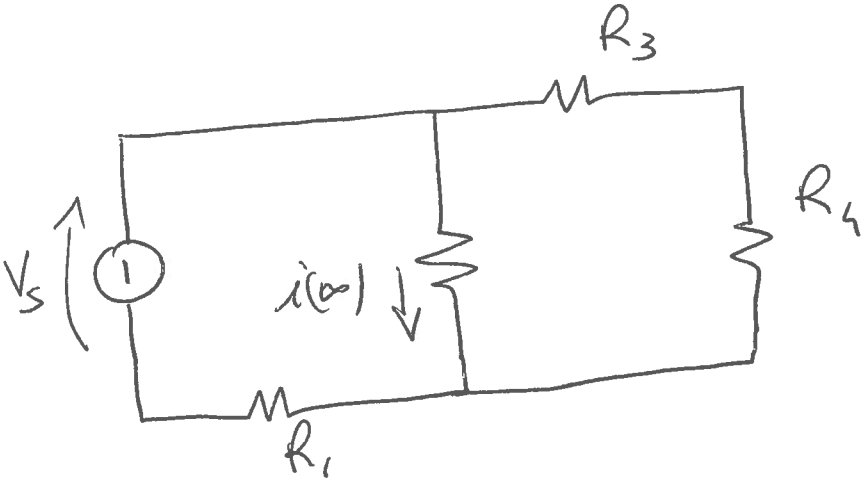
$t = 0^+$

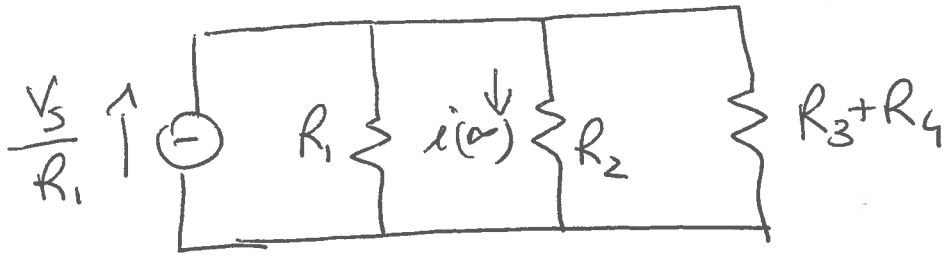


$$i(0^+) = i_L(0^-)\,\frac{R_3 + R_4}{R_2 + R_3 + R_4} = V_s\,\frac{R_3 + R_4}{R_1 + R_2}\;\frac{1}{R_2 + R_3 + R_4}$$

$$= 2{,}08\,A$$

$t = \infty$

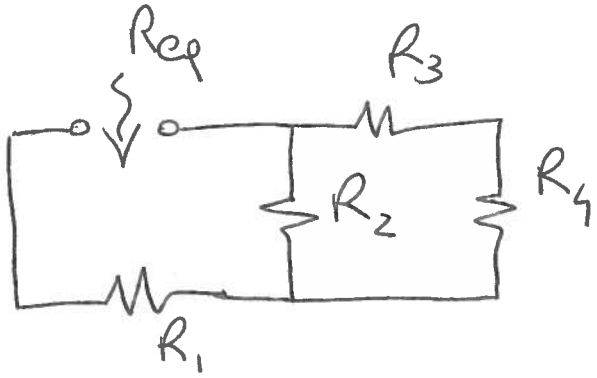




$$i(\infty) = \frac{V_s}{R_1} \frac{\frac{1}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3+R_4}} = \frac{V_s\,(R_3+R_4)}{(R_1+R_2)(R_3+R_4) + R_1 R_2}$$

$$= 2{,}17\ A$$

τ



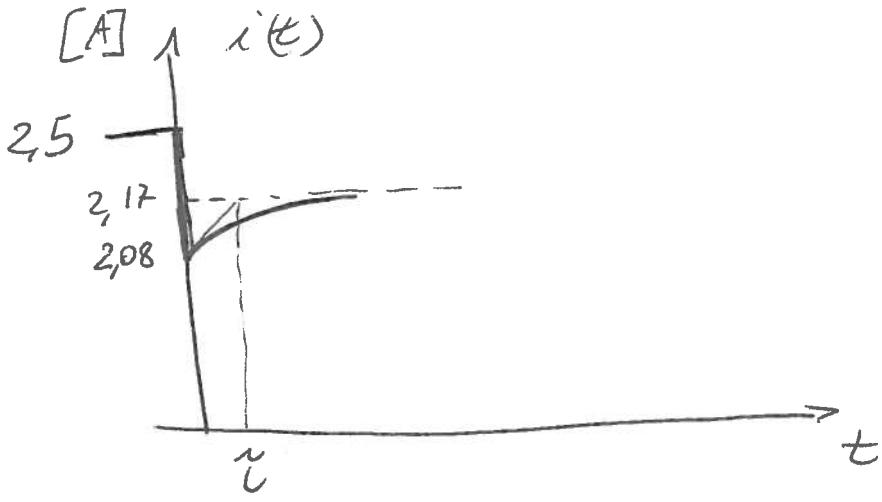
$$R_{eq} = R_1 + \frac{R_2(R_3+R_4)}{R_2+R_3+R_4}$$

$$= 3{,}83\ \Omega$$

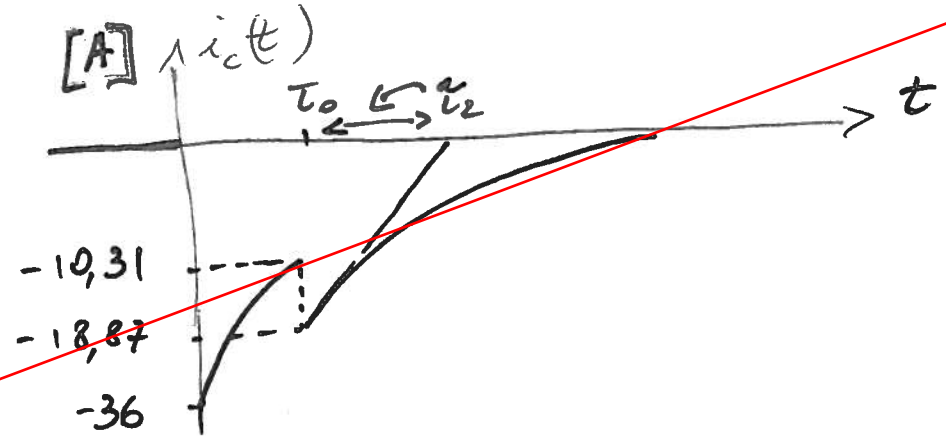
$$\tau = \frac{L}{R_{eq}} = 0{,}26\ s$$

$$i(t) = [i(0^+) - i(\infty)] \exp\left(-\frac{t}{\tau}\right) + i(\infty)$$

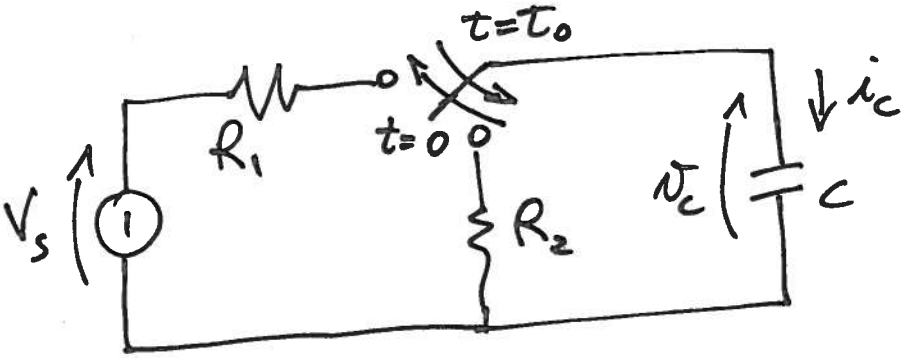
$$= -0{,}09 \exp\left(-\frac{t}{0{,}26}\right) + 2{,}17\ A$$


[A]
i(t)
2,5
2,17
2,08
τ
t

$i_c(t_0^+) = -18,876\ A$



ES 28 (FLASH FOTOGRAFICO)



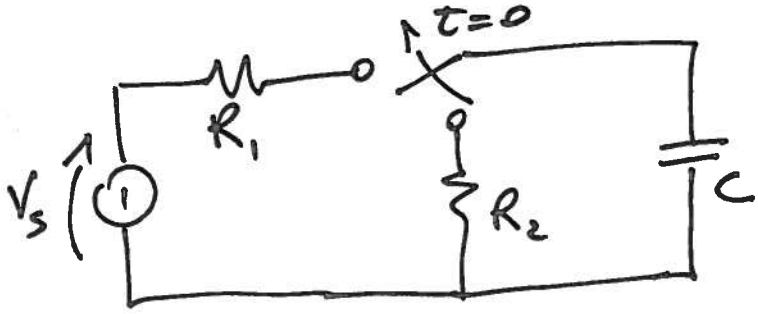
$v_c(0) = 0$

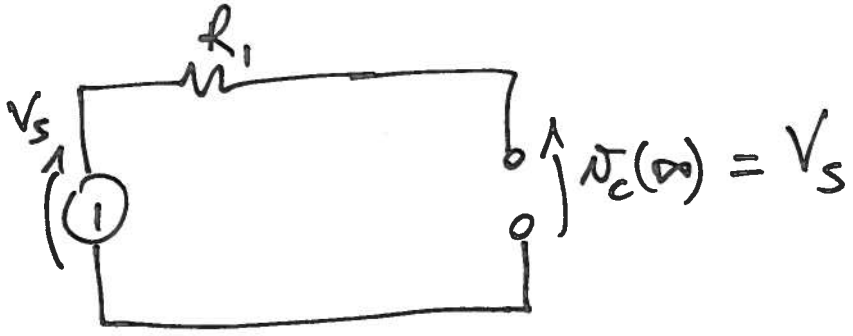
V_s - Tensione elevata

R_1 - resistore di resistenza elevata ($\Rightarrow$ limitatore di corrente nella fase di carica)

R_2 - lampada del flash, resistenza piccola

1) fase di carica $0 < t < t_0 \ll 5\,\tau_1$





$\tau_1 = R_1 C$, elevate

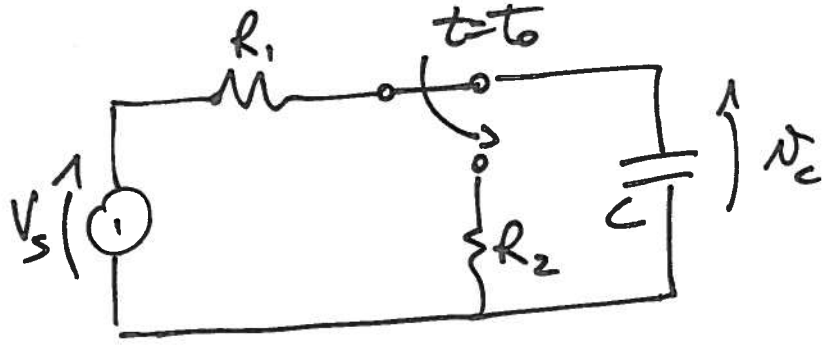
$$v_c(t) = \left[v_c(0) - v_c(\infty)\right] \exp\left(-\frac{t}{\tau_1}\right) + v_c(\infty)$$

$$= V_s \left[1 - \exp\left(-\frac{t}{\tau_1}\right)\right]$$

$$i_c(t) = C \frac{dv_c}{dt} = \frac{V_s C}{R_1 C} \exp\left(-\frac{t}{\tau_1}\right)$$

$$= \frac{V_s}{R_1} \exp\left(-\frac{t}{\tau_1}\right)$$

2) fase di scarica



$t = t_0 \quad v_c(t_0) = V_s \quad (t_0 \gg 5\tau_1)$

$v_c(\infty) = 0$

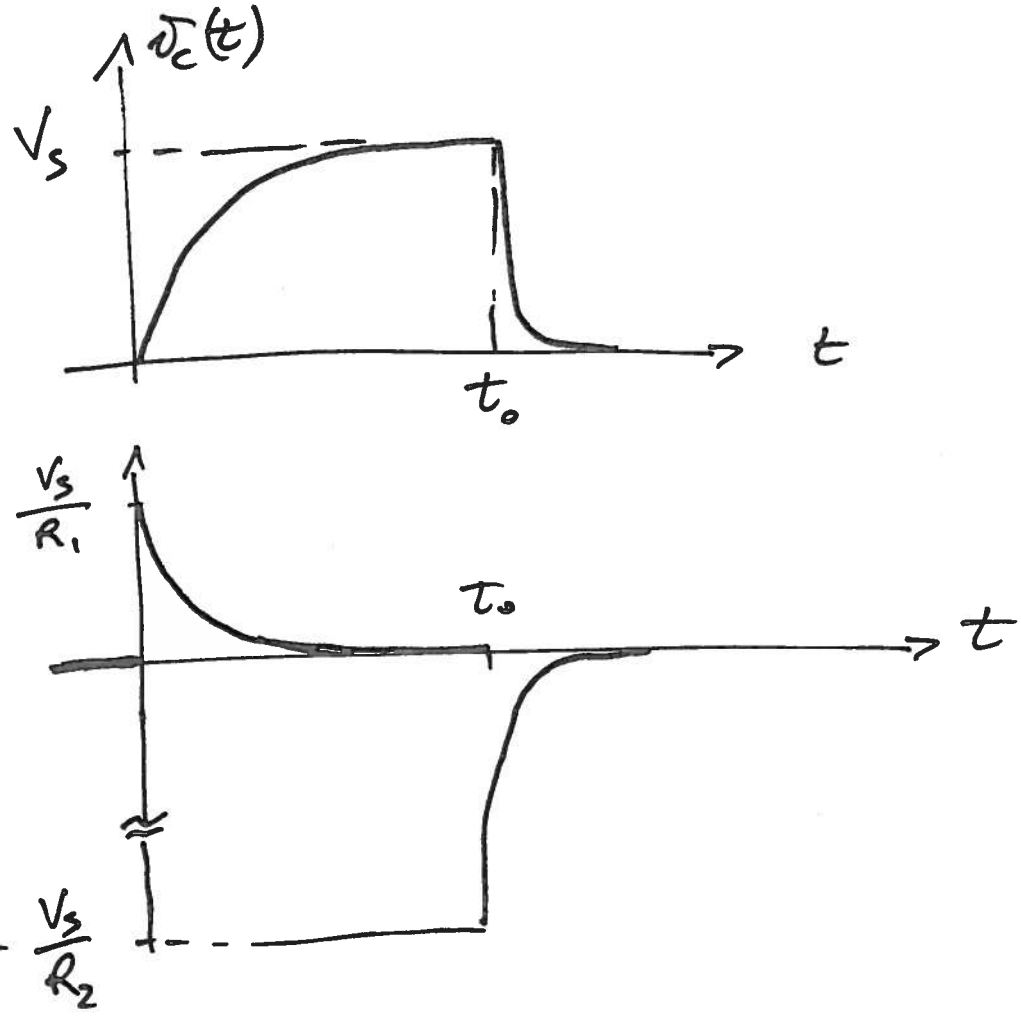
$\tau_2 = R_2 C$, piccola

$$v_c(t) = \left[v_c(t_0) - v_c(\infty)\right] \exp\left(-\frac{t-t_0}{\tau_2}\right) + v_c(\infty)$$

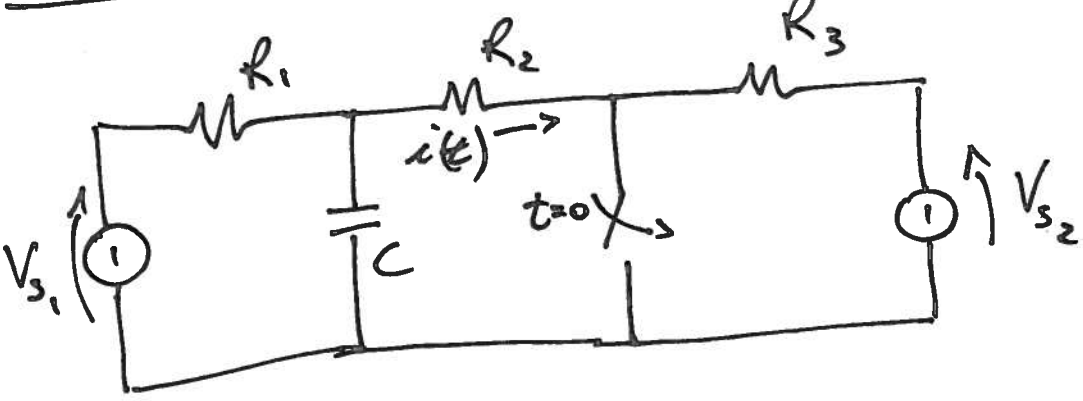
$$= V_s \exp\left(-\frac{t-t_0}{\tau_2}\right)$$

$$i_c(t) = C\frac{dv_c}{dt} = -\frac{V_s C}{R_2 C} \exp\left(-\frac{t-t_0}{\tau_2}\right)$$

$$= -\frac{V_s}{R_2} \exp\left(-\frac{t-t_0}{\tau_2}\right)$$



ES 29



$V_{s_1} = 36\,V$

$V_{s_2} = 12\,V$

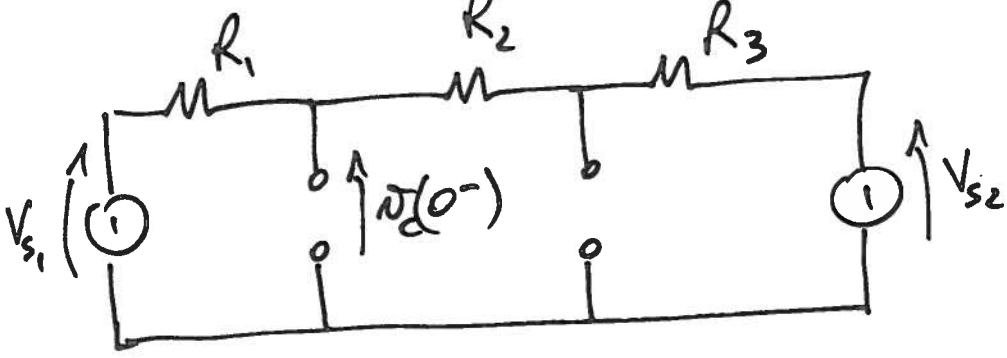
$R_1 = 2\,k\Omega$

$R_2 = 6\,k\Omega$

$R_3 = 4\,k\Omega$

$C = 100\,\mu F$

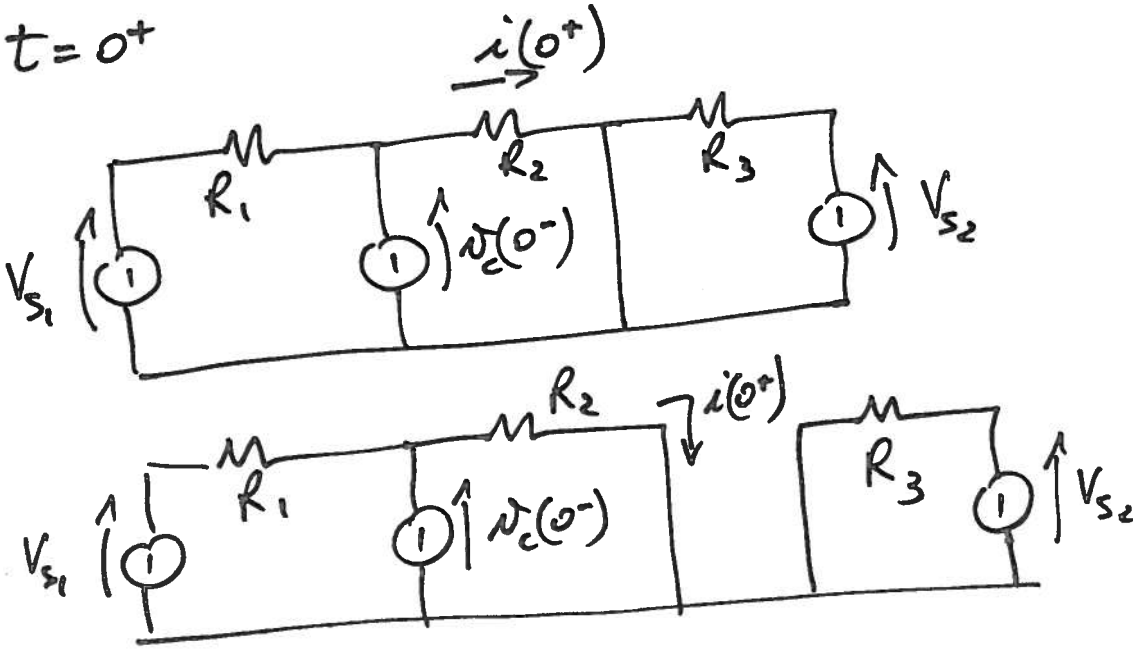
$t = 0^-$



$$i(0^-) = \frac{V_{s_1} - V_{s_2}}{R_1 + R_2 + R_3} = 2\,mA$$

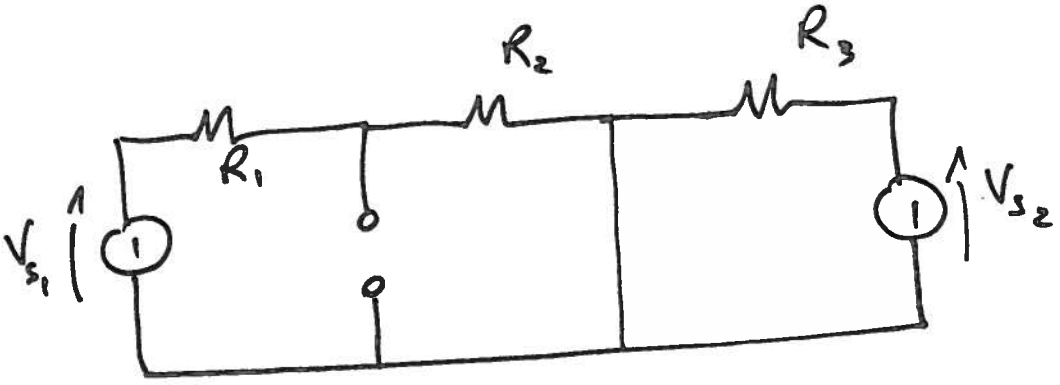
$$v_c(0^-) = V_{s_1} - R_1\, i(0^-) = 32\,V$$

$t = 0^+$



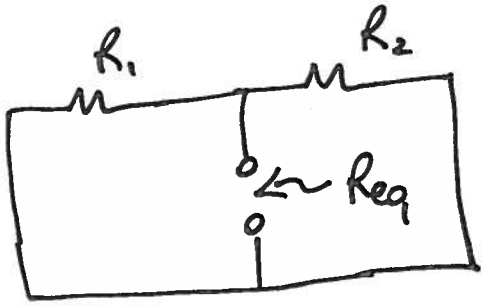
$$i(0^+) = \frac{v_c(0^-)}{R_2} = \frac{16}{3}\ mA$$

$t = \infty$



$$i(\infty) = \frac{V_{S1}}{R_1 + R_2} = \frac{9}{2}\ mA$$

τ



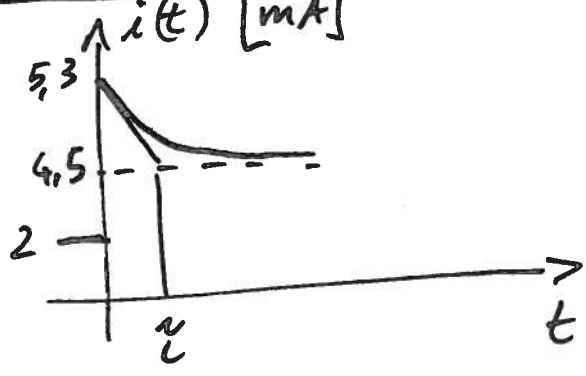
$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{3}{2}\ k\Omega$$

$$\tau = R_{eq} C = 150\ ms$$

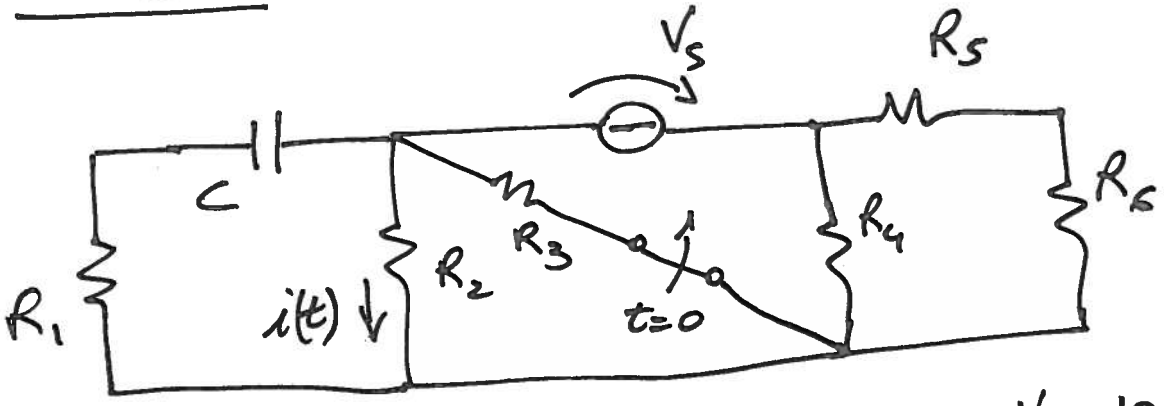
$$i(t) = [i(0^+) - i(\infty)] \exp\left(-\frac{t}{\tau}\right) + i(\infty)$$

$$= \left(\frac{16}{3} - \frac{9}{2}\right) \exp\left(-\frac{t}{\tau}\right) + \frac{9}{2}\ mA$$

$$= \frac{5}{6} \exp\left(-\frac{t}{\tau}\right) + \frac{9}{2}$$



ES 30



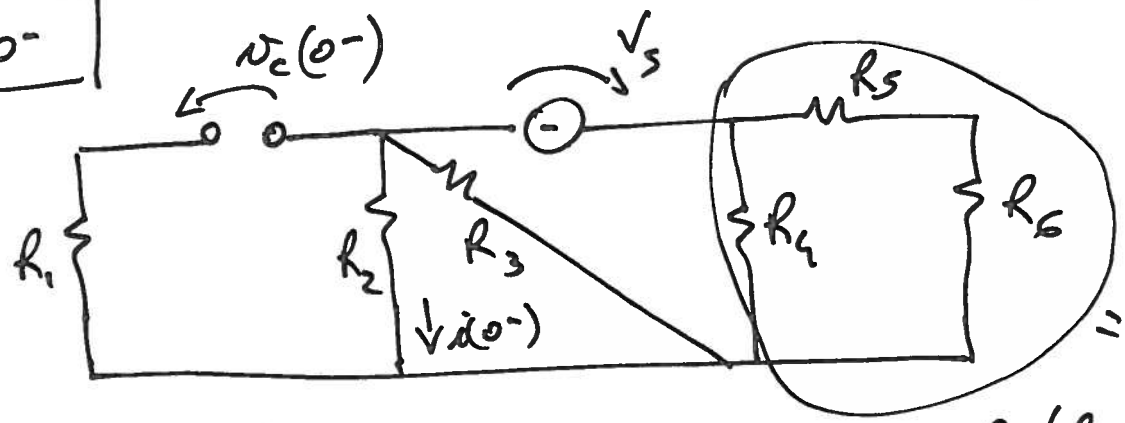
$V_S = 10\,V$

$R_1 = R_5 = R_6 = 5\,\Omega$

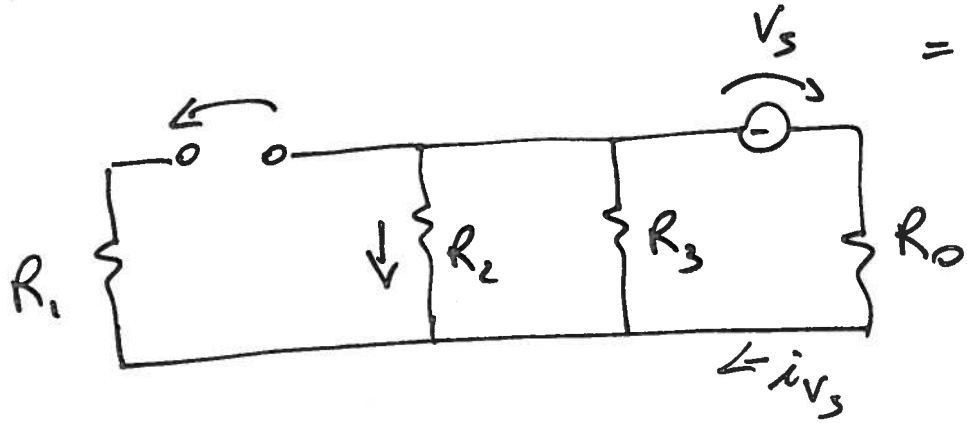
$R_2 = R_3 = R_4 = 10\,\Omega$

$C = 10\,\mu F$

$t = 0^-$



$$R_0 = \frac{R_4(R_5+R_6)}{R_4+R_5+R_6} = 5\,\Omega$$



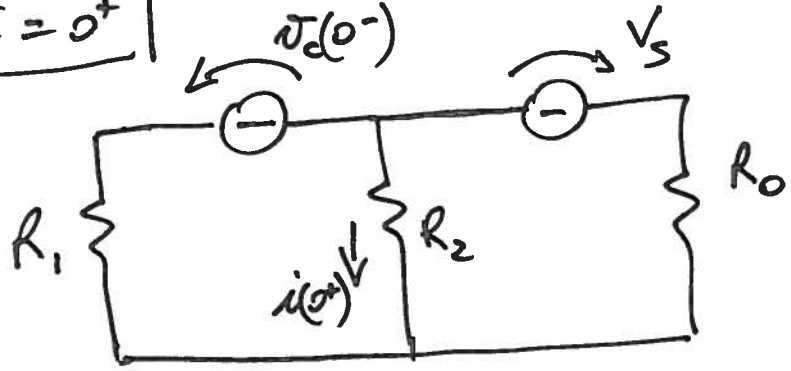
$$i_{V_S} = \frac{V_S}{R_0 + \dfrac{R_2 R_3}{R_2+R_3}} \Rightarrow i(0^-) = -\frac{R_3}{R_2+R_3}\, i_{V_S}$$

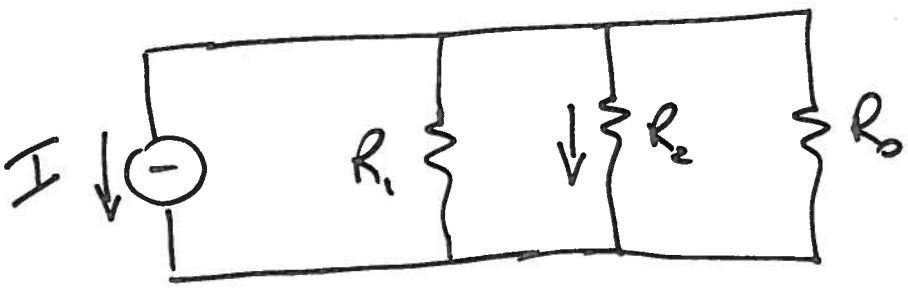
$$i(0^-) = -\frac{R_3 V_s}{R_2 R_3 + R_0(R_2+R_3)} = -0{,}5\,A$$

$$v_c(0^-) = -R_2\, i(0^-) = \frac{R_2 R_3 V_s}{R_2 R_3 + R_0(R_2+R_3} = 5\,V$$

$$v_c(0^+) = v_c(0^-)$$

$\boxed{t = 0^+}$





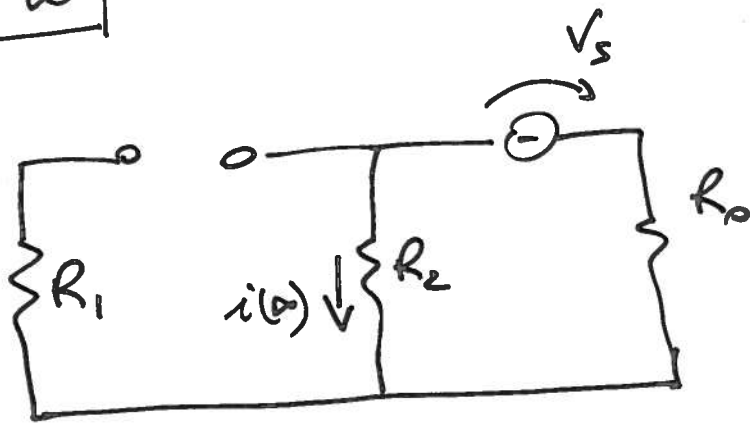
$$I = \frac{V_s}{R_0} + \frac{v_c(0^-)}{R_1}$$

$$i(0^+) = -\frac{1}{R_2} I \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_0}}$$

$$= -\left(\frac{V_s}{R_0} + \frac{v_c(0^-)}{R_1}\right) \frac{R_1 R_0}{R_1 R_2 + R_1 R_0 + R_2 R_0}$$

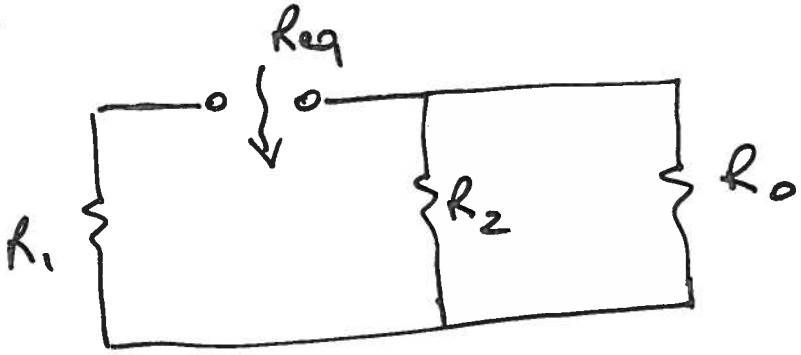
$$= -0{,}6\,A$$

$t \to \infty$



$$i(\infty) = -\frac{V_s}{R_2 + R_0} = -0{,}67\ A$$

τ



$$R_{eq} = R_1 + \frac{R_2 R_0}{R_0 + R_2} = 8{,}33\ \Omega$$

$$\tau = R_{eq} C = 83{,}3\ \mu s$$

$$i(t) = [i(0^+) - i(\infty)] \exp\left(-\frac{t}{\tau}\right) + i(\infty)$$

$$= -0{,}07 \exp\left(-\frac{t}{\tau}\right) - 0{,}67\ A$$