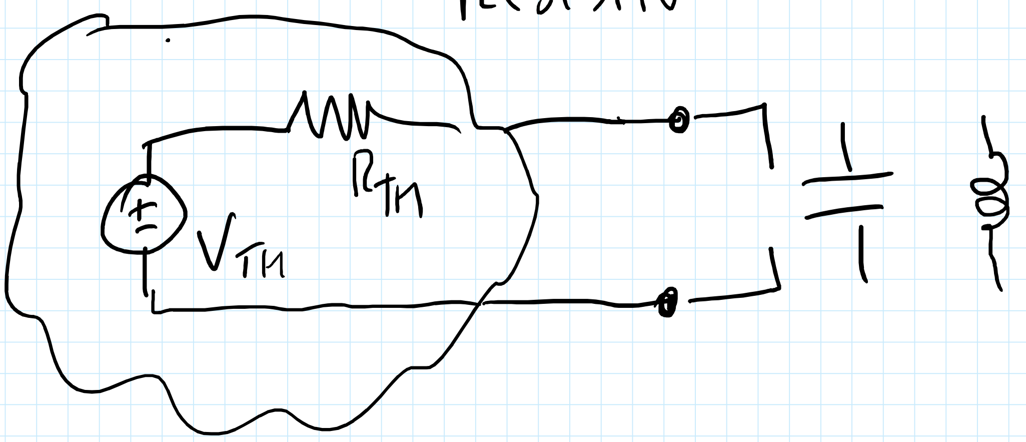
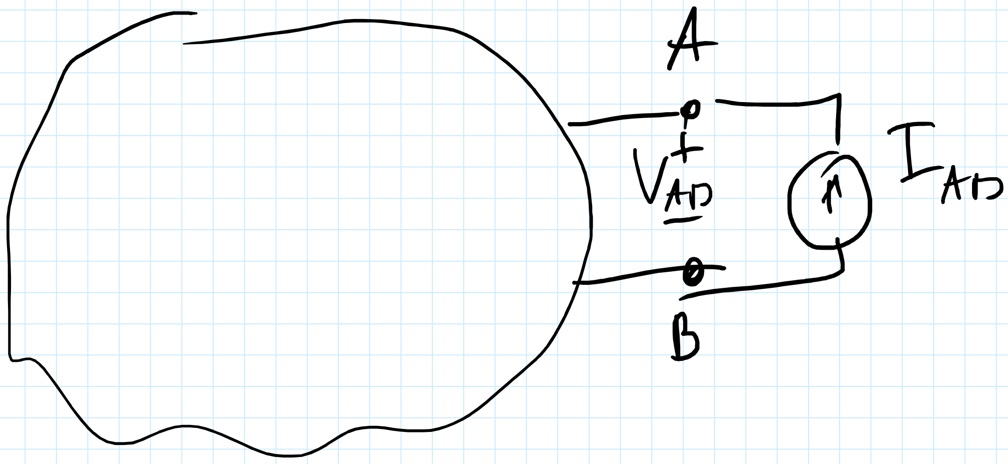
CIRCUITO RESISTIVO



$V_C(t) = Q(t)$, $Q = CV$

$i_C = C\frac{dV(t)}{dt}$

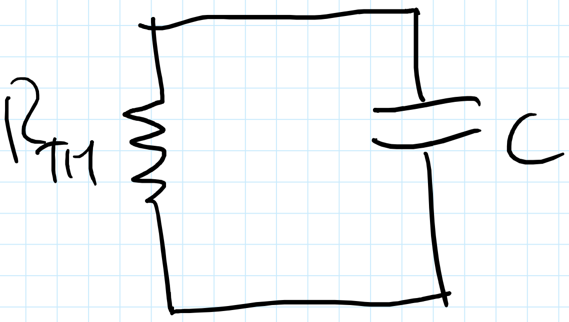
$W_C = \frac{1}{2} C V_C^2(t)$

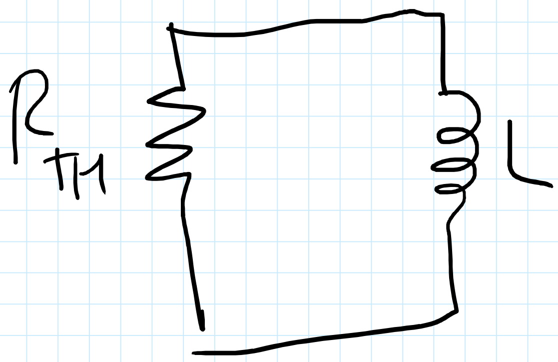


$i_L(t) \rightarrow \phi = L i$

$V_L(t) = L\frac{di_L(t)}{dt}$

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





$V_C(t) = V_0 e^{-\frac{t}{\tau}}$

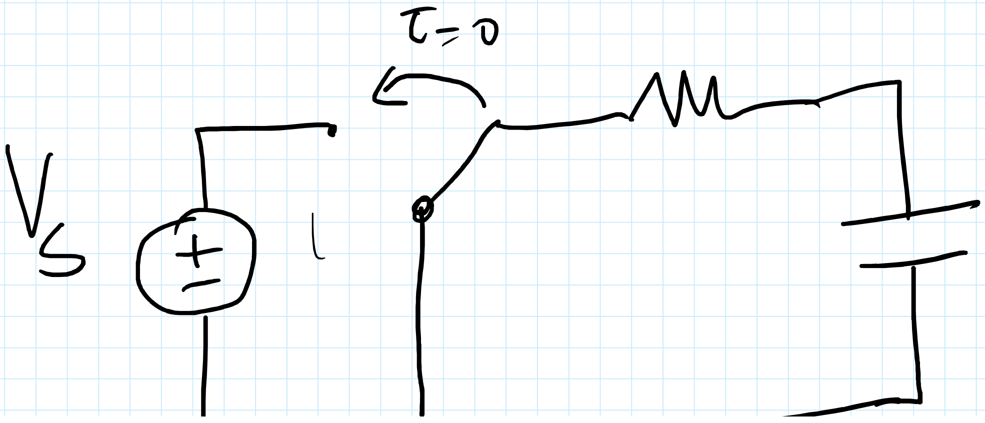
$\tau = RC$

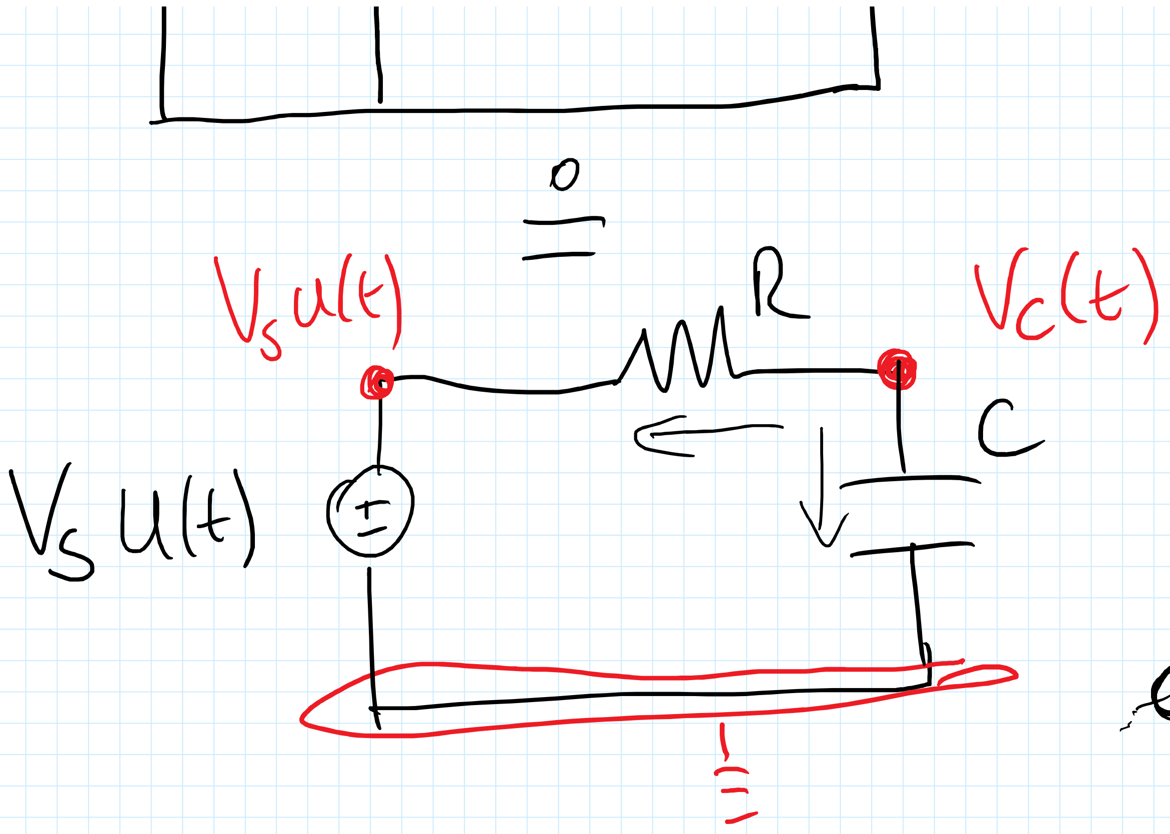
$I_L(t) = I_0 e^{-\frac{t}{\tau}}$

$\tau = \frac{L}{R}$

$\dot{x} = \alpha x \qquad \dot{x} + \frac{1}{\tau}x = 0$

$$\dot{x} + \frac{1}{\tau}x = \frac{F}{\tau}$$





KCL

$$i_C(t) + \frac{V_C(t) - V_S u(t)}{R} = 0$$

$$\Downarrow$$

$$C\frac{dV_c(t)}{dt} + \frac{V_C(t) - V_S u(t)}{R} = 0$$

$V_C(t=0)$ NOTO $\rightarrow$ COME EVOLVE $V_C(t)$ per $t>0$

$$\frac{dV_c(t)}{dt} = -\frac{V_c(t) - V_s u(t)}{RC} \quad \begin{cases} \dfrac{dV_c(t)}{dt} = -\dfrac{V_c(t)}{RC} & t<0 \text{ SPENTO} \\[2ex] \dfrac{dV_c(t)}{dt} = -\dfrac{V_c(t) - V_s}{RC} & t>0 \text{ ACCESO} \end{cases}$$

$$V_C(t=0) = V_0$$

$$\Downarrow$$

$$\frac{d\,V_c(t)}{V_c(t) - V_s} = -\frac{1}{\tau}\,dt$$

$$\int_{t'=0}^{t} d\left[\ln\left(V_c(t') - V_s\right)\right] = -\frac{1}{\tau}\int_{t=0}^{t} dt'$$

$$\frac{dx}{x - x_0} = d\ln(x - x_0)$$

$$\ln\left(V_c(t) - V_s\right)\Big|_{t=0}^{t} = -\frac{1}{\tau}\,t'\Big|_{t=0}^{t}$$

$$\ln\left(V_C(t) - V_S\right) - \ln\left(V_C(0) - V_S\right) = -\frac{t}{\tau}$$

$$\ln(V_C(t)-V_S) - \ln(V_C(0)-V_S) = -\frac{t}{\tau}$$

$$\ln \frac{V_C(t)-V_S}{V_0-V_S} = -\frac{t}{\tau}$$

$$\frac{V_C(t)-V_S}{V_0-V_S} = e^{-\frac{t}{\tau}} \Rightarrow$$

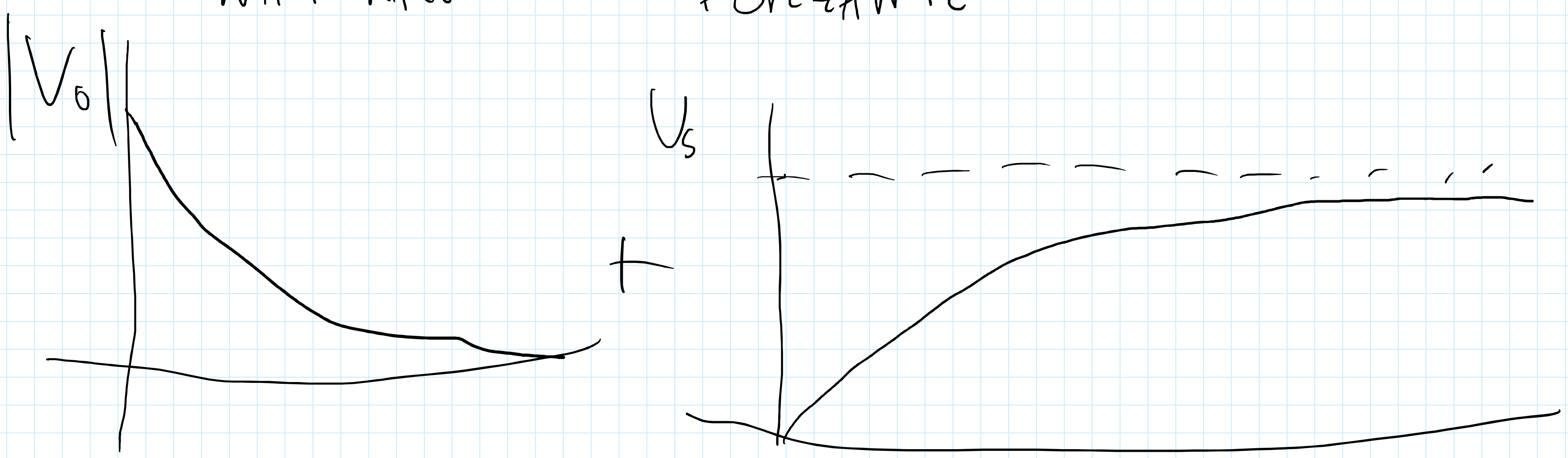
costante di tempo RC

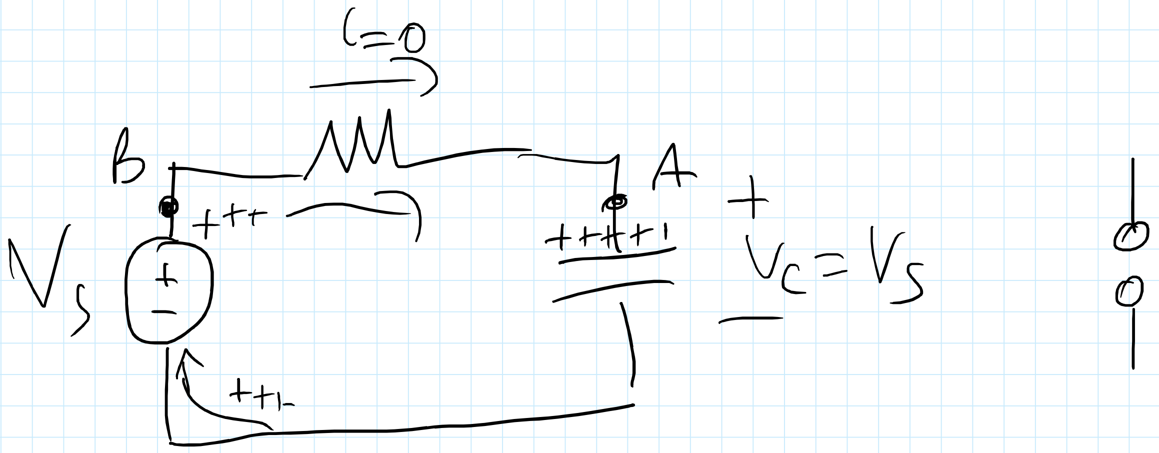
tensione gen indipendente

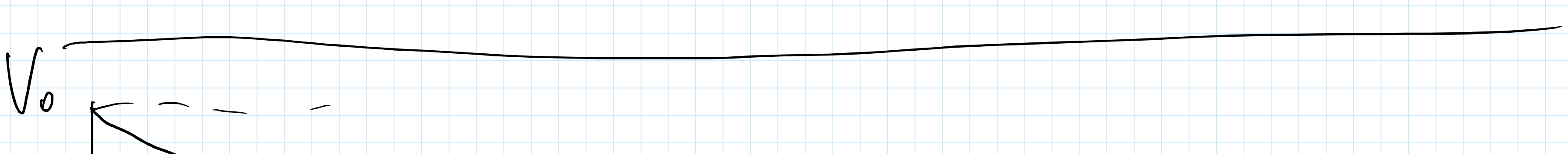
$$V_C(t) = [V_0 - V_S]\,e^{-\frac{t}{\tau}} + V_S$$

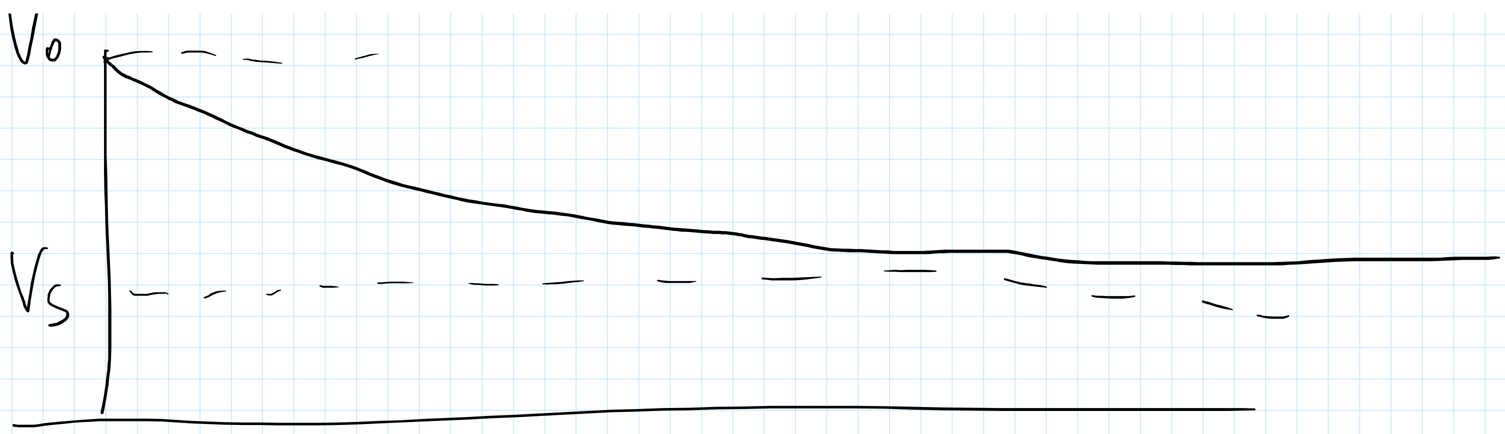
tensione iniziale del condensatore

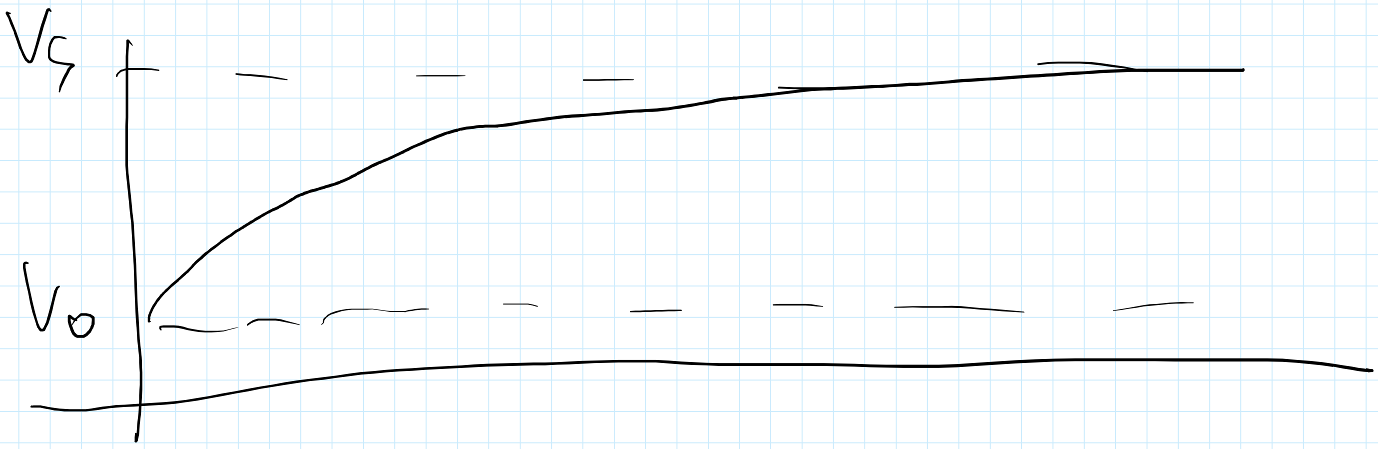
$$V_C(t) = \underbrace{V_0\, e^{-\frac{t}{\tau}}}_{\text{RISPOSTA NATURALE}} + \underbrace{V_S\left[1 - e^{-\frac{t}{\tau}}\right]}_{\text{RISPOSTA FORZANTE}}$$











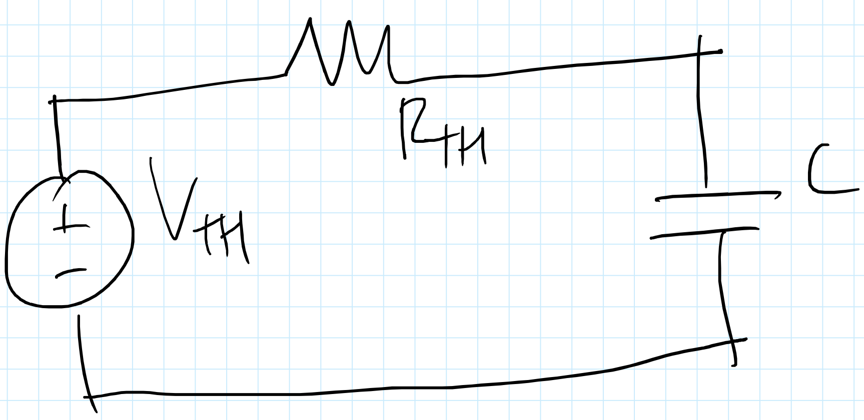
$V_C(t) =$ risp. naturale + risp. forzata

risp. transitorio + risp$_{SS}$

$$\underbrace{V_S}_{V_{SS}} + \underbrace{[V_0 - V_S]\, e^{-\frac{t}{\tau}}}_{\text{risp. transitoria}}$$

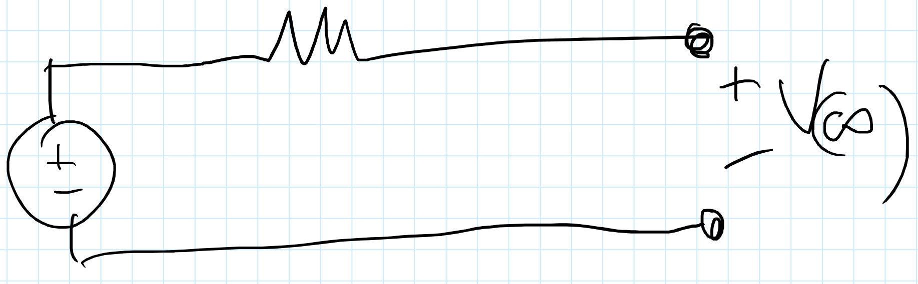
$$V(\infty) + [V(0^+) - V(\infty)]\, e^{-\frac{t}{\tau}}$$

$V(0)$ la condizione iniziale



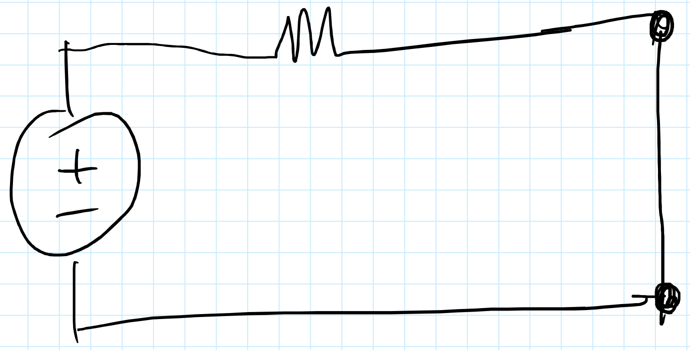
$\tau = R_{TH} \cdot C$

$V(\infty) = V_{TH}$

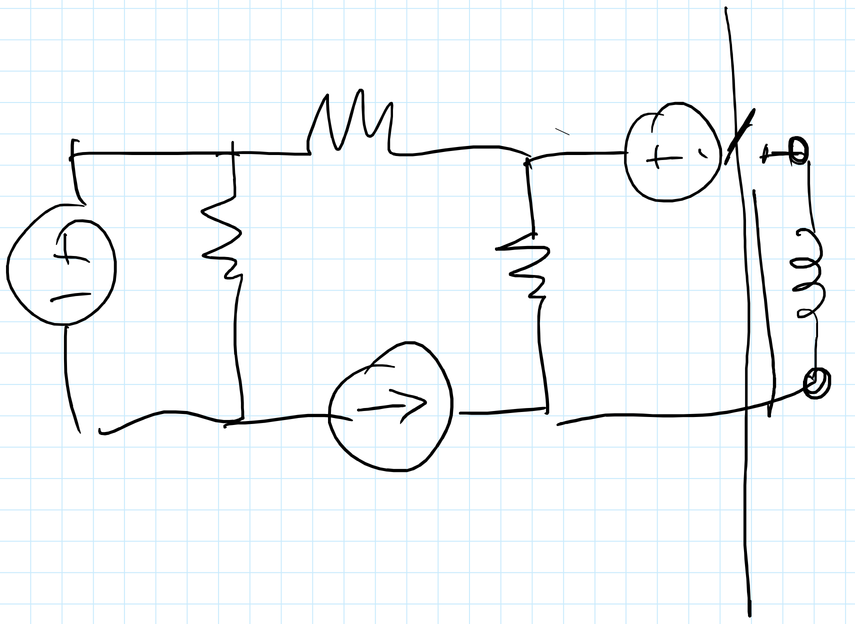


$$i_L(t) = i_L(+\infty) + [i_L(0^+) - i_L(+\infty)]e^{-\frac{t}{\tau}} \qquad \tau = \frac{L}{R}$$

$$V = L\frac{di}{dt}$$



$$i_L(+\infty) = i_{cc}^{THEVENI} = i_{NORTON} = \frac{V_{TH}}{R_{TH}}$$



$\rightarrow i_L(0)$

$\rightarrow R_{eq} = R_{TH} = R_{NORTON}$

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

$$\rightarrow i_L(\infty) = \frac{V_{TH}}{R_{eq}} = I_N$$

ESERCIZIO 4 APRILE

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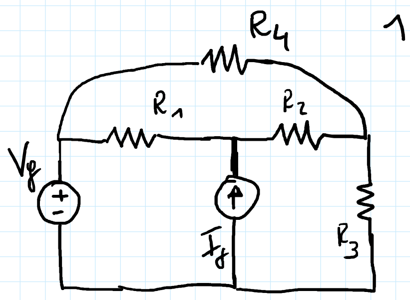
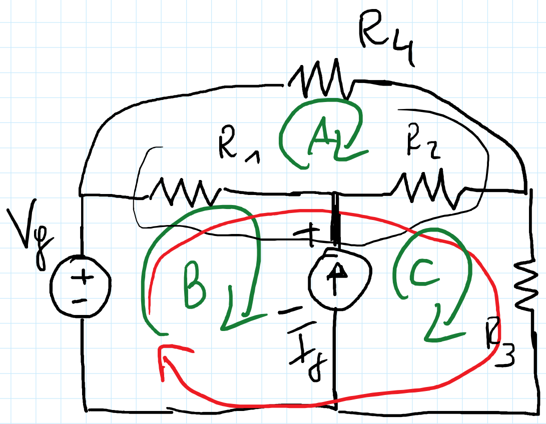


1 DETERMINARE LA POTENZA ASSORBITA DALLE RESISTENZE E QUELLA GENERATA DAI GENERATORI E VERIFICARE CHE

$$\sum_k P_{R_k} = P_{V_g} + P_{I_g}$$

2) Per la resistenza R_3 calcolare i circuiti equivalenti di Thevenin e Norton e verificare il valore di P_{R_3} trovato in precedenza.



$$I_C - I_B = I_g \Rightarrow I_C = I_g + I_B$$

(A) $I_A R_4 + (I_A - I_C)\cdot R_2 + (I_A - I_B) R_1 = 0$

(B) $(I_B - I_A) R_1 + V_{I_g} = V_g$

(C) $(I_C - I_A) R_2 + I_C R_3 - V_{I_g} = 0$

$$V_{I_g} = (I_C - I_A) R_2 + I_C R_3$$

ELIMINO (C) e sostituisco V_{I_g} in (B)

(A) $I_A R_4 + (I_A - I_C) R_2 + (I_A - I_B) R_1 = 0$

(B-C) $(I_B - I_A) R_1 + (\underbrace{I_C}_{I_B + I_g} - I_A) R_2 + \underbrace{I_C}_{I_B + I_g} R_3 = V_g$

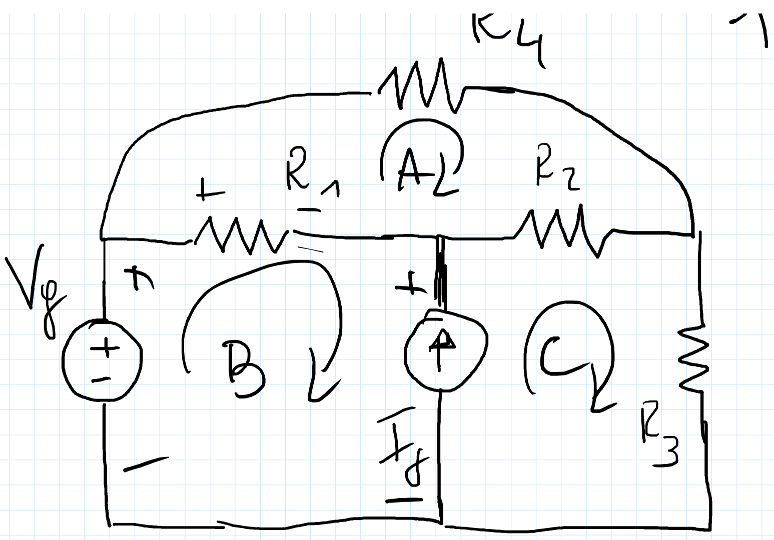
$I_C = I_g + I_B$ (A) $I_A (R_4 + R_2 + R_1) - I_B (R_2 + R_1) = I_g R_2$

$$I_B (R_1 + R_2 + R_3) - I_A (R_1 + R_2) = V_g - I_g (R_2 + R_3)$$

$$\begin{bmatrix} R_1 + R_2 + R_4 & -(R_1 + R_2) \\ -(R_1 + R_2) & (R_1 + R_2 + R_3) \end{bmatrix} \begin{bmatrix} I_A \\ I_B \end{bmatrix} = \begin{bmatrix} I_g R_2 \\ V_g - I_g (R_2 + R_3) \end{bmatrix}$$

R_4 1

$$P_{R_1} = (I_B - I_A)^2 \cdot R_1 = (I_A - I_B)^2 \cdot R_1$$

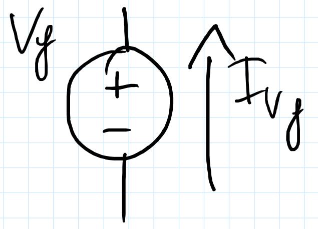


$$P_{R_1} = (I_B - I_A)^2 \cdot R_1 = (I_A - I_B)^2 \cdot R_1$$

$$P_{R_2} = (I_C - I_A)^2 R_2$$

$$P_{R_3} = I_C^2 R_3$$

$$P_{R_4} = I_A^2 R_4$$



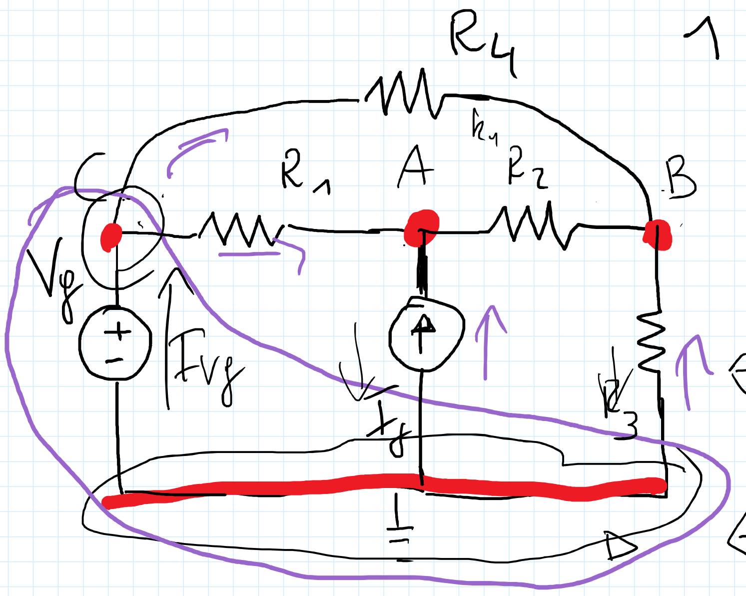
$$P_{V_g} = V_g \cdot I_{V_g} = P_{generata} \left(\begin{matrix}\text{conv}\\ \text{generatori}\end{matrix}\right)$$

$$P_{I_g} = V_g \cdot I_{V_g} = P_{assorbita} \left(\begin{matrix}\text{conv}\\ \text{utilizzatori}\end{matrix}\right)$$

$$P_{V_g} = V_g \cdot I_B$$

$$P_{I_g} = V_{I_g} \cdot I_g = \left[(I_C - I_A) R_2 + I_C R_3\right] \cdot I_g$$

$$\left[V_g + (I_A - I_B) R_1\right] \cdot I_g$$



$e_D = 0$

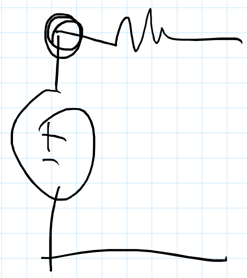
$e_C = V_g$

e_A, e_B incogniti

$$A: \quad (e_A - e_C) G_1 + (e_A - e_B) G_2 = I_g$$

$$B: \quad (e_B - e_C) G_4 + (e_B - e_A) G_2 + e_B G_3 = 0$$

$-V_G$



$$A: \quad e_A (G_1 + G_2) - e_B G_2 = I_g + V_g G_1$$

$$B: \quad -e_A (G_2) + e_B (G_2 + G_3 + G_4) = V_g G_4$$

$$\begin{bmatrix} G_1 + G_2 & -G_2 \\ -G_2 & G_2 + G_3 + G_4 \end{bmatrix} \begin{bmatrix} e_A \\ e_B \end{bmatrix} = \begin{bmatrix} I_g + V_g G_1 \\ V_g G_4 \end{bmatrix}$$

$$C: \quad (V_g - e_B) G_4 + (V_g - e_A) G_1 = I_{V_g}$$

$$\boxed{I_{V_g} = -I_g + e_B G_3}$$

$$P_{R_1} = (e_A - V_g)^2 G_1; \; P_{R_2} = (e_A - e_B)^2 G_2; \; P_{R_3} = e_B^2 G_3; \; P_{R_4} = (e_C - e_B)^2 G_4 = (V_g - e_B)^2 G_4$$

$$P_{I_g} = \text{(current source } I_g \text{, signs } + / -) = e_A \cdot I_g$$

$$P_{V_g} = V_g \left[(V_g - e_B) G_4 + (V_g - e_A) G_1 \right] = V_g \left[-I_g + e_B G_3 \right]$$

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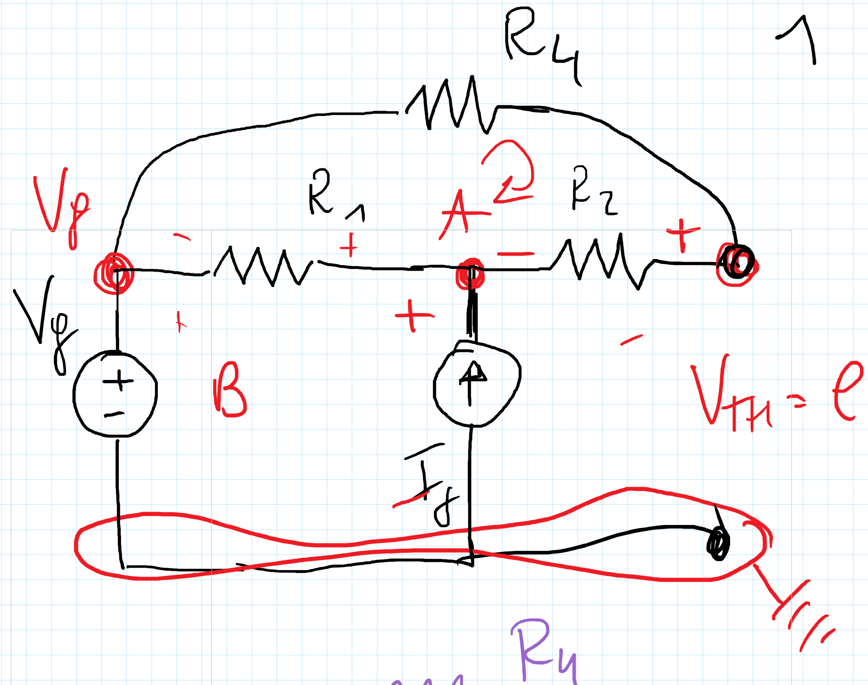
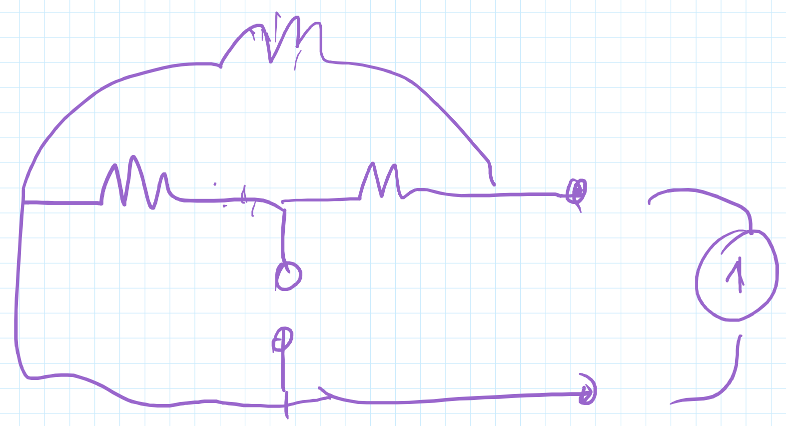
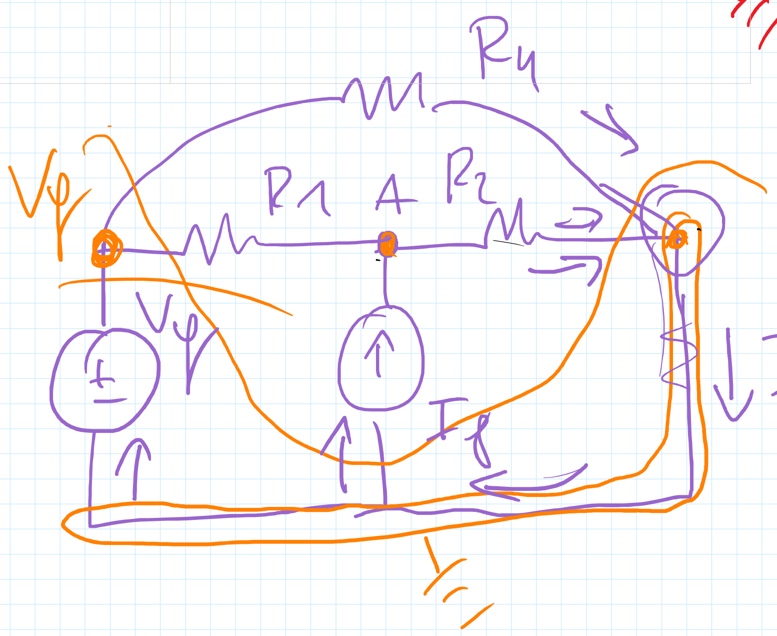


$V_{TH} = e_B$



$$\frac{(R_1 + R_2) R_4}{R_1 + R_2 + R_4}$$



$$I_N = I_{V_g} + I_g = (e_A - 0) G_2 + V_g G_4$$

(

THEVENIN

(A) $(e_A - e_C) G_1 + (e_A - e_B) G_2 = I_g$

(B) $(e_B - e_C) G_4 + (e_B - e_A) G_2 + \quad = 0$