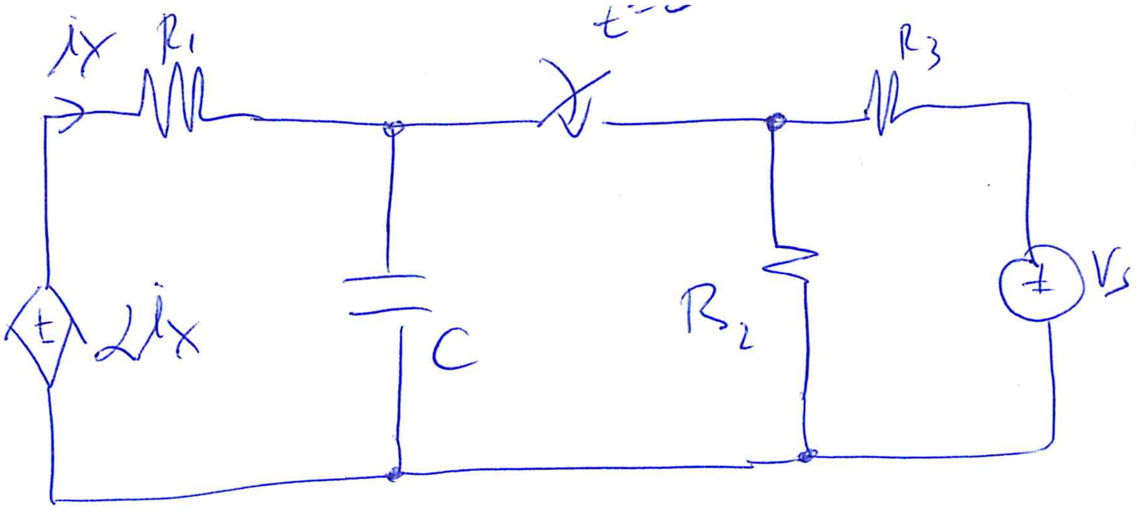
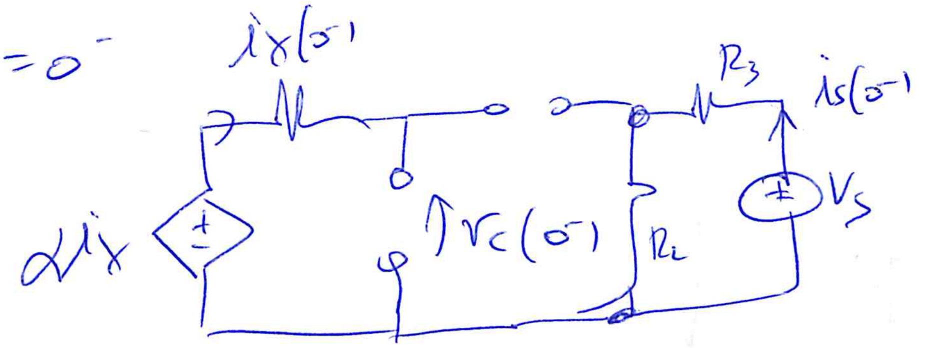


$R_1 = 4\ k\Omega$
$R_2 = 4\ k\Omega$
$R_3 = 2\ k\Omega$
$\alpha = 3\ k\Omega$
$V_s = 3V$
$C = 1\ \mu F$

$t = 0^-$



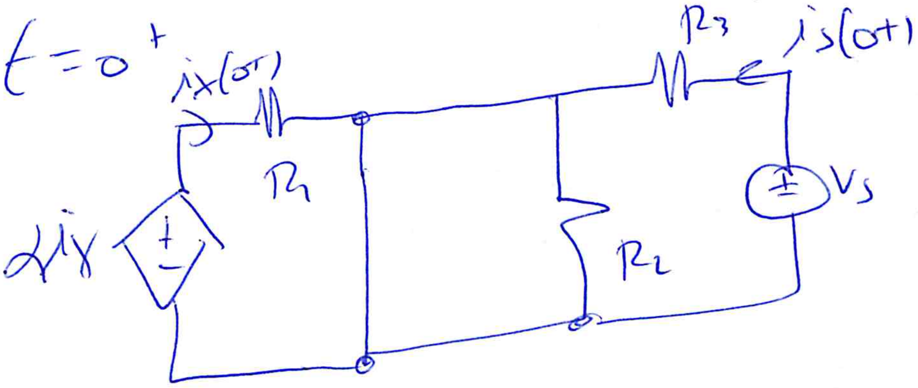
$i_x(0^-) = 0$

$v_C(0^-) = 0$

~~$i_s = \frac{V_s}{R_3} = 0{,}0015\ mA$~~

$i_s = \frac{V_s}{R_2+R_3} = 0{,}5\ mA$

$t = 0^+$

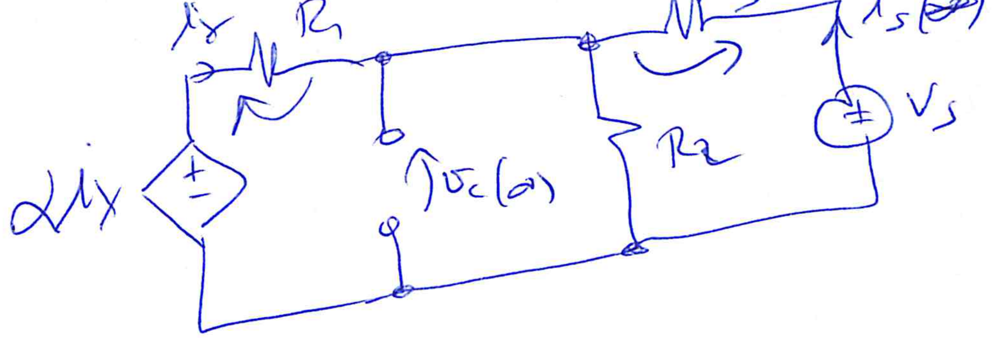


$v_C(0^+) = v_C(0^-) = 0$

~~$i_s(0^+) = 0{,}8\ mA$~~

$i_s(0^+) = \frac{V_s}{R_3} = 1{,}5\ mA$

$t = \infty$



$$\begin{cases} v_C(\infty) = -R_1 i_x + \alpha i_x \\ v_C(\infty) = \dfrac{\frac{\alpha i_x}{R_1} + \frac{V_s}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \end{cases}$$

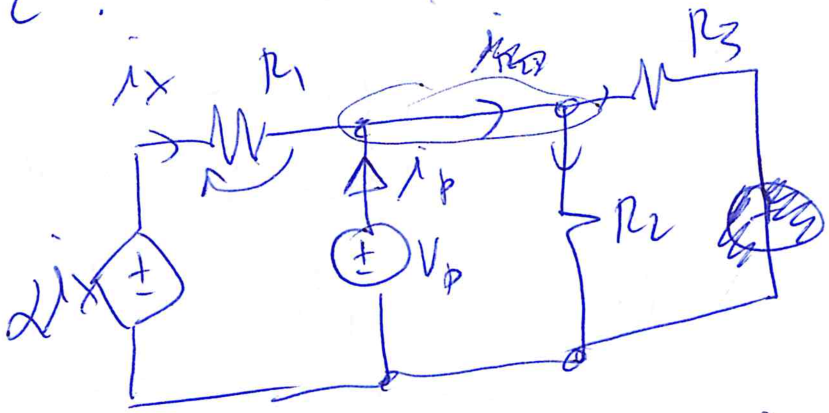
$$i_x = \frac{V_s R_1 R_2}{-\alpha R_2 R_3 - R_1 k + \alpha h} = 0{,}857 \text{ mA}$$

$$k = R_1 R_2 + R_2 R_3 + R_1 R_3$$

$$v_C(\infty) = -R_1 i_x + \alpha i_x = i_x(\alpha - R_1) = 857 \text{ mV}$$

$$i_s(\infty) = \frac{v_s(\infty) - v_C(\infty)}{R_3} = 1{,}1 \text{ mA}$$

2 :



$$V_p = -R_1 i_x + \alpha i_x \Rightarrow i_x = \frac{V_p}{\alpha - R_1}$$

$$i_p = -i_x + \frac{V_p}{R_2} + \frac{V_p}{R_3} =$$

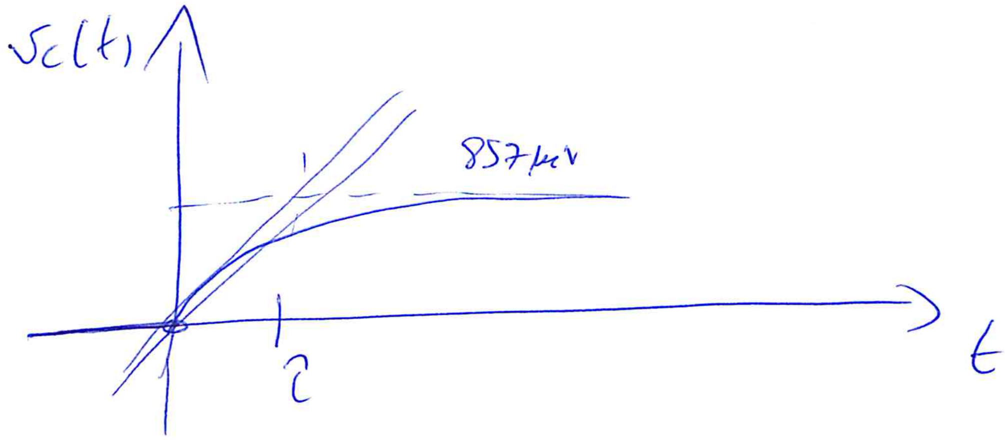
$$= -\frac{V_p}{\alpha - R_1} + \frac{V_p}{R_2} + \frac{V_p}{R_3} = V_p \left(\frac{-R_2 R_3 + (\alpha - R_1) R_3 + (\alpha - R_1) R_2}{(\alpha - R_1) R_2 R_3} \right)$$

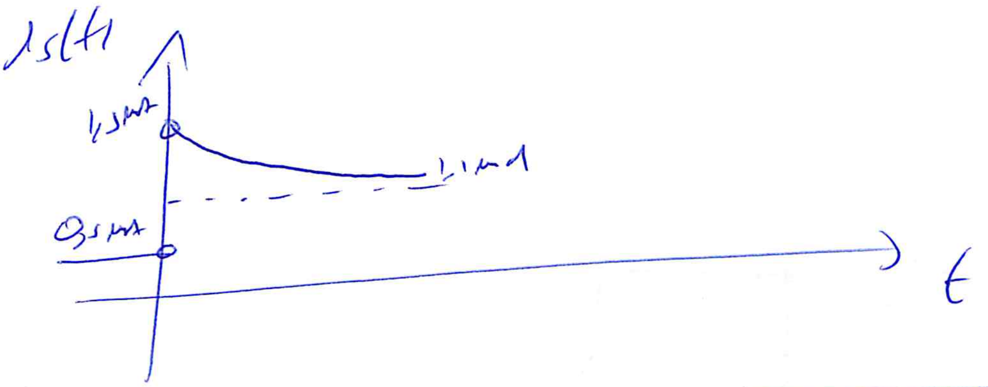
$$R_{eq} = \frac{V_p}{i_p} = \frac{(\alpha - R_1) R_2 R_3}{-R_2 R_3 + (\alpha - R_1)(R_3 + R_2)} = 571\ \Omega$$

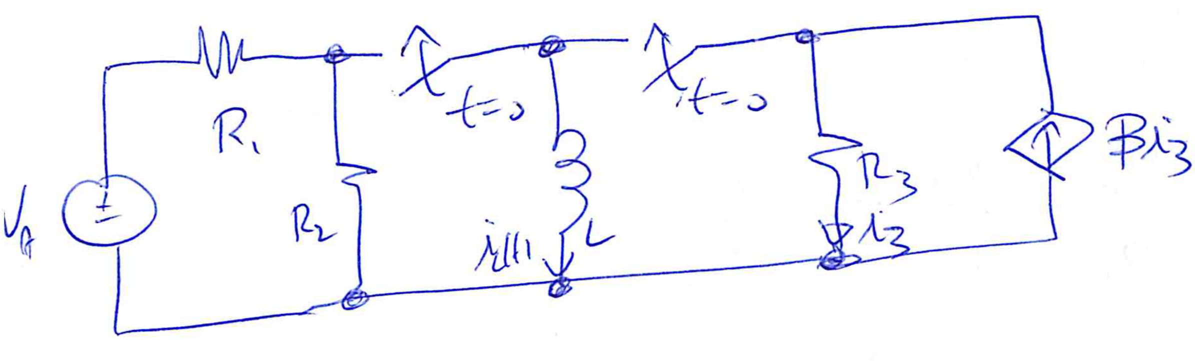
$$\tau = R_{eq} C = 0{,}571 \text{ s}$$

$$v_c(t) = \left(v_c(0^+) - v_c(\infty)\right) e^{-t/\tau} + v_c(\infty) \quad t \geq 0$$

$$i_s(t) = \left(i_s(0^+) - i_s(\infty)\right) e^{-t/\tau} + i_s(\infty) \quad t > 0$$







$R_1 = 2\Omega$

$R_2 = 5\Omega$

$R_3 = 1k\Omega$

$L = 20\ mH$

$V_A = 10V$

$\beta = 3$

$t = 0^-$

$i_L(0^-) = 0$

$t = 0^+$

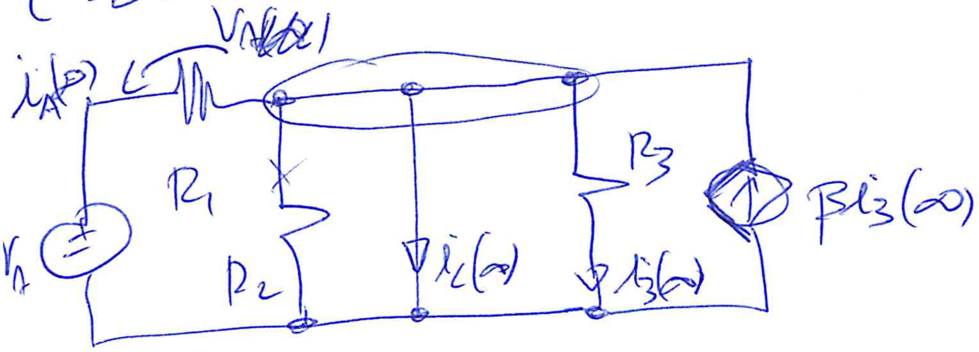
$i_L(0^-) = i_L(0^+) = 0$

$i_L(t) = ?$

$E_L(t = 10\mu s) = ?$

$E_L(t = \infty) = ?$

$t = \infty$



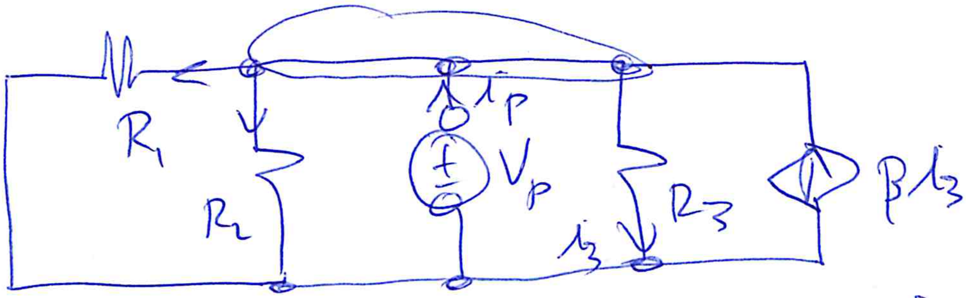
$$i_A(\infty) = \frac{V_A}{R_1}$$

$$i_L(\infty) = i_A(\infty) = \frac{V_A}{R_1} = 5\,A$$

$$i_3(\infty) = 0$$

$$\beta i_3(\infty) = 0$$

τ



$$i_3 = \frac{V_p}{R_3}$$

$$i_p = \frac{V_p}{R_1} + \frac{V_p}{R_2} + \frac{V_p}{R_3} - \beta\frac{V_p}{R_3}$$

$$i_p = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1-\beta}{R_3}\right)V_p$$

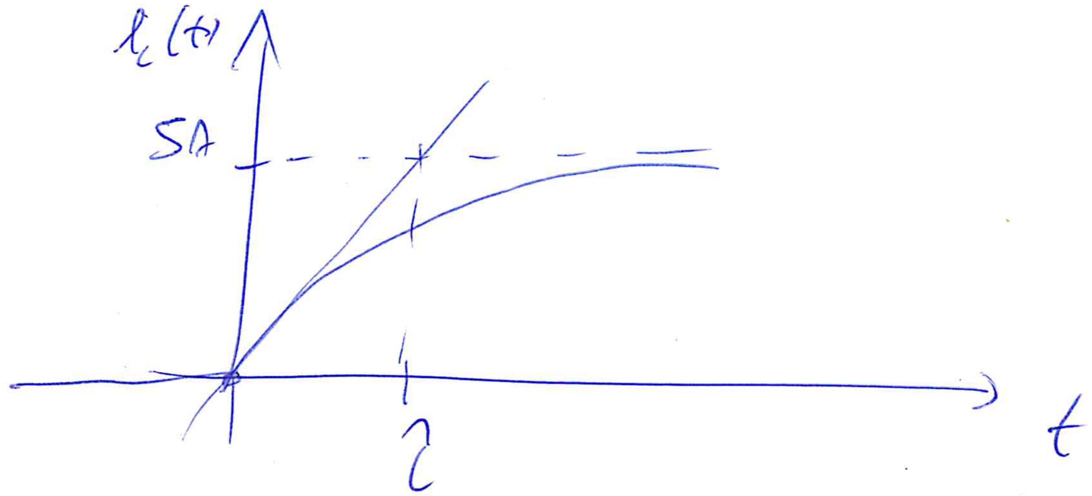
$$R_{eq} = \frac{V_p}{i_p} = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1-\beta}{R_3}} = 2\,\Omega \quad =$$

$$\tau = \frac{L}{R_{eq}} = 10\,\mu s$$

$i_L(t) = i_L(0^-) = 0 \qquad t \leq 0$

$i_L(t) = [i_L(0^+) - i_L(\infty)]\, e^{-t/\tau} + i_L(\infty) =$

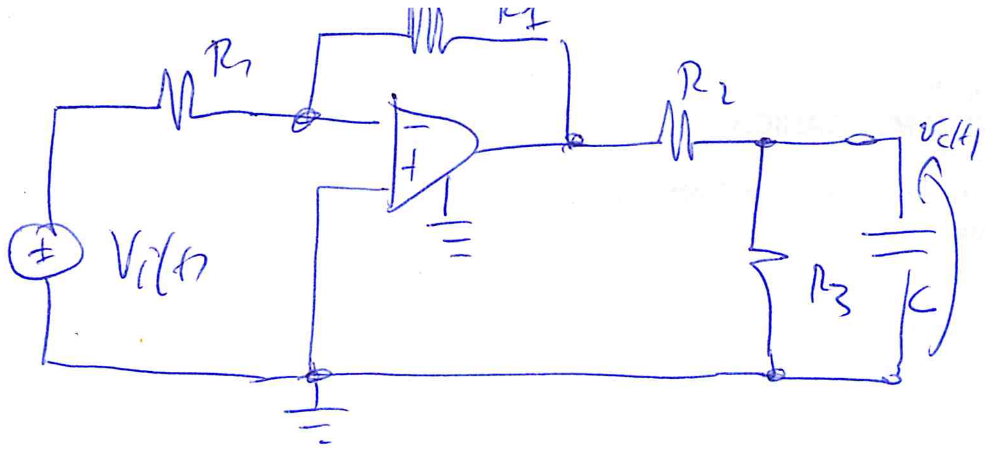
$= -5\, e^{-t/\tau} + 5 \;, A \qquad t \geq 0$



$E_L(t) = \frac{1}{2} L \, i_L(t)^2$

$E_L(t = 10ms) = \frac{1}{2} L \, i_L(t = 10ms)^2 = 0{,}1 \; J$

$E_L(t \to \infty) = \frac{1}{2} L \, i_L(\infty)^2 = 0{,}250 \; J$



$v_i(t) = 2u(t)\,V$

$R_1 = 20\ k\Omega$

$R_f = 50\ k\Omega$

$R_2 = R_3 = 10\ k\Omega$

$C = 2\,\mu F$

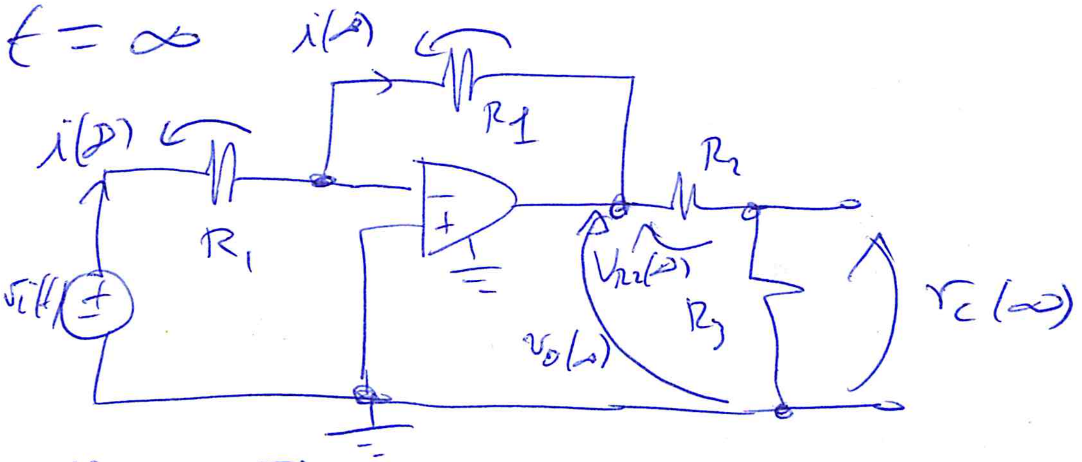
$t = 0^-$

$v_i(0^-) = 0 \;;\; v_c(0^-) = 0$

$t = 0^+$

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

$t = \infty$



$$i(\infty) = \frac{v_i(\infty)}{R_1} = 0{,}1\ mA$$

$$v_o(\infty) = -R_f\, i(\infty) = -5\ V$$

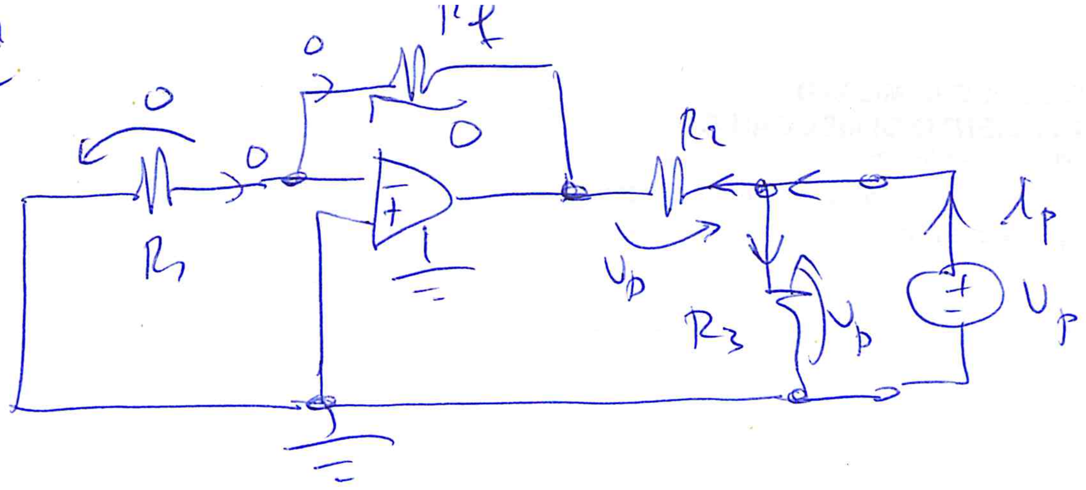
$$v_c(\infty) = \frac{v_o(\infty)\cdot R_3}{R_2 + R_3} = -2{,}5\ V$$

$$v_c(t) = v_c(0^-) = 0 \quad , t \le 0$$

$$v_c(t) = [v_c(0^+) - v_c(\infty)]\,e^{-t/2} + v_c(\infty) =$$

$$= 2{,}5\,e^{-t/2} - 2{,}5\ V \quad t \ge 0$$

τ

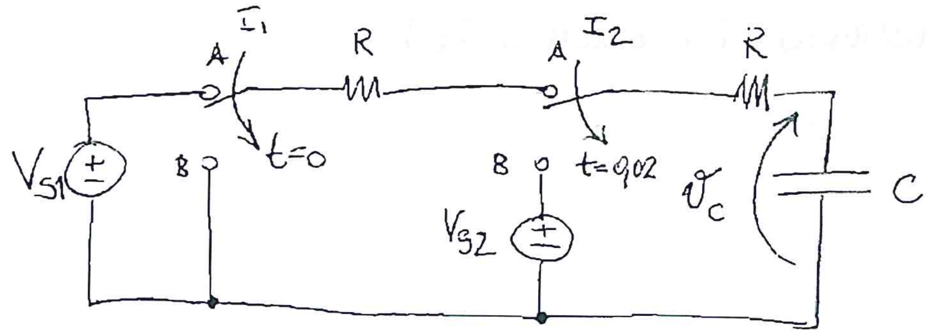


$$i_p = \frac{V_p}{R_2} + \frac{V_p}{R_3} = V_p\left(\frac{R_2+R_3}{R_2R_3}\right)$$

$$R_{eq} = \frac{V_p}{i_p} = \frac{R_1R_3}{R_2+R_3} = 5\ k\Omega$$

$$\tau = R_{eq}C = 0{,}01\ s$$

EX



$V_{S1} = 10\ V$ $\quad R = 100\ \Omega$

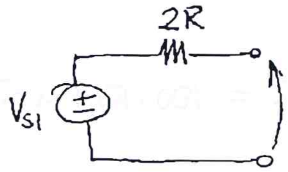
$V_{S2} = 5\ V$ $\quad C = 0{,}1\ mF$

$v_C(t) = ?$

Il circuito e' a regime.
In $t=0$ l'interruttore I_1 si sposta da A in B.
In $t=0{,}02\ s$ l'interruttore I_2 si sposta da A in B

PRIMO TRANSITORIO (Interruttore I_1)

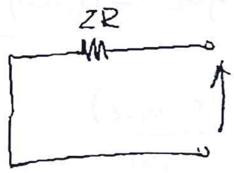
1) Per $t=0^-$



$v_c(0^-) = V_{S1} = 10\ V$

Per $t=0^+$ $\quad v_c(0^+) = v_c(0^-) = v_c(0) = 10\ V$

2) Per $t \to \infty$



$v_c(\infty) = 0\ V$

3) Costante di tempo $\quad \tau = 2RC = 200 \cdot 0{,}1 \cdot 10^{-3} = 20\ ms$

4) Soluzione

$$v_c(t) = [v_c(0) - v_c(\infty)]\, e^{-t/\tau} + v_c(\infty)$$

$$\boxed{v_c(t) = 10\, e^{-50t}\ ,V \quad \text{per } 0 \leq t \leq 0{,}02\ s}$$

Infatti per $t = 0{,}02\ s$ commuta l'interruttore I_2, quindi la formula $v_c(t)$ non e' piu' valida: dobbiamo risolvere un nuovo transitorio

SECONDO TRANSITORIO (Interruttore I_2)

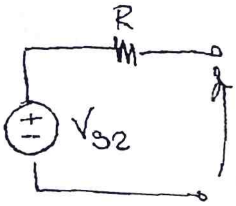
1) Per $t = 0{,}02^-$

$$v_c(t) = 10\, e^{-50 \cdot 0{,}02} = \frac{10}{e} = \frac{10}{2{,}718} = 3{,}679\ V$$

Per $t = 0{,}02^+$

$$v_c(0{,}02^+) = v_c(0{,}02^-) = v_c(0{,}02) = 3{,}679\ V$$

2) Per $t \to \infty$



$v_c(\infty) = V_{S2} = 5\ V$

3) Costante di tempo $\tau = RC = 100 \cdot 0{,}1 \cdot 10^{-3} = 10\ ms$

4) Soluzione

$$v_c(t) = \left[v_c(0{,}02) - v_c(\infty) \right] e^{-\frac{(t-0{,}02)}{\tau}} + v_c(\infty)$$

$$v_c(t) = \left[3{,}679 - 5 \right] e^{-\frac{(t-0{,}02)}{0{,}01}} + 5$$

$$\boxed{v_c(t) = 5 - 1{,}321\, e^{-100t+2}\ ,\ V \quad \text{per } t \geq 0{,}02\ s}$$

GRAFICO