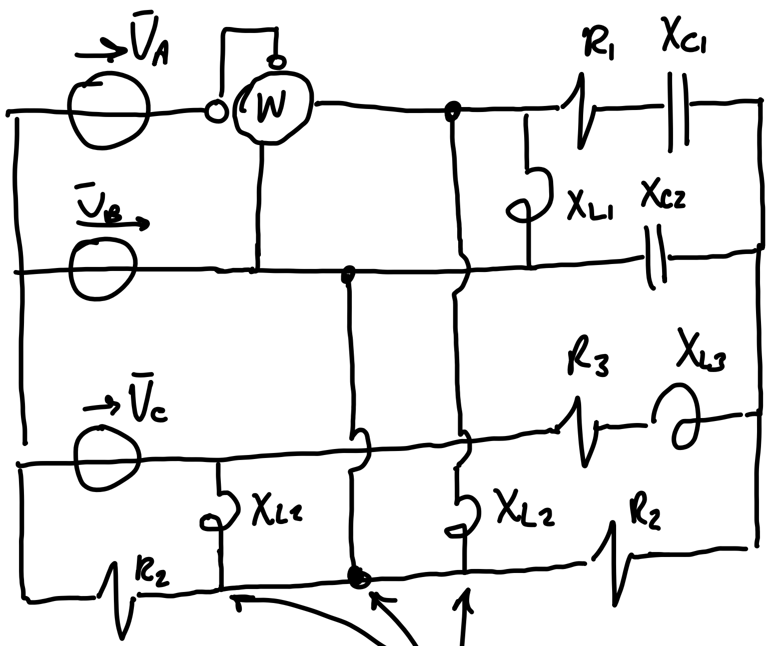
Esercitazione 8

Trifase → Importante: capire come cambiare tipologia



Tutti questi sono lo stesso punto sul secondo ramo ;)

$V_A = V_B = V_C = 240\,V$

$R_1 = 30\,\Omega$

$R_2 = 40\,\Omega$

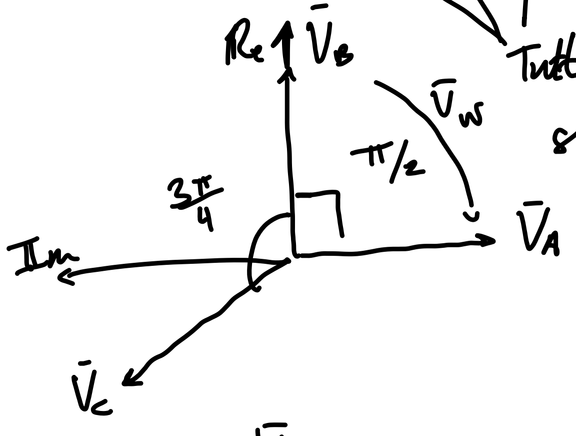
$R_3 = 20\,\Omega$

$X_{C1} = X_{C2} = 20\,\Omega$

$X_{L1} = 30\,\Omega$

$X_{L2} = X_{L3} = 20\,\Omega$

$P_W = ?$



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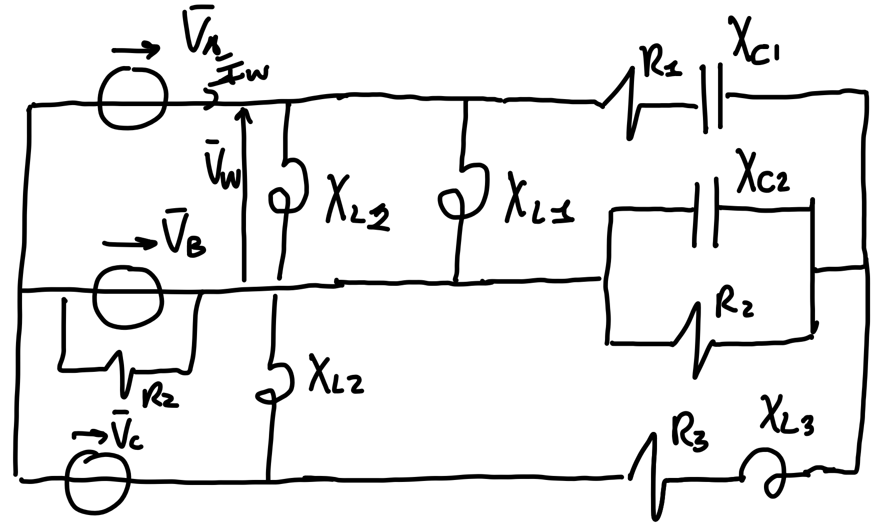
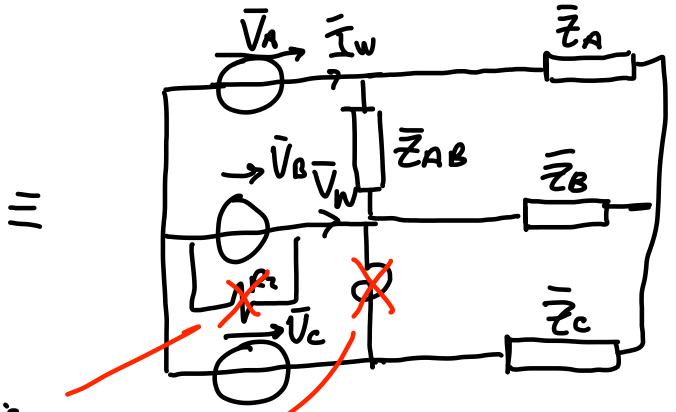




Nu se utilizează
$\bar I_W$ o $\bar V_M$

$$\bar Z_{AB} = \frac{jX_{L1} \; jX_{L2}}{jX_{L1} + jX_{L2}} = j\frac{X_{L1}X_{L2}}{X_{L1}+X_{L2}} = j12\,\Omega$$

$$\bar Z_A = R_1 - jX_C = 30 - j20\,\Omega$$

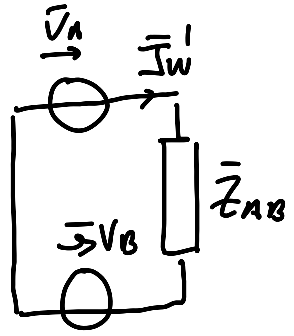
$$\bar Z_B = \frac{R_2(jX_{C2})}{R_2 + jX_{C2}} = 8 - j16\,\Omega$$

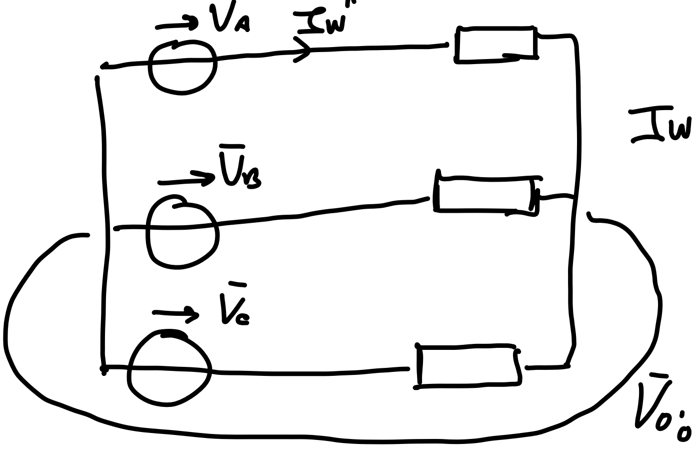
$$\bar Z_C = R_3 + jX_{L3} = 20 + j20\,\Omega$$

$$\bar V_A = -j240\,V$$

$$\bar V_B = 240\,V$$

$$\bar V_C = V_C e^{j\frac{3}{4}\pi} = -169{,}7 + j169{,}7\,V$$





$I_W = I_W' + I_W''$

$$\bar V_W = \bar V_A - \bar V_B = -240 - j240\,V$$

$$\bar{V}_{O'O} = \frac{\frac{\bar{V}_A}{\bar{Z}_A} + \frac{\bar{V}_B}{\bar{Z}_B} + \frac{\bar{V}_C}{\bar{Z}_C}}{\frac{1}{\bar{Z}_A} + \frac{1}{\bar{Z}_B} + \frac{1}{\bar{Z}_C}} = 184,8 + j98,21 \text{ V}$$

$$\bar{I}_W'' = \frac{\bar{V}_A - \bar{V}_{O'O}}{\bar{Z}_A} = 0,9386 - j10,65 \text{ A}$$

$$\bar{I}_W' = \frac{\bar{V}_A - \bar{V}_B}{\bar{Z}_{AB}} = -20 + j20 \text{ A}$$

$$\bar{I}_W = \bar{I}_W' + \bar{I}_W'' = -19,06 + j9,35 \text{ A}$$

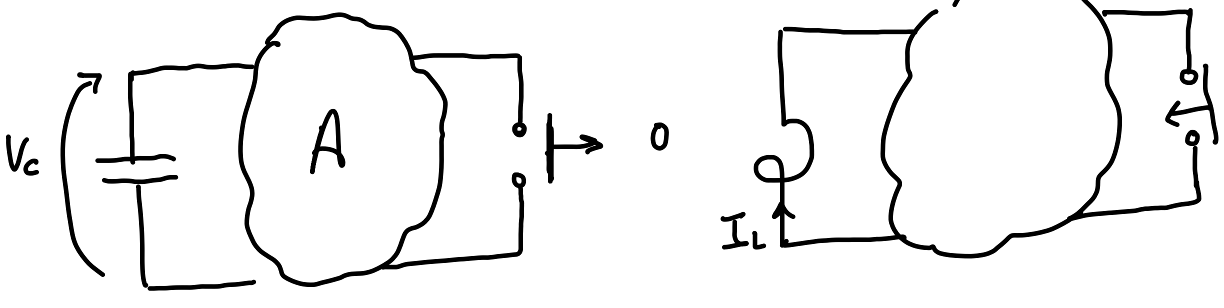
Chiedeva la parte reale non solo quella complessa

$$P_W = \mathrm{Re}(\bar{V}_W \underline{I}_W)$$

$$= \mathrm{Re}(2330 + j6818) = 2330 \text{ W}$$

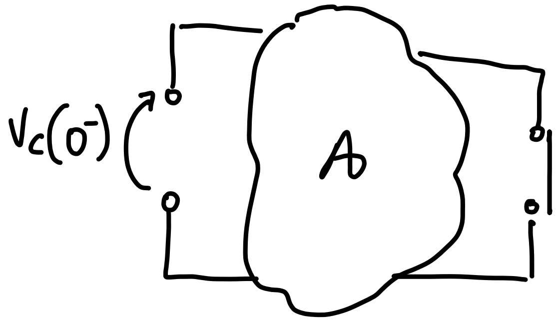
Circuiti Dinamici di primo ordine

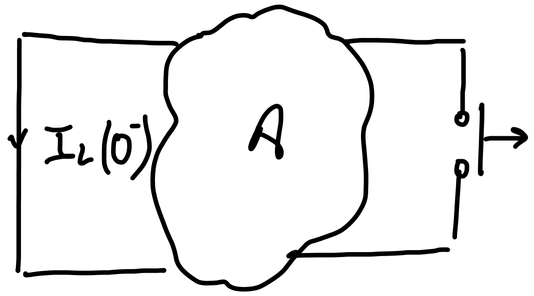
↳ unici che studiamo



Come si ricavano (Passi):

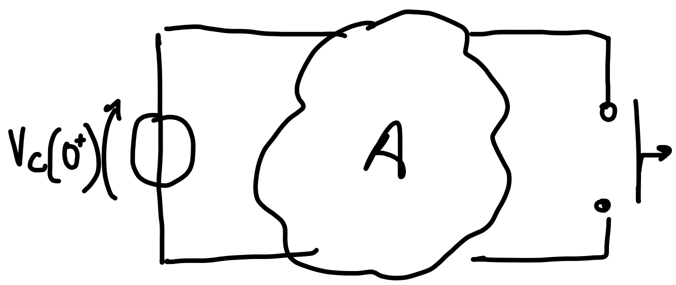
- Passo $t = 0^-$

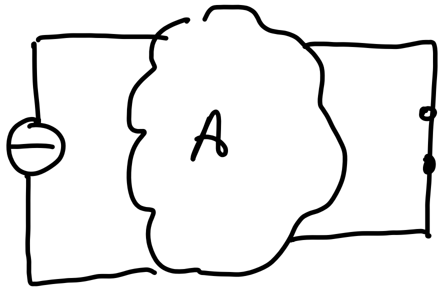




questo passo restituisce $x(0^-)$ grandezza di interesse

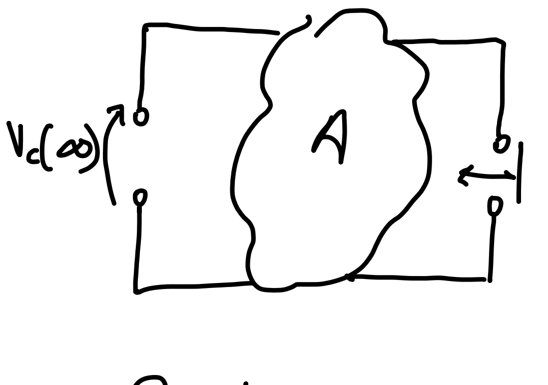
- Passo a $t = 0^+$

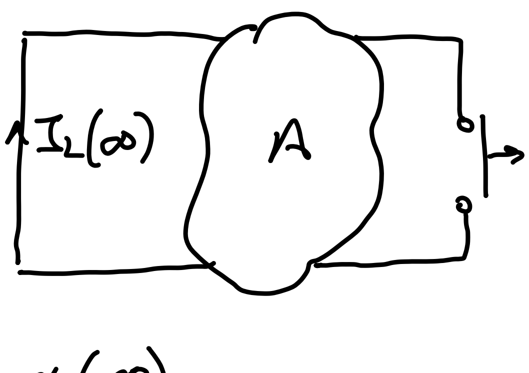




Questo passo restituisce $x(0^+)$

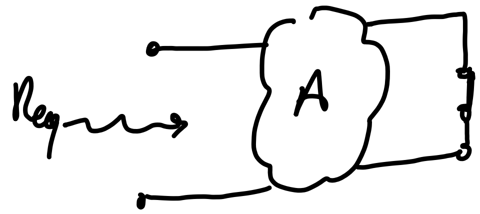
- Passo a $t \Rightarrow \infty$





Questo passo restituisce $x(\infty)$

- Passo τ



si spengono i generatori e si impone l'interruttore nella posizione finale

si calcola la Req vista da C/L

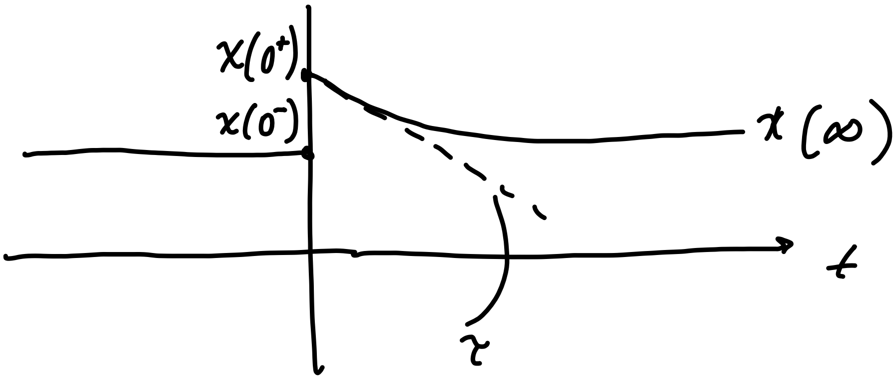
Caso condensatore:

$\tau = R_{eq} C$

Caso induttore:

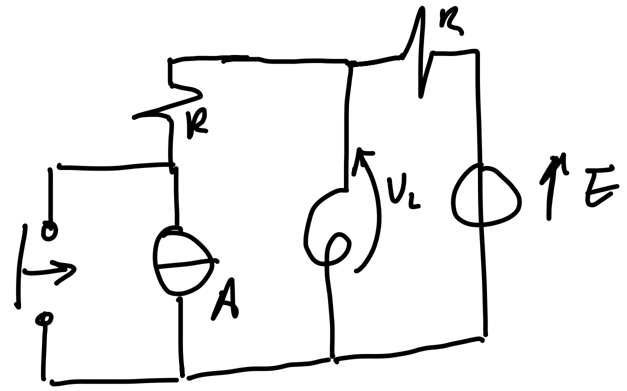
$\tau = \frac{L}{R_{eq}}$

$$x(t) \begin{cases} x(0^-) & \text{, per } t<0 \\ x(0^+) - x(\infty) e^{-t/\tau} + x_\infty & \text{, per } t>\infty \end{cases}$$



x è una variabile qualsiasi, se x è variabile di stato allora $x(0^-) = x(0^+)$

Esercizio 1 - Transitori



$A = 12A$

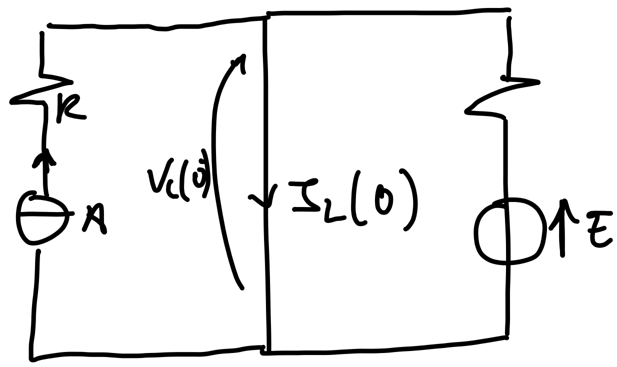
$E = 20V$

$R = 4\Omega$

$L_1 = 1,5 mH$

$V_L(t) = ?$

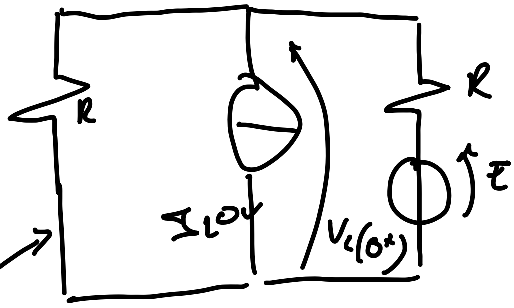
$t = 0^-$



$V_L(0^-) = 0$ $\qquad I_L(0) = A + \frac{E}{R} = 17A$

con sovrapposizione degli effetti

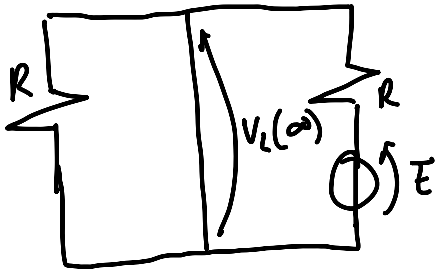
<u>$t = 0^+$</u>



Perché l'interruttore è chiuso, quindi si elimina il generatore

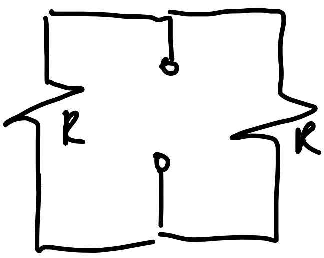
$$V_L(0^+) = \frac{-I_{L0} + \frac{E}{R}}{\frac{1}{R} + \frac{1}{R}} = \frac{-17+5}{\frac{1}{2}} = -24V$$

$t = \infty$



$V_L(\infty) = 0$

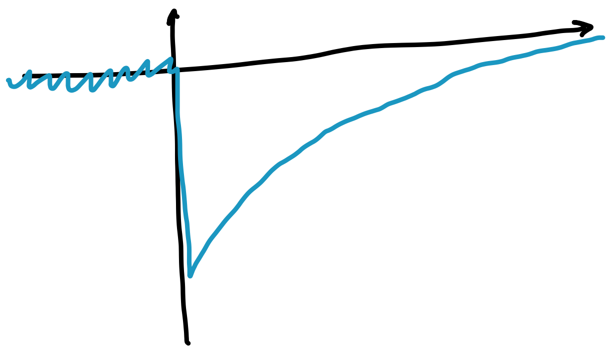
Calcolo τ



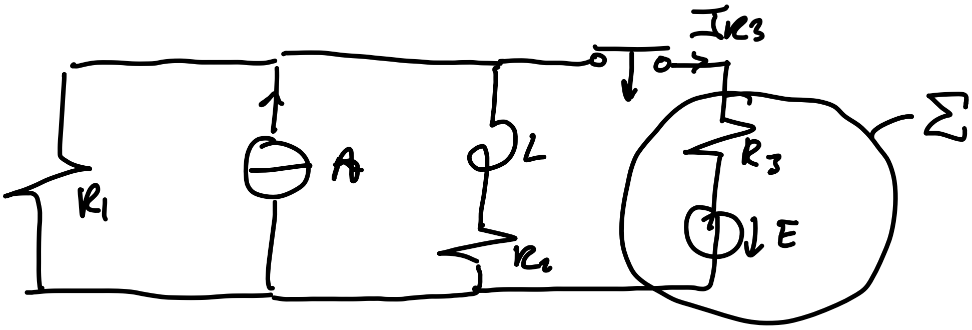
$$R_{eq} = \frac{RR}{R+R} = 2\,\Omega$$

$$\tau = \frac{L}{R_{eq}} = 750\,\mu s$$

$$V_L(t) = \begin{cases} 0 & \text{per } t<0 \\ (-24-0)\,e^{-t/750} + 0 = -24\,e^{-t/750\cdot 10^{-6}} & \text{per } t>0 \end{cases}$$



Esercizio 2



$R_1 = 4\,\Omega$
$R_2 = 6\,\Omega$
$R_3 = 8\,\Omega$

$T^{\alpha} = 70\,\mu s$

$i_{R3}(t) = ?$

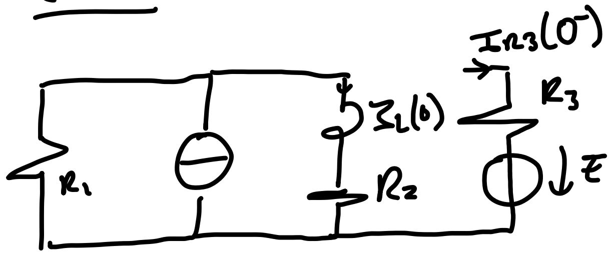
$L = 1\,mH$

$E = 18V$

$A = 12A$

$P_E(T^*)$ assorbita

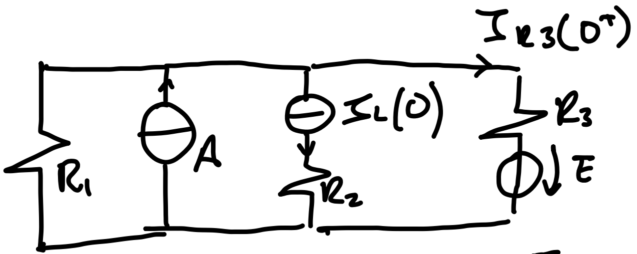
$\underline{t = 0^-}$



$$I_L(0) = \frac{R_1}{R_1+R_2} A = 4{,}8A$$

$$I_{R3}(0^-) = 0$$

$\underline{t = 0^+}$



$$I_{R3}(0^+) = \frac{V_M + E}{R_3}$$

$$I_{R3}(0^+) = 3{,}9A$$

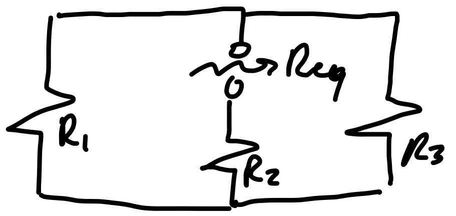
$$V_M(0^+) = \frac{A - I_L(0) - \frac{E}{R_3}}{\frac{1}{R_2} + \frac{1}{R_3}} = 13{,}2V$$

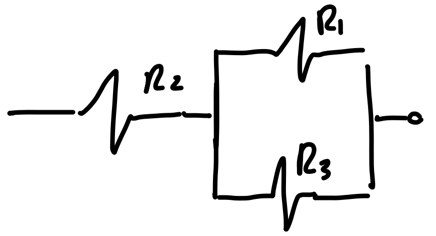
$\underline{t = \infty}$

$$V_M(\infty) = \frac{A - \frac{E}{R_3}}{\frac{1}{R_1} - \frac{1}{R_2} - \frac{1}{R_3}} = 18V$$

$$I_{R3}(\infty) = \frac{V_{R_1 0'0} + E}{R_3} = 4{,}5\,A$$

$\underline{\tau}$



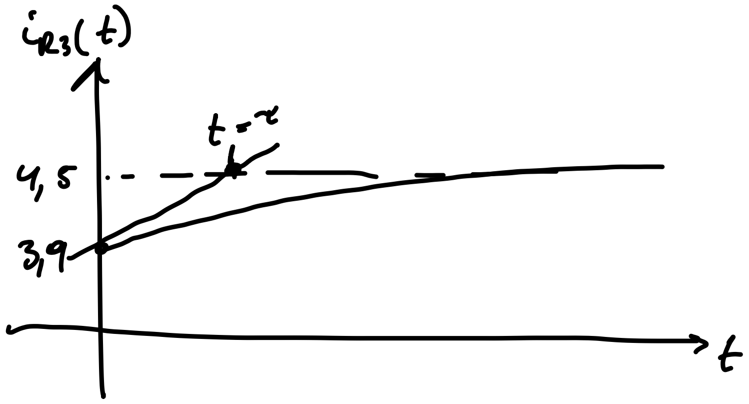


$$R_{eq} = R_2 + \frac{R_1 R_3}{R_1 + R_3} = 8{,}667\ \Omega$$

$$\tau = \frac{L}{R_{eq}} = 115{,}38\ \mu s$$

$$i_{R3}(t) = \begin{cases} 0 & \text{per } t<0 \\ (3{,}9 - 4{,}5)\, e^{-t/\tau} + 4{,}5 & \text{per } t>0 \end{cases}$$

$$-0{,}6\, e^{-t/\tau} + 4{,}5 \quad A$$



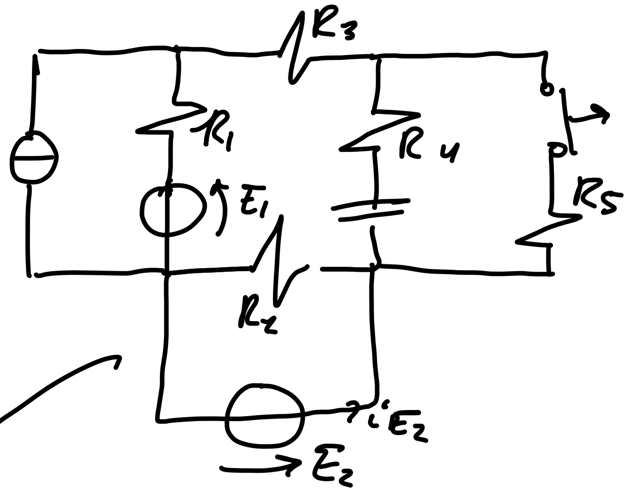
$$i_{R3}(t=T^*) = 4{,}5 - 0{,}6\, e^{-\frac{T^*}{\tau}} =$$

$$P_\Sigma = R_3\, i_{R3}^2(t=T^*) - E\, i_{R3}(t=T^*)$$

$=$

perchè I e V hanno lo stesso verso, se fossero opposti sarebbe positivo, i generatori erogano potenza quindi è negativo (indipendente dal valore vero che potrebbe esser negativo)

<u>Esercizio 3</u>



$E_1 = 15V$

$E_2 = 21V$

$A = 4A$

$R_1 = 10\Omega$

$R_2 = 60\Omega$

$R_3 = 20\Omega$

$R_4 = 5\Omega$

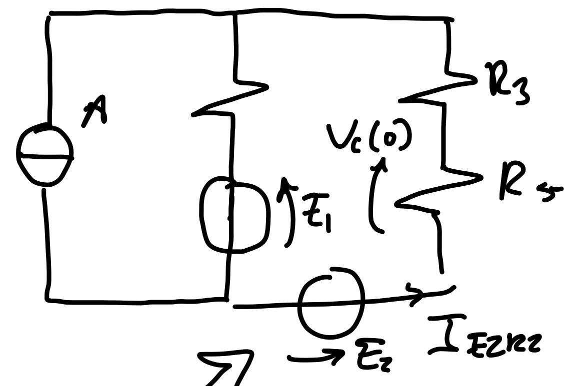
$R_5 = 5\Omega$

$C = 100\mu F$

$i_{E2}(t)$?

$i_{E2}(t=\tau)$?

$t=0^-$



$$I_{E2}(0^-) = I_{E2R2}(0^-) + I_{R2}$$

Equivalente di Thevenin

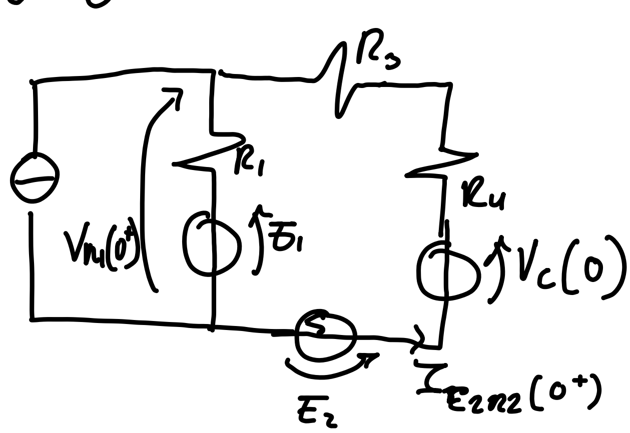
$$V_M(0^-) = \frac{A + \frac{E_1}{R_1} + \frac{E_2}{R_3+R_5}}{\frac{1}{R_1} + \frac{1}{R_3+R_5}} = 45{,}285\,V$$

$$I_{E2R2}(0^-) = \frac{E_2 - V_M(0^-)}{R_3+R_5} = -0{,}972\,A$$

$$I_{E2}(0^-) = I_{E2R2}(0^-) + I_{R2} \qquad V_c(0) = -R_5\, I_{E2R2}(0^-) = 4{,}858\,V$$

$$I_{B2}(0^-) = I_{E2R2}(0^-) + \frac{E_2}{R_2} = -0{,}622\,A$$

$t=0^+$

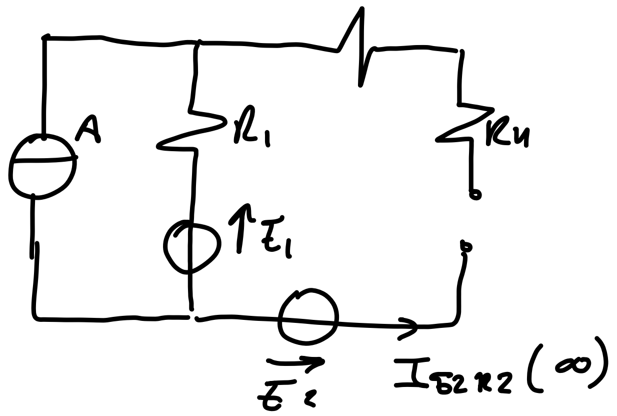


$$V_{R1}(0^+) = \frac{A + \frac{E_1}{R_1} + \frac{E_2 + V_C(0)}{R_3 + R_4}}{\frac{1}{R_1} + \frac{1}{R_3 + R_4}} = 46,67V$$

$$I_{E2R2}(0^+) = \frac{E_2 + V_C(0) - V_{R1}(0^+)}{R_3 + R_4} = 0,83A$$

$$I_{E2}(0^+) = -0,48A$$

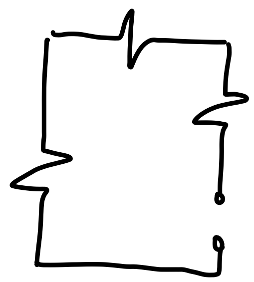
$\underline{t \Rightarrow \infty}$



$$I_{E2R2}(\infty) = 0$$

$$I_{E2}(\infty) = \frac{E_2}{R_2} = 0,35A$$

$\underline{\tau}$



$$R_{eq} = R_1 + R_3 + R_4 = 35\Omega$$

$$\tau = R_{eq} \cdot C = 3,5ms$$

Quando c'è una grande parte del circuito immutabile nel tempo, è più facile fare un equivalente di Thevenin o Norton

Come nell'ultimo problema