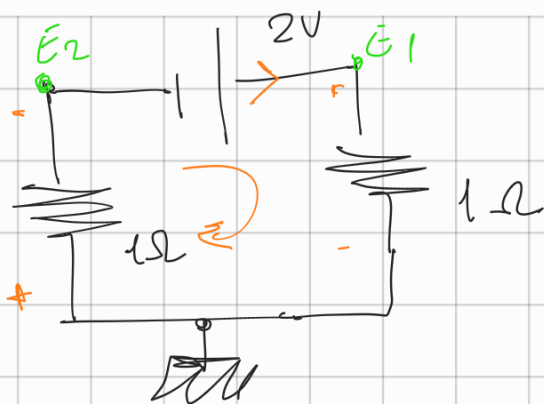




$$0 - E_2 = i_0 1\Omega \Rightarrow$$

$$E_1 - 0 = i_0 1\Omega$$

$$E_2 = -1V$$

$$E_1 = 1V$$

$$E_1 - E_2 = 1i_0 + i_0 1\Omega$$

$$2V = 2i_0 \Rightarrow i_0 = 1A$$

$$R_1 = 2\Omega$$

$$R_2 = 3\Omega$$

$$V_{g1} = 15V$$

$$V_{g2} = 10V$$

? V_1, V_2 , verificare
Tellegen

Una sola maglia, una corrente
blocc. generata:

$$10V + 3i_0 - 15V + 2i_0 = 0$$

$$5V = 5i_0 \Rightarrow i_0 = 1A$$

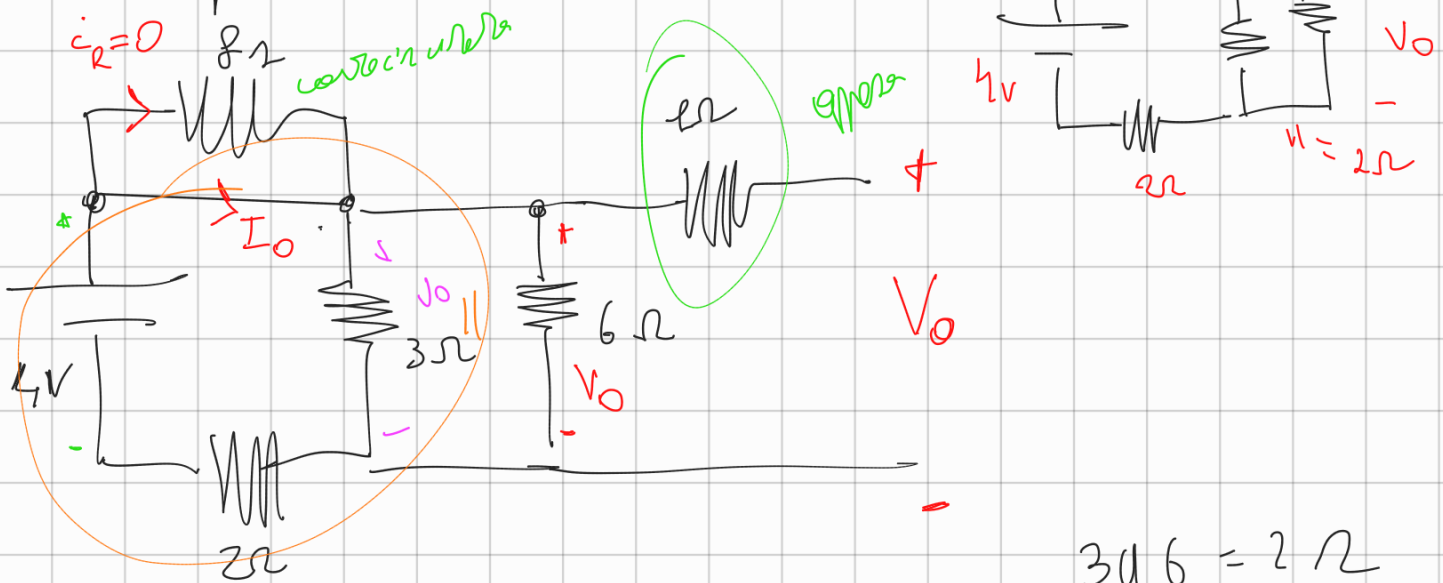
Pot. absorvida da $R_2 = i^2 \cdot 3 = 3 \text{ W}$

Pot. erogada da $V_{g1} = 15 \text{ W}$

Pot. absorvida $R_1 = 2 \text{ W}$

Pot. erogada $V_{g2} = -10 \text{ W}$, s. da lâmpada

Exemplo

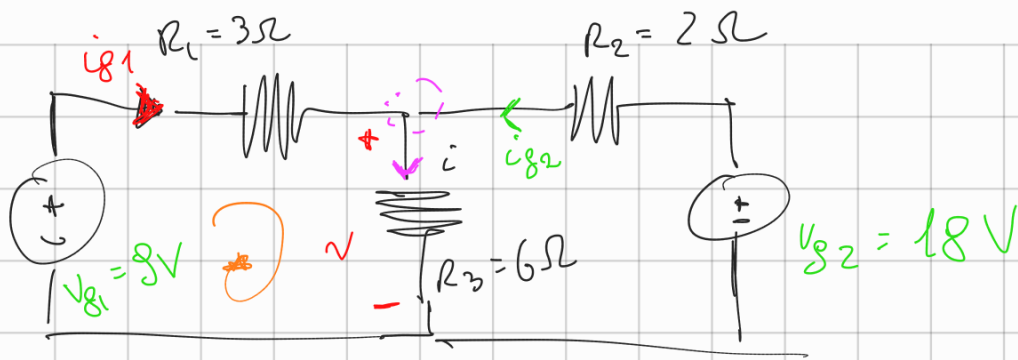


Partição Tensão

$$V_0 = \frac{4 \text{ V} \cdot 2 \Omega}{4 \Omega} = 2 \text{ V}$$

$$I_0 = \frac{2 \text{ V}}{2 \Omega} = 1 \text{ A}$$

Partição
Corrente



Connetti e
potere istant
scopre dai
2 generatori

Tipica configurazione a Millera

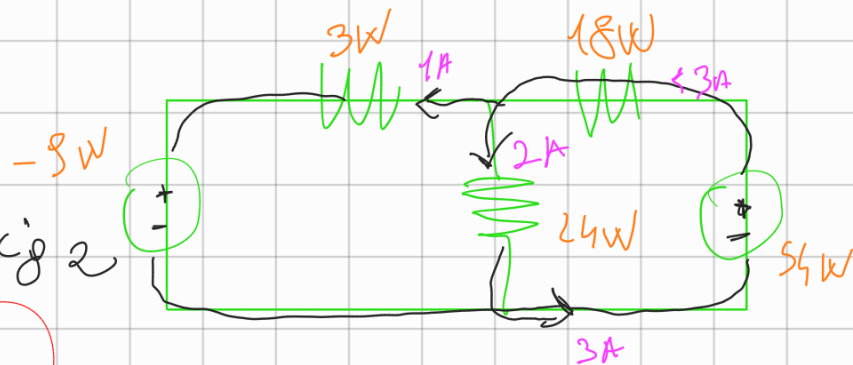
$$\frac{\frac{9}{3} + \frac{18}{2}}{\frac{1}{3} + \frac{1}{6} + \frac{1}{2}} = \frac{3 + 9}{\frac{2+1+3}{6}} = \frac{12}{1} \text{ Volts}$$

$V = 12 \text{ V}$

da KI

$$i = i_{g1} + i_{g2}$$

$$i = \frac{V}{R} = 2 \text{ A}$$



$$KV_1 = -9V + 3i_{g1} + 12 = 0$$

$$i_{g1} = -1 \text{ A}$$

$$i_{g2} = i - i_{g1} = 3 \text{ A}$$

$P_{Vg1} = -9 \text{ W}$, si può ricavare

$P_{Vg2} = 54 \text{ W}$

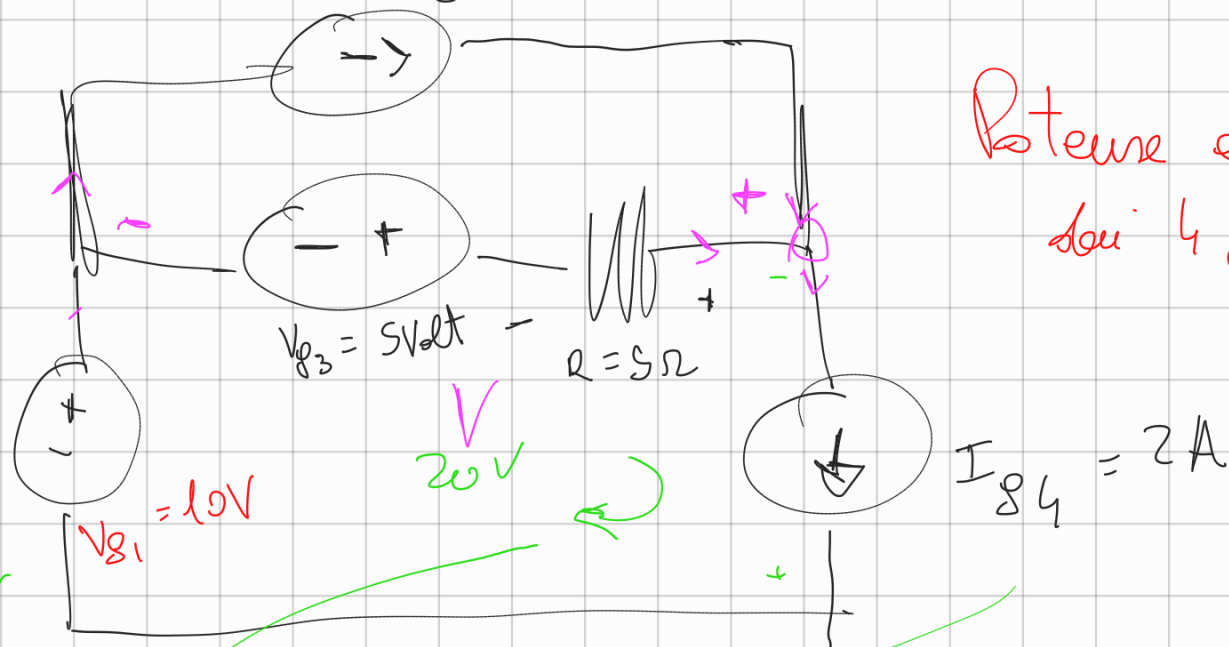
$P_{R2} = 18 \text{ W}$

$P_{R3} = 24 \text{ W}$

$P_{R1} = 3 \text{ W}$

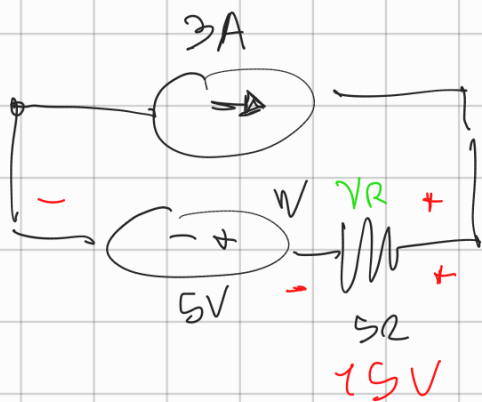
$45 \text{ W} = 45 \text{ W}$

$$I_{g2} = 5A$$



Potenza erogata
dai 4 generatori

Ho in serie generatori Corrente e Tensione
Vince generatori corrente



$$= \text{Millman } \frac{3A + 1A}{\frac{1}{5}} = 20V$$

$$V_R = 15V$$

$$P_{WR} = 45W$$

$$P_{g2} = 5A \cdot 20 = 100W$$

$$P_{Vg1} = 10 \cdot 2 = 20W$$

$$20 + 100 - 75 + 45 = 0$$

$$P_{Vg3} = -15W$$

$$I_{g3} = 2A - 5A = -3A$$

da KV $\rightarrow$

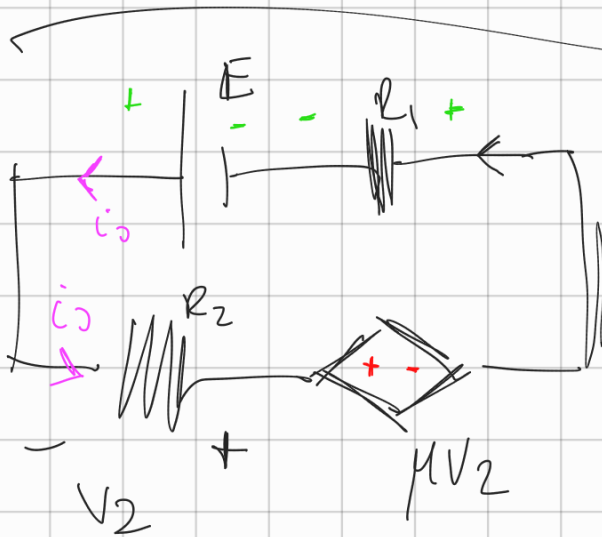
$$V_{g4} = -V_{g1} - V = -30V$$

$$P_{g4} = -60W$$

$$20 - 5 + 500 = 0$$

$$i_0 = -3A$$

$$P_{R2} = 8.5 = 45W$$



? V_2

$$KVL: -E - V_2 + \mu V_2 + R_1 i_0 = 0$$

$$V_2 = -R_2 i_0$$

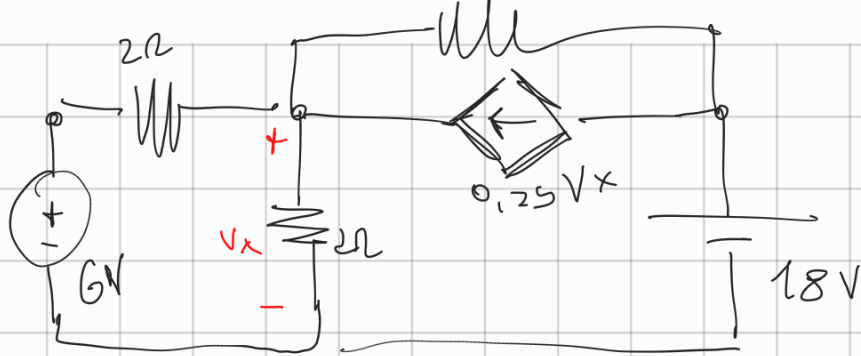
$$\Rightarrow -E + R_2 i_0 - \mu R_2 i_0 + R_1 i_0 = 0$$

$$i_0 = \frac{E}{R_2 + R_1 - \mu R_2}$$

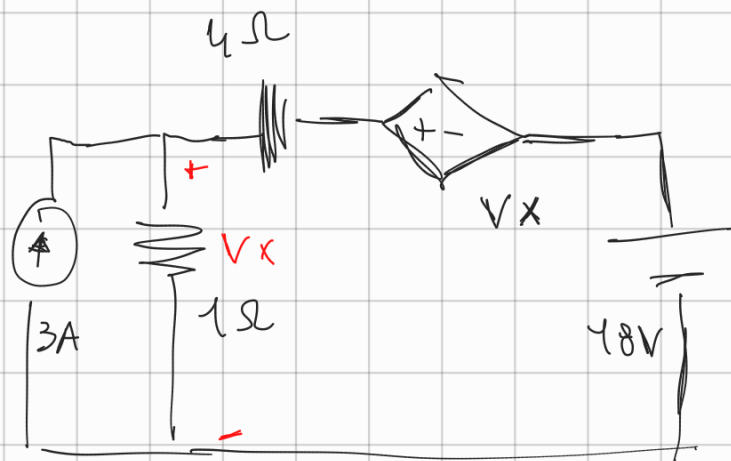
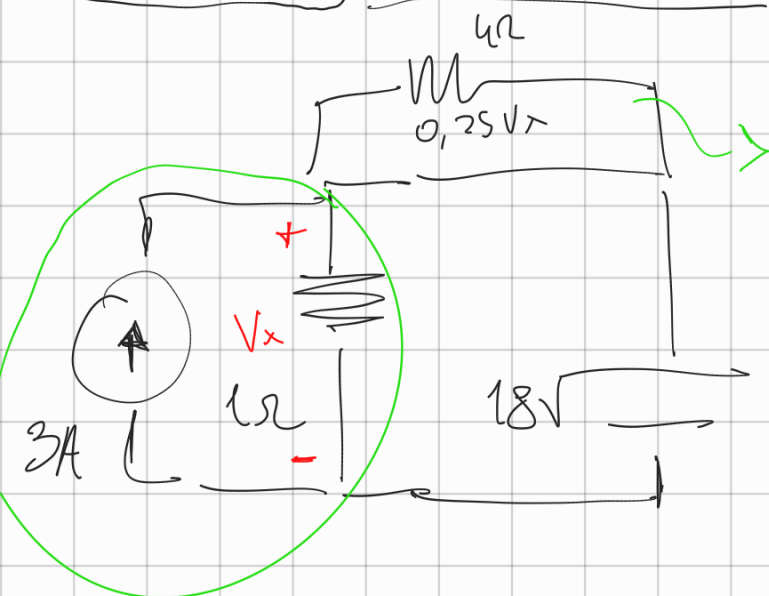
$$V_2 = \frac{-R_2 E}{R_2 + R_1 - \mu R_2}$$

Calcolare V_x usando equi. v. da ge.

4Ω



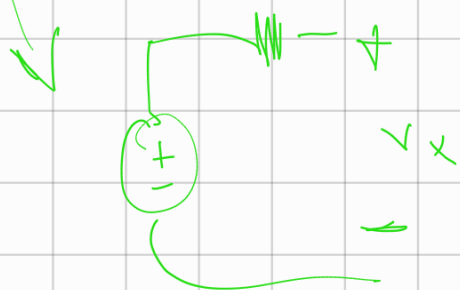
NON serve per la
Vx e la Vx



$$V_x = \frac{3A + \frac{18 + V_x}{4}}{\frac{1}{4} + 1} = \frac{12A + 18 + V_x}{5} = V_x$$

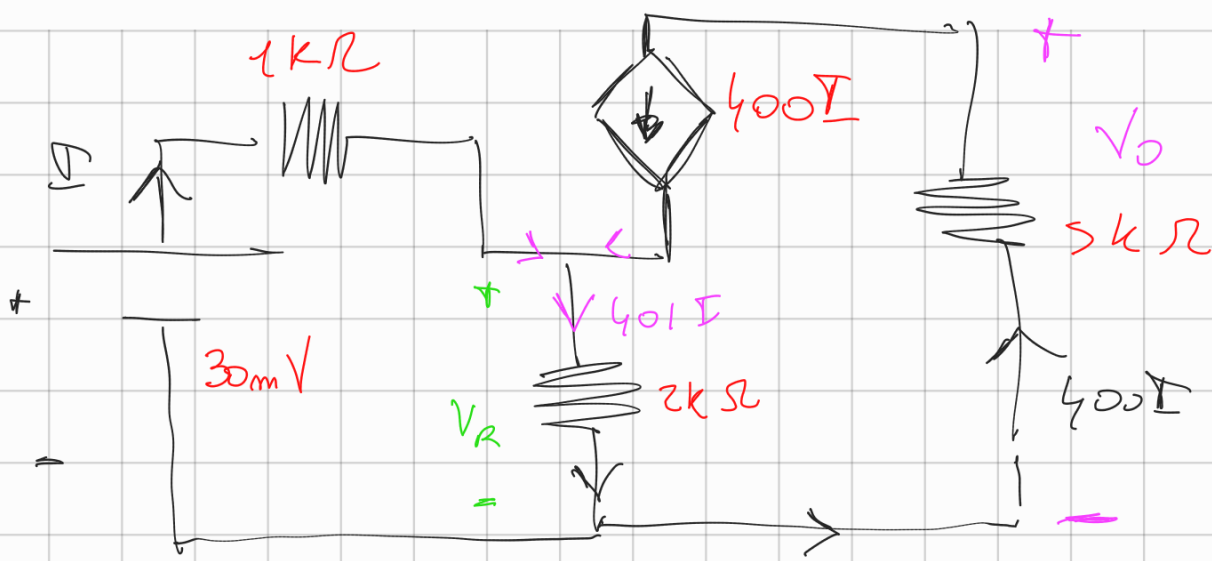
$$\frac{12}{5} + \frac{18}{5} = V_x - \frac{V_x}{5} = \frac{4}{5} V_x$$

$$12 + 18 = 4 V_x \Rightarrow V_x = \frac{15}{2} V$$



Secondo, Vx non è più 0
Tensione sul resistor,
ma full'intero valore

6 Determinare Vo per il circuito a Dracina



Now Determine I

$$V_R = 400I \cdot 2k\Omega = 802kV$$

$$-30mV + 1k\Omega I + V_R = 0$$

$$30 \cdot 10^{-3} = 1000I + 802000$$

$$\frac{30 \cdot 10^{-3}}{803000} = I = 3,73 \cdot 10^{-8}$$

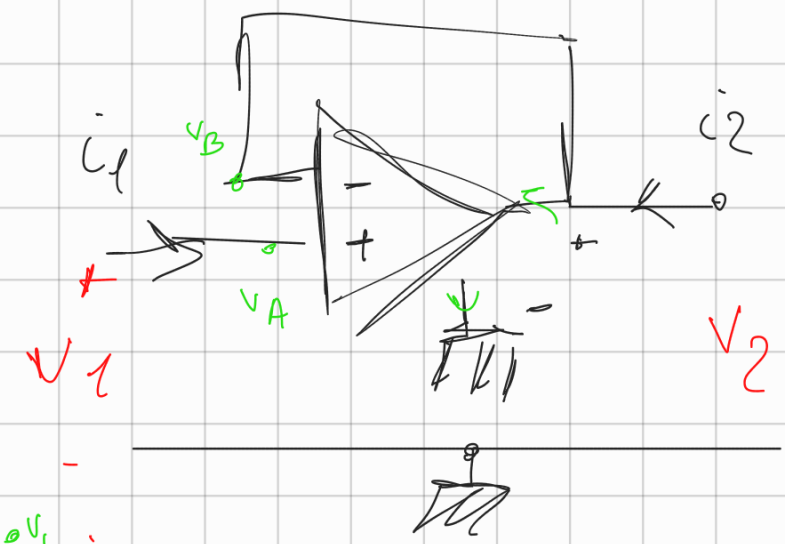
$$\downarrow 400I$$

$\Rightarrow$

$$V_O = (-R) \cdot 400I = (-) 0,075V, 0,75mV$$

comple. pherole. sur R

CIRCUITO BUFFER

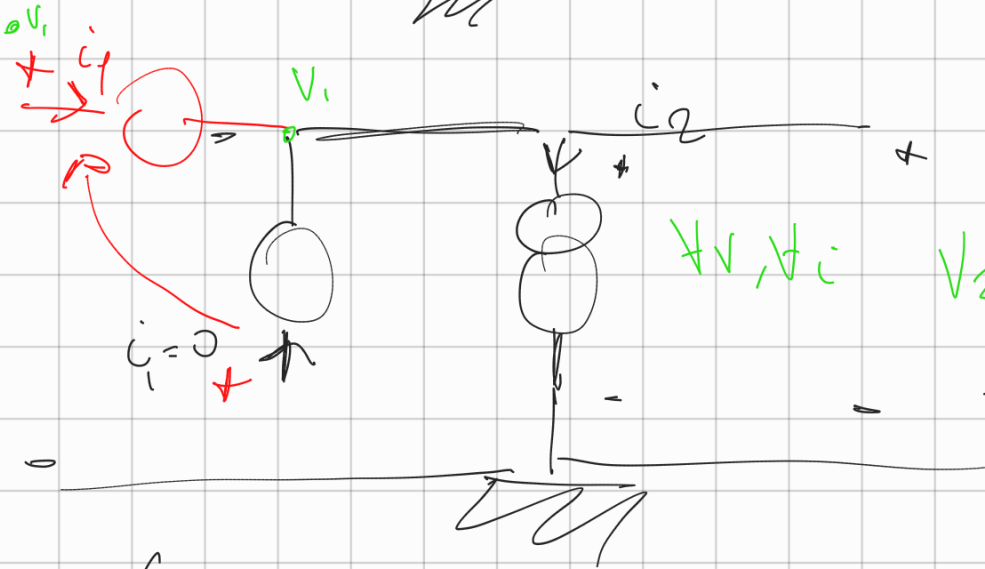


$$i_1 = 0$$

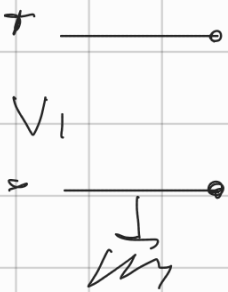
$$V_A = V_1 = V_B$$

$$V_1 = V_2$$

$$V_{i2}$$



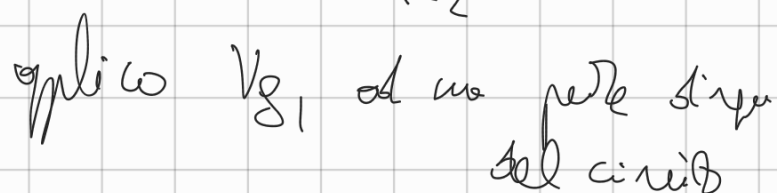
$$\left\{ \begin{array}{l} V_1 = V_2 \\ i_1 = 0 \end{array} \right.$$



$$V_1$$

Steady State
Cost il,

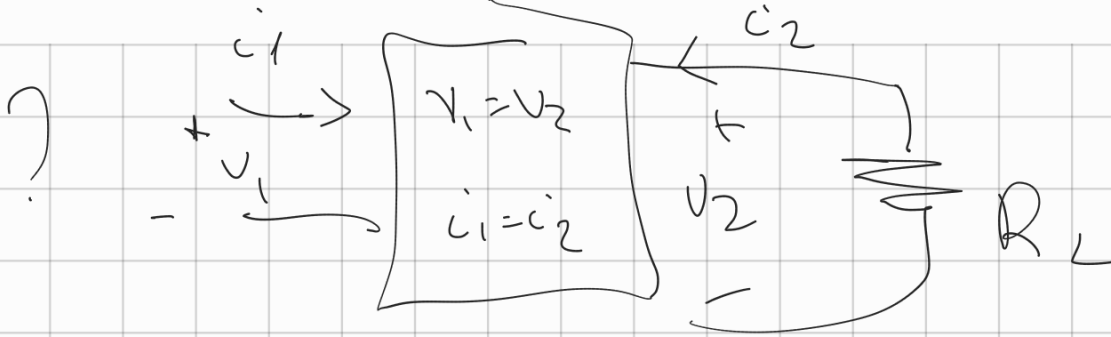
Circolo con Buffer

$$E^+ > E^-$$


esendo $V_1 = V_2$
 $C_1 = C_2$

$$V_1 - V_0 = c_1 R$$

$$V_2 - V_0 = I_2 R$$



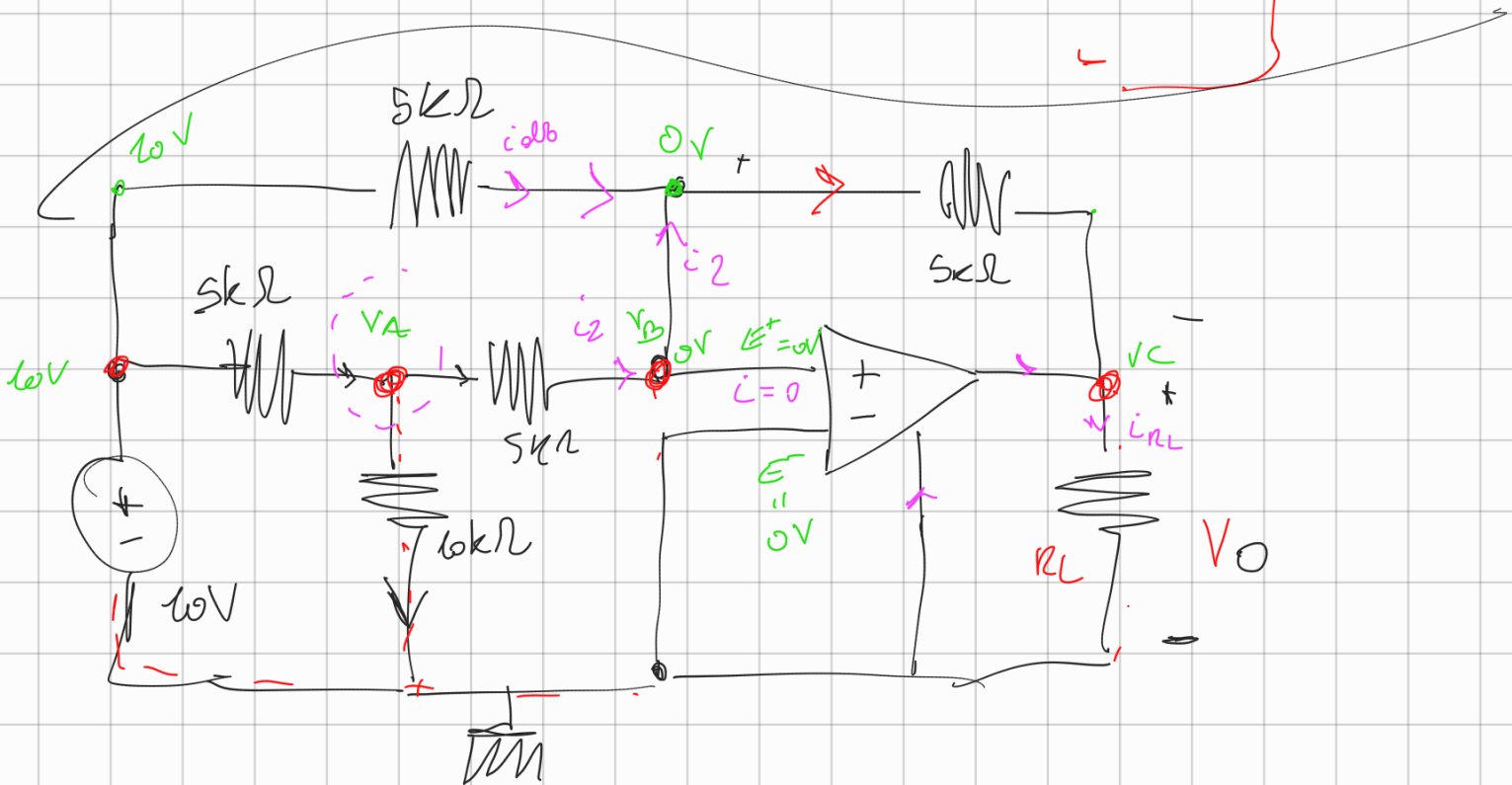
can guess
posso over
represent
negative

$$V_1 = V_2$$

$$i_1 = i_2$$

$$V_2 = -i_2 R_L$$

$$\frac{V_1}{i_1} = -R_L$$



KI summa A

$$-\left(\frac{10 - V_A}{5k\Omega}\right) + \frac{V_A - 0}{5k\Omega} + \frac{V_A - 0}{10k\Omega} = 0$$

$$\frac{-10 + V_A}{5k\Omega} + \frac{V_A}{5k\Omega} + \frac{V_A}{10k\Omega} = 0$$

$$\frac{-20 + 2V_A + 2V_A + V_A}{10} = 0$$

$$-20 + 5V_A = 0 \quad V_A = 4V$$

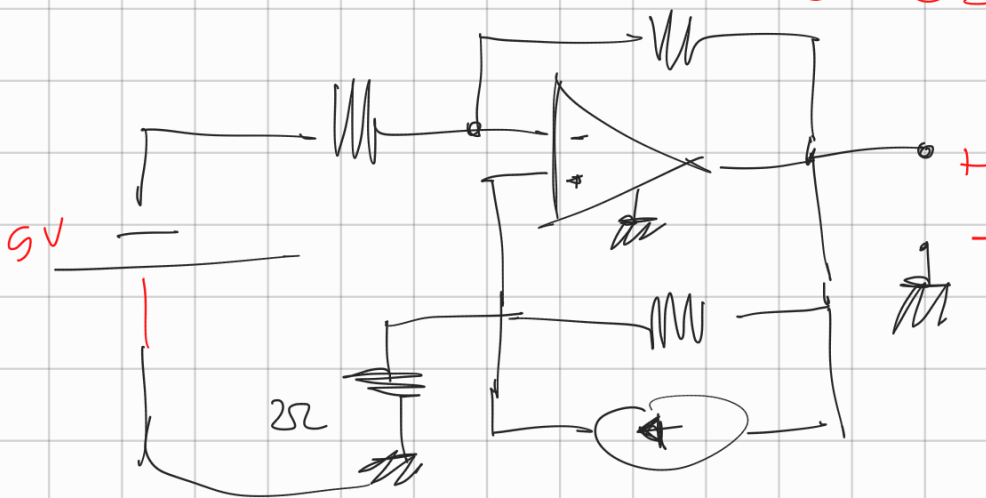
$k1 \quad 50 \quad V_C$

$$i_3 = \frac{V_A - 0}{5k\Omega} + \frac{10 - 0}{5k\Omega}$$

$$= \frac{4}{5k\Omega} + \frac{10}{5k\Omega} A = \frac{14}{5k\Omega} A$$

$$-V_C = 5k\Omega \cdot \frac{14}{5k} A = \boxed{V_C = -14V}$$

Determino V_0 usando PSE

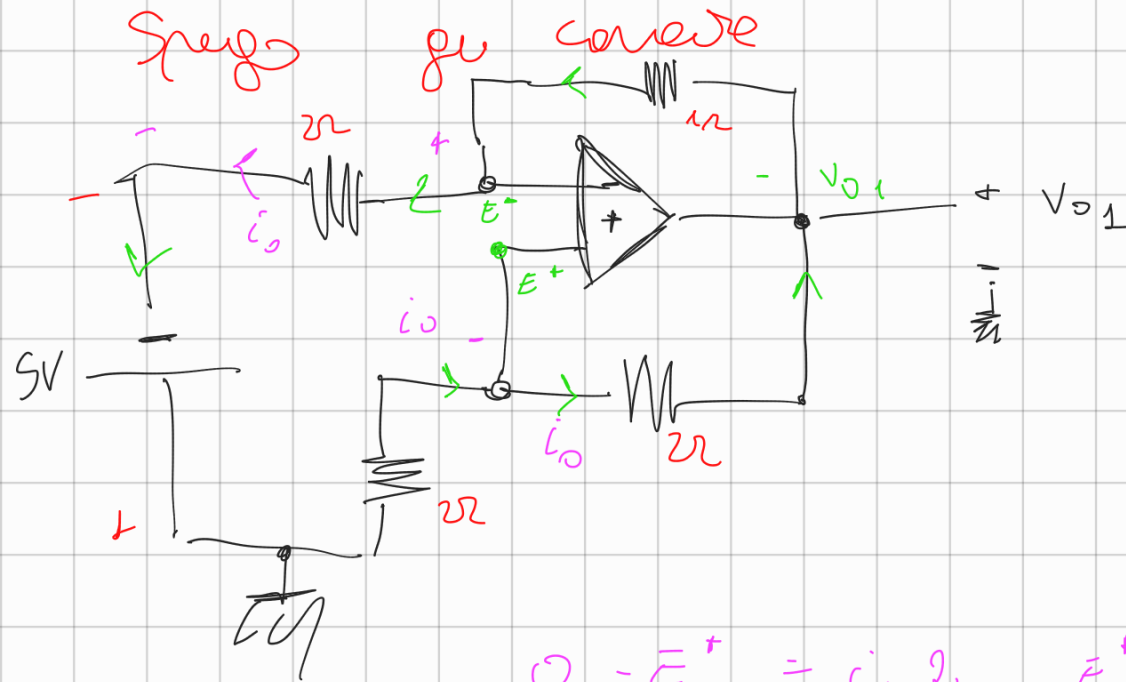


• imp lo camp
gli effetti sono dati
dalla see del.

$$V_0 = V_{01} + V_{02}$$

2A

effekt. Wert 2,46 V



$$0 - E^+ = i_0 \cdot 2 \quad E^+ - V_{01} = i_0 \cdot 2$$

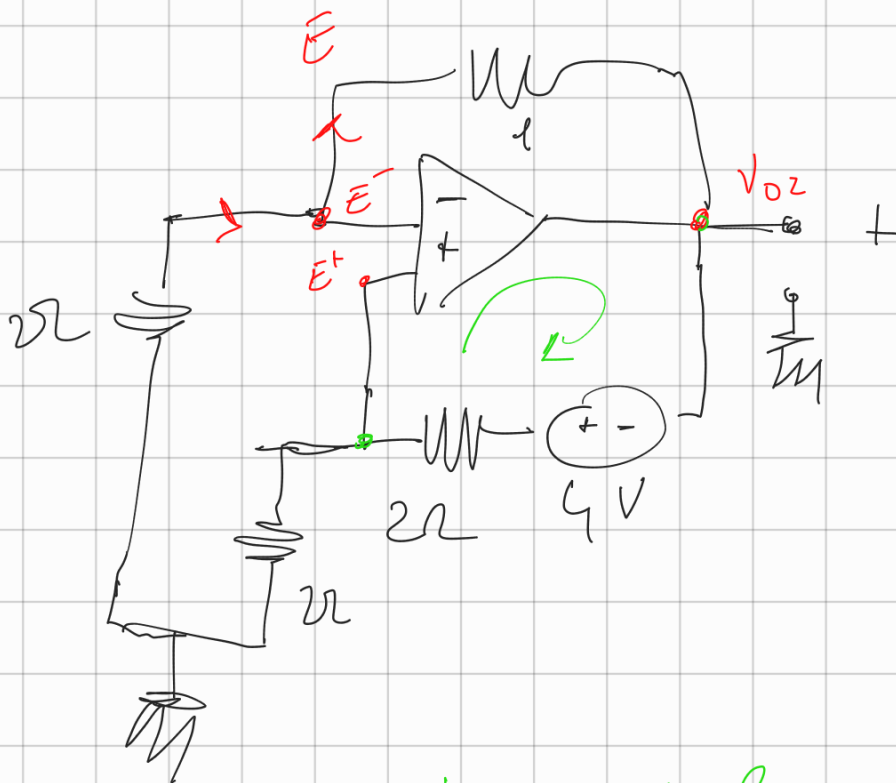
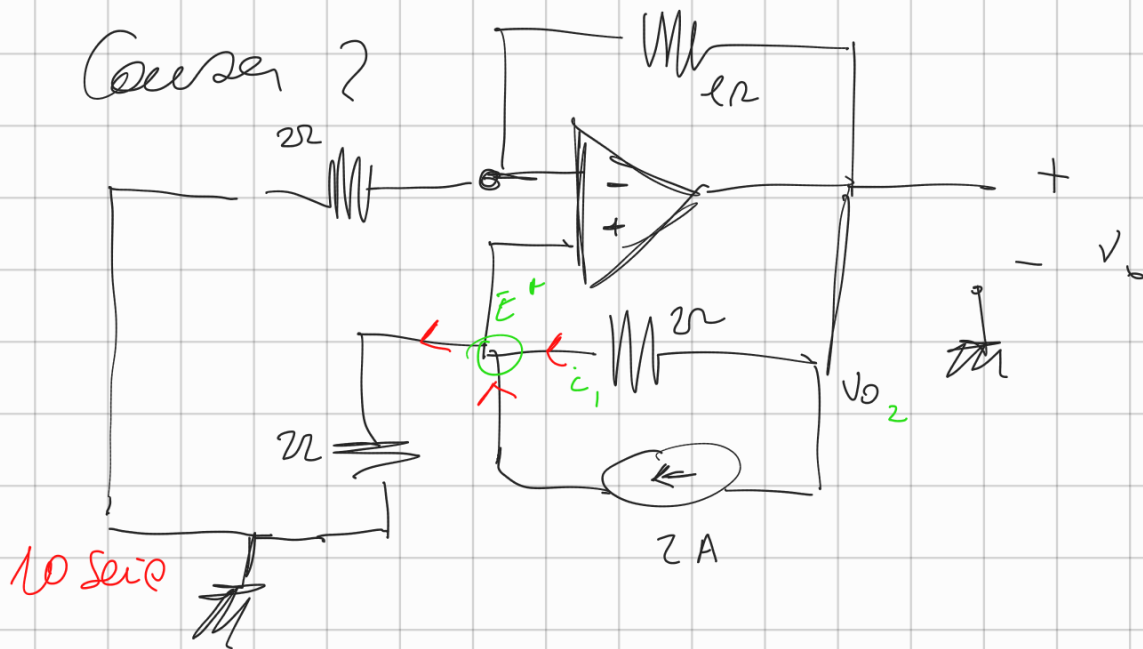
$$\frac{0 - E^+}{2} = \frac{E^+ - V_0}{2}$$

$$E^+ = \frac{V_0}{2}$$

$$\frac{V_{01} - E^+}{1} = \frac{E^- + 5}{2}$$

$$2V_{01} - V_{01} = \frac{V_0}{2} + 5 \Rightarrow$$

$$\frac{V_0}{2} = 5 \text{ V} \Rightarrow V_0 = 10 \text{ V}$$



$$2A + \frac{(V_{o2} - E)}{2\Omega} = \frac{E - 0}{2}$$

$$2 + \frac{V_o}{2} - \frac{E}{2} = \frac{E}{2} \Rightarrow$$

$$2 + \frac{V_o}{2} - E = 0$$

$$V_{o2} = 2E - 4$$

$$\frac{-E}{2} = E - V_{o2}$$

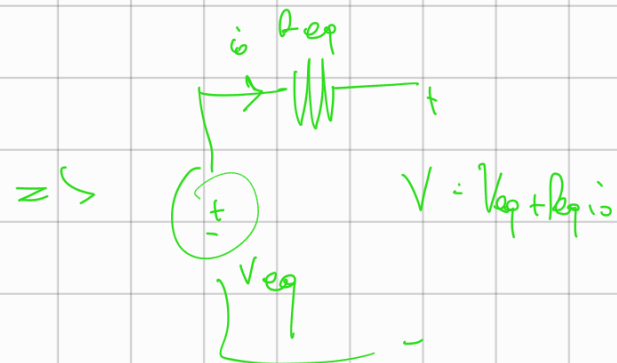
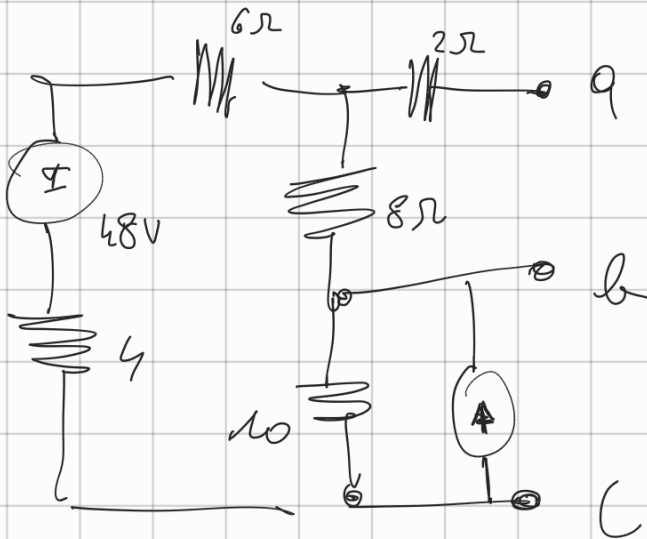
$$\frac{-E}{2} - E + 2E - 4 = 0$$

$$\frac{1}{2} E = 4 \quad E = 8$$

$$V_{o2} = 12 \text{ V}$$

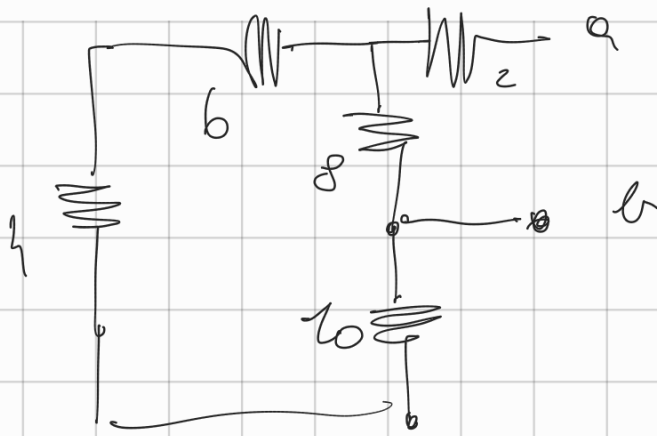
$$V_o = V_{o1} + V_{o2} = 12 + 10 = 22 \text{ V}$$

Equivalent Thevenin Bipolo a b e b c



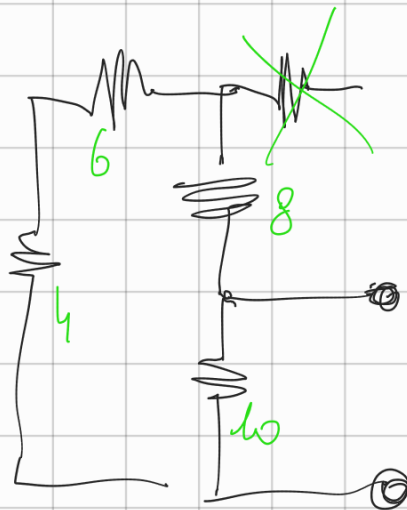
• Req Spesso i circuiti

Req ab



$$2018 = \frac{160}{28} = \frac{54}{7} \Omega$$

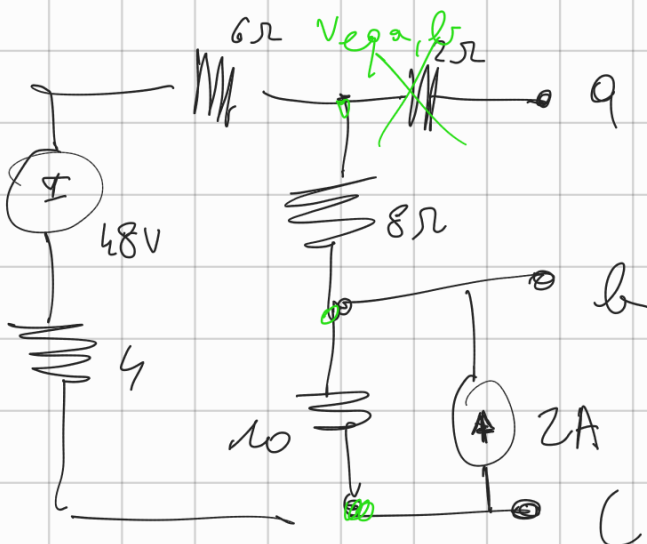
Req bc



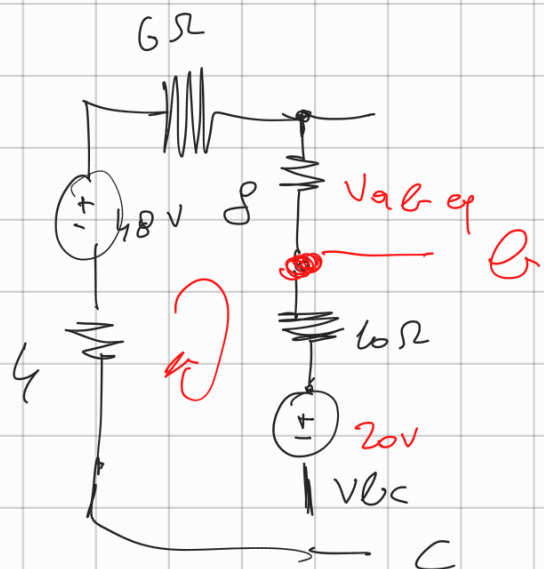
$$\frac{1}{\frac{1}{10} + \frac{1}{18}} = \frac{18}{10+18}$$

$$= 6,43$$

Veq



d selu nupla



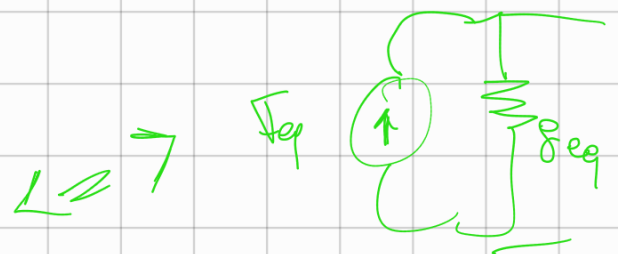
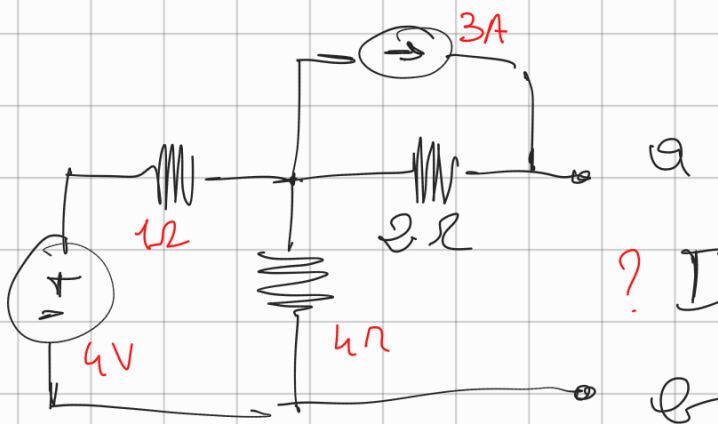
$$KV \Rightarrow 4i_o - 48 + 6i_o + 8i_o + 10i_o + 20 = 0$$

$$28 i_o = 28 \quad i_o = 1 A$$

$$V_{eq\ ab} = 8 V$$

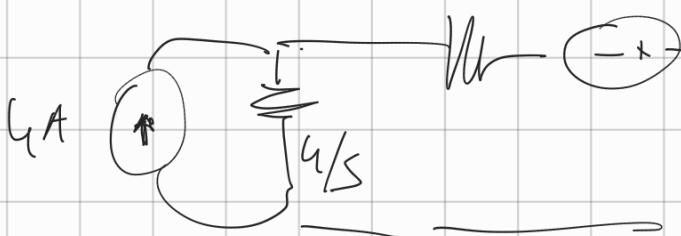
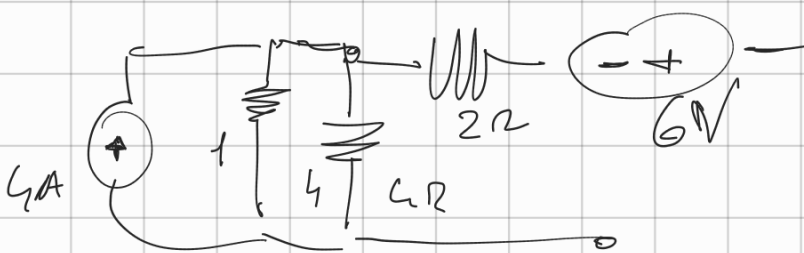
$$V_{dep\ b} = 20V + 10 \cdot i_o = 30 V$$

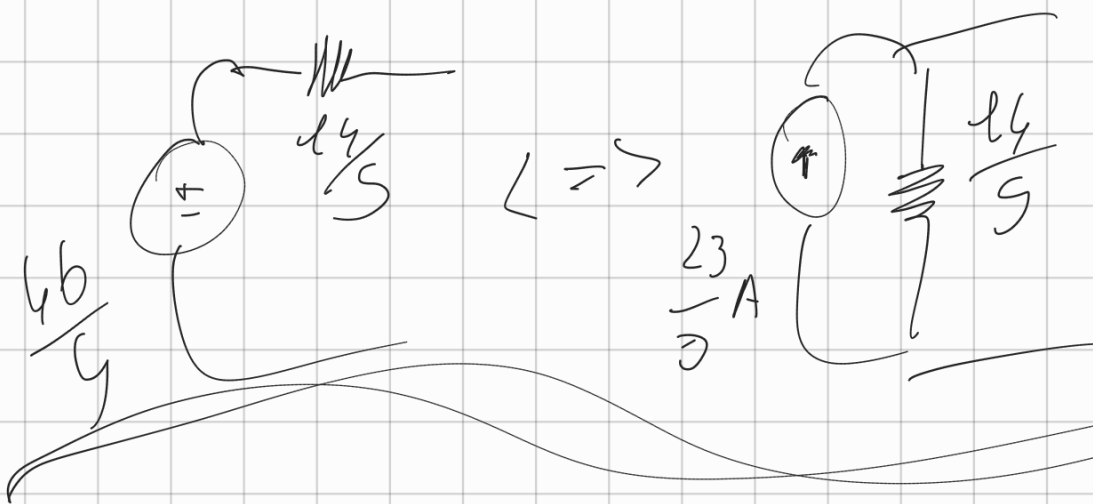
Norton Bipolo AB



? I_{eq} di C.C.

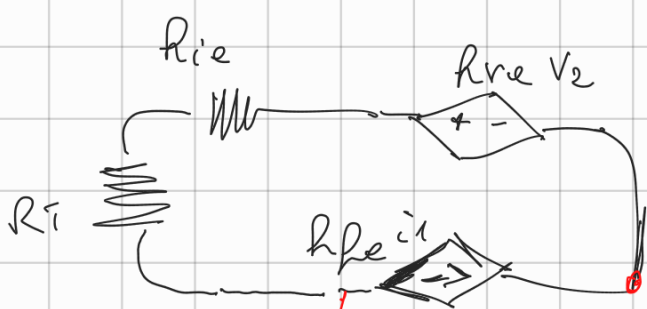
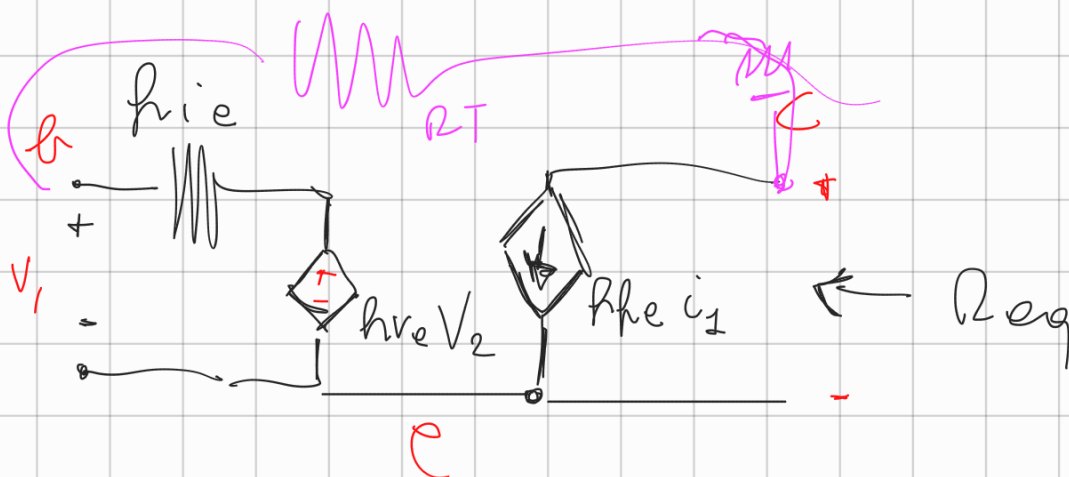
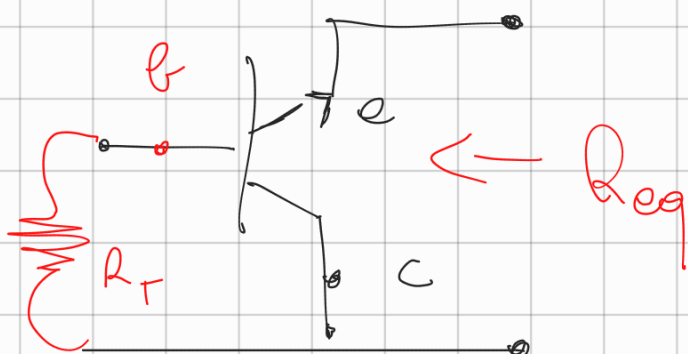
uso Thevenin.



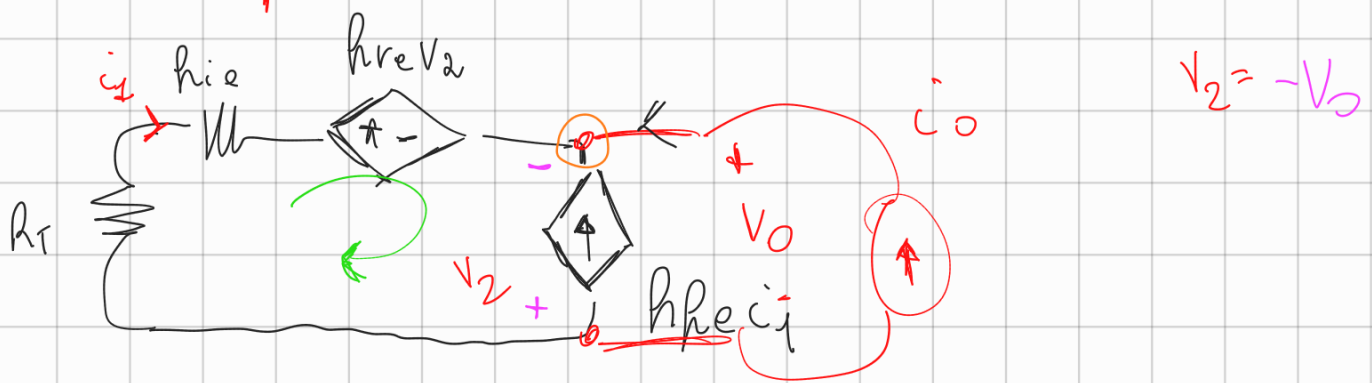


Determine R_{eq} Modello BJT
 or parameter i_b or a ~~equivalent~~ common

$$R_{oe} = 0 \Omega$$



Problema Per R_{eq}
 Trova i_b per V_o
 con i_o e V_o



$$V_o = \frac{-\frac{h_{fe} V_o}{R_i + R_T} + h_{fe} i_1 + i_o}{h_{fe} + R_T}$$

i_1 !

$$h_{fe} i_1 - h_{fe} v_o - v_o + R_T i_1 = 0$$

$$i_1 = -\frac{(1 + h_{fe}) v_o}{h_{fe} + R_T}$$

$$v_2 = h_{fe} i_1 - h_{fe} v_o + R_T i_1$$

$$v_o = -h_{fe} i_1 + h_{fe} v_o - R_T i_1$$

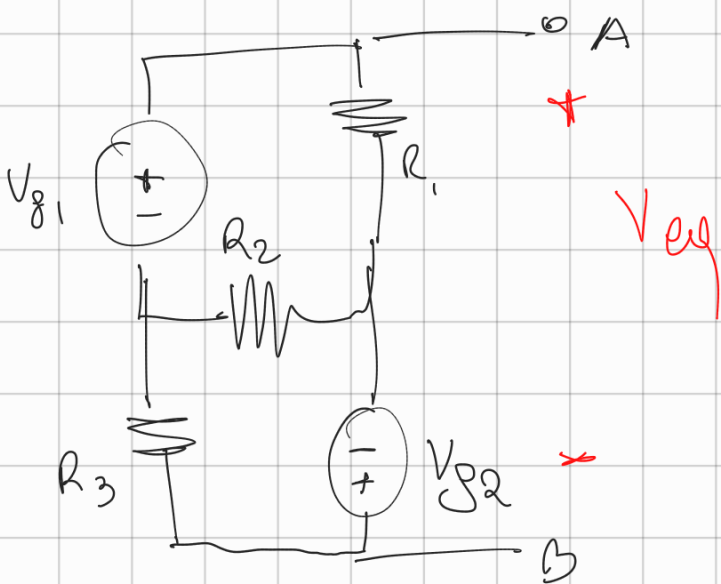
$$i_1 = -h_{fe} i_1 - i_o$$

$$i_1(1 + h_{fe}) = -i_o \Rightarrow i_1 = \frac{-i_o}{1 + h_{fe}}$$

$$v_o(1 - h_{fe}) = \frac{(R_i + R_T) i_o}{(1 + h_{fe})}$$

$$V_0 = \frac{-(R_{ie} + R_T) c' o}{(1 + h_{fe})(1 + h_{re})}$$

$$V_0 = \frac{R_{ie} + R_T}{(1 + h_{fe})(1 - h_{re})}$$



trova eq. Thevenin / volt

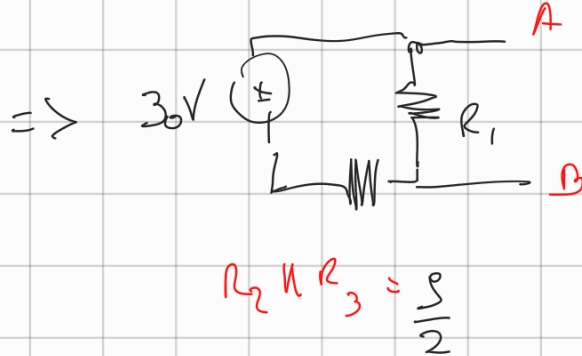
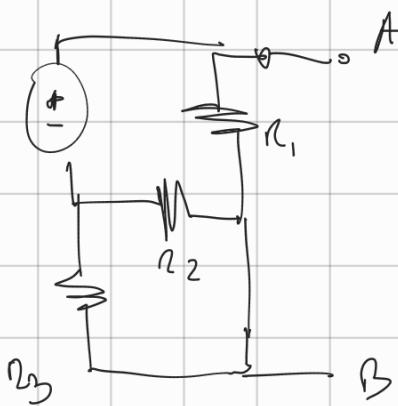
$$R_1 = 5 \Omega \quad R_2 = 18 \Omega$$

$$R_3 = 6 \Omega \quad V_{g1} = 30V$$

$$V_{g2} = 10V$$

USO PSE

Spezzo V_{g2}

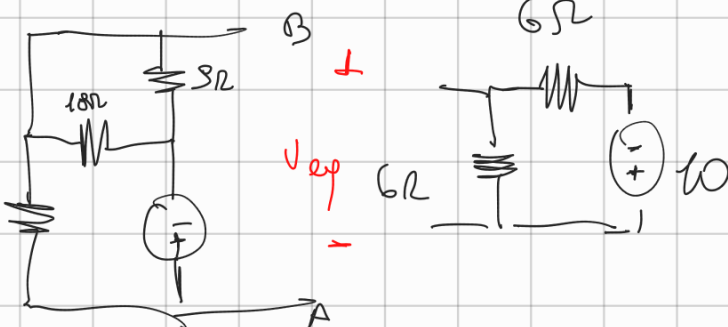


Perz. Iven

$$V_{AB1} = \frac{30 \cdot 3}{\frac{5}{2} + 5}$$

$$V_{AB} = 20V$$

Spezzo V_{g1}



$$= \frac{10 \cdot 6}{12} = -5V$$

$$V_{AB} = 15V$$

Req

$$G_{eq} = \frac{1}{8} + \frac{1}{12} + \frac{1}{6} = \frac{1}{3}$$

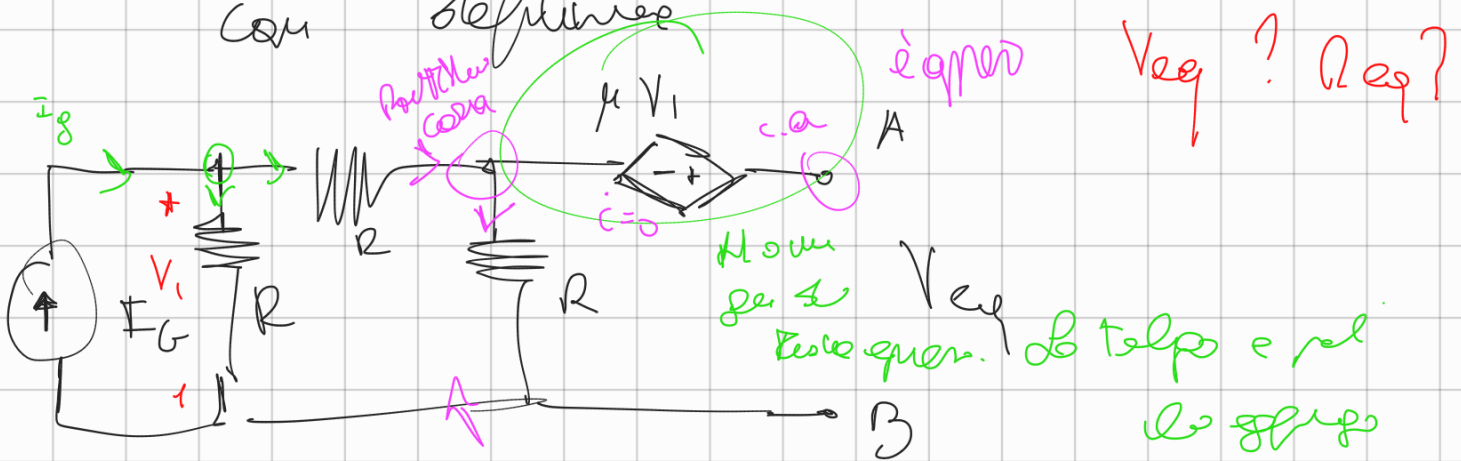


$$R_{eq} = 3$$

$$I_{eq} = \frac{V_{eq}}{R_{eq}} = 5A$$

Esercizio Thevenin Monta AB

con riferimento



Dato trovare V_1

$$V_1 = R \cdot \frac{2I_g}{3}$$

$$\frac{I_g \cdot R}{\frac{3}{2}} =$$

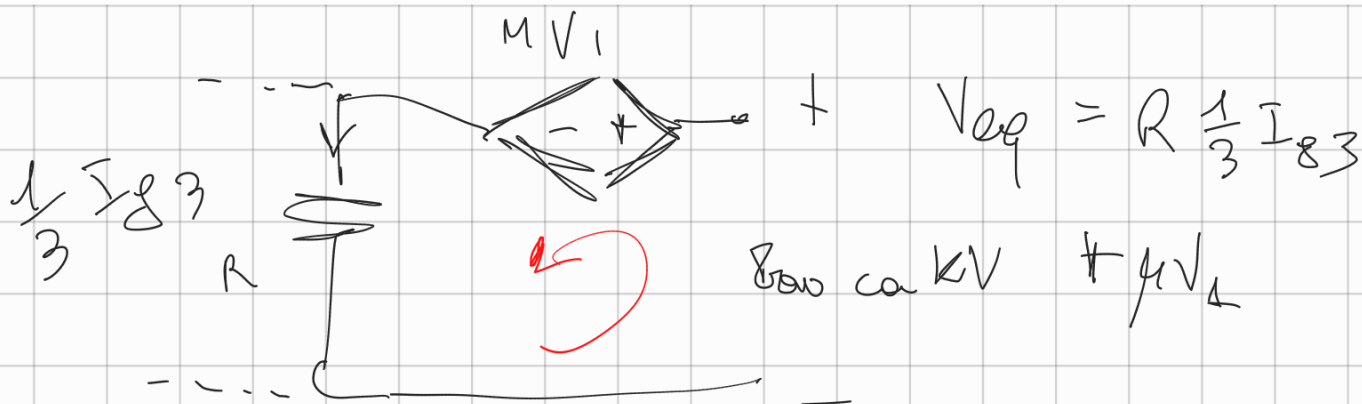
Rapporto
convertito
nel valore
più piccolo

$$V_{eq} = V_1 + \mu V_1$$

$$V_1 = R \cdot \frac{2I_g}{3}$$

ora da ho il valore



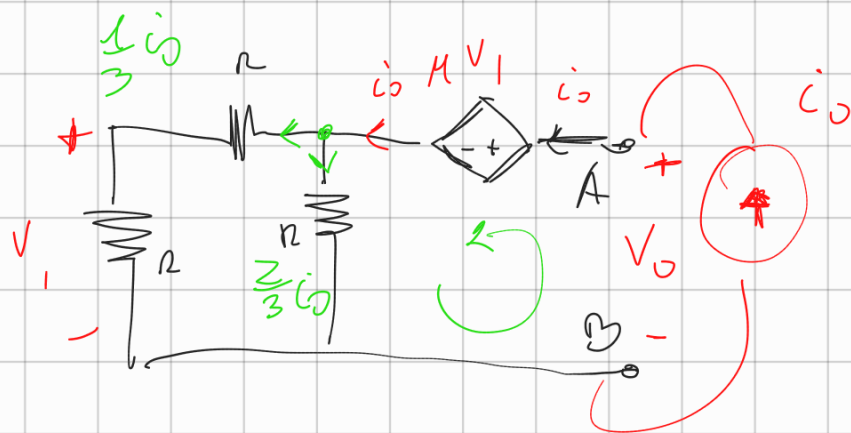


Per R_{eq} .

$$R \frac{1}{3} I_{s3} + \mu R \frac{2}{3} I_{s3}$$

Spiega per indip. e dimando perché - gr. calcoli

$$R_{eq} = \frac{V_0}{i_0}$$



Portat. correto

$$V_1 = \frac{1}{3} i_0 R$$

$$R_{eq} = \frac{1}{3} \mu R + \frac{2}{3} R$$

$$V_0 = \frac{1}{3} \mu R i_0 + \frac{2}{3} R i_0$$

$$i_{eq} - i_{cc} = \frac{V_{eq}}{R_{eq}} =$$

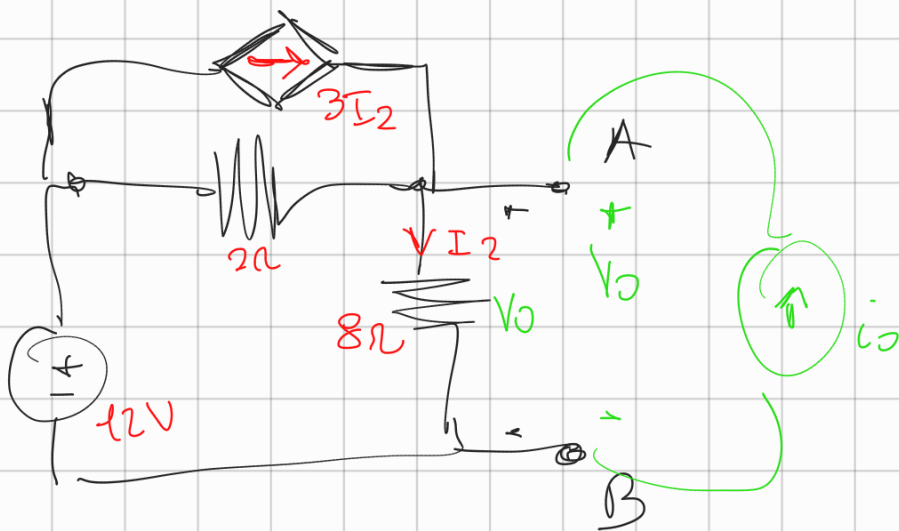
$$\frac{\frac{2}{3} \mu R I_{s3} + \frac{1}{3} R I_{s3}}{\frac{2}{3} R + \frac{1}{3} \mu R}$$

$$I_{s3} \frac{1 + \mu}{2 + \mu}$$

? Thevenin Norton AB

Metodo Loop

$$V_o = V_{eq} + R_{eq} i_o$$



Mi fingo di conoscere V_o

$$I_2 = \frac{V_o}{8} \text{ A}$$

$$i = i_o - \frac{V_o}{8} \text{ con KCL}$$

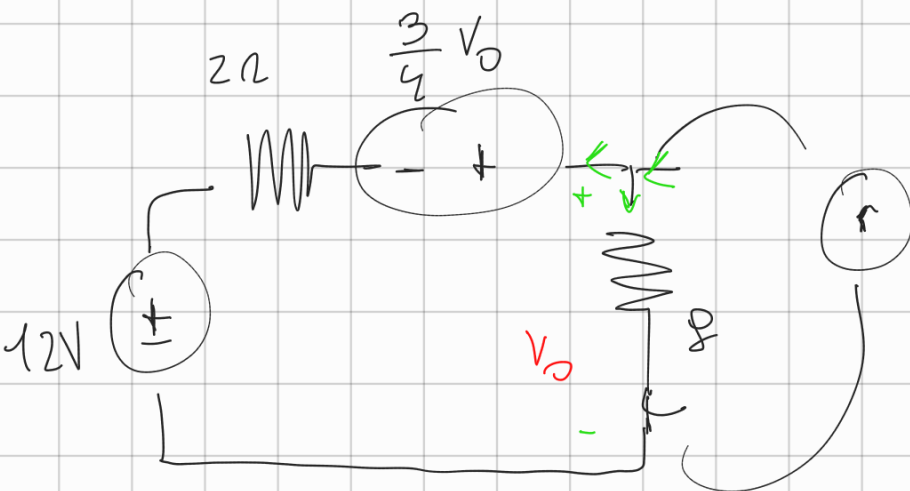
$$V_o = 12V + 2\left(i_o - \frac{V_o}{8}\right) + \frac{3}{4}V_o$$

$$= 12 + 2i_o - \frac{V_o}{4} + \frac{3}{4}V_o$$

$$V_o = 12 + 2i_o + \frac{2}{4}V_o$$

$$\frac{2}{4}V_o = 12 + 2i_o$$

$$= 24 + 4i_o$$



Alleanza

$$V_o = \frac{6 + \frac{3}{8}V_o + i_o}{\frac{1}{2} + \frac{1}{8}} = \frac{48 + 3V_o + 8i_o}{5}$$

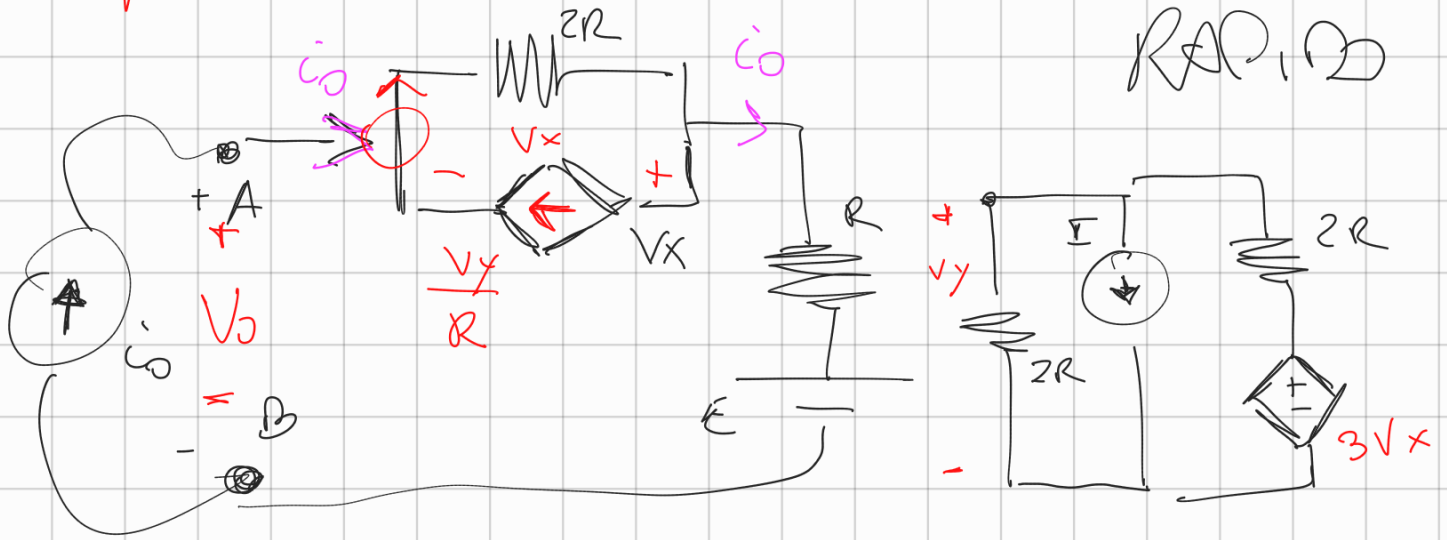
$$\frac{48}{5} + \frac{8i_o}{5} = \frac{2}{5}V_o$$

$\Rightarrow$

$$V_o = 24V + 4i_o$$

$$i_{cc} = 6A$$

Esempio ? Thevenin (Norton) AB V_{oc} R_{AB}



Bravo V_y con millen - mi figuro di cosa se V_x

$$V_y = \frac{-I + \frac{3V_x}{2R}}{\frac{1}{2R} + \frac{1}{2R}} = -RI + \frac{3V_x}{2} = V_y$$

$$\text{da KI: } -\frac{V_x}{R} - i_0 - \frac{V_x}{2R} = 0$$

$$= I - \frac{3}{2R} V_x - i_0 - \frac{V_x}{2R} = 0$$

$$\frac{4}{2R} V_x = I - i_0$$

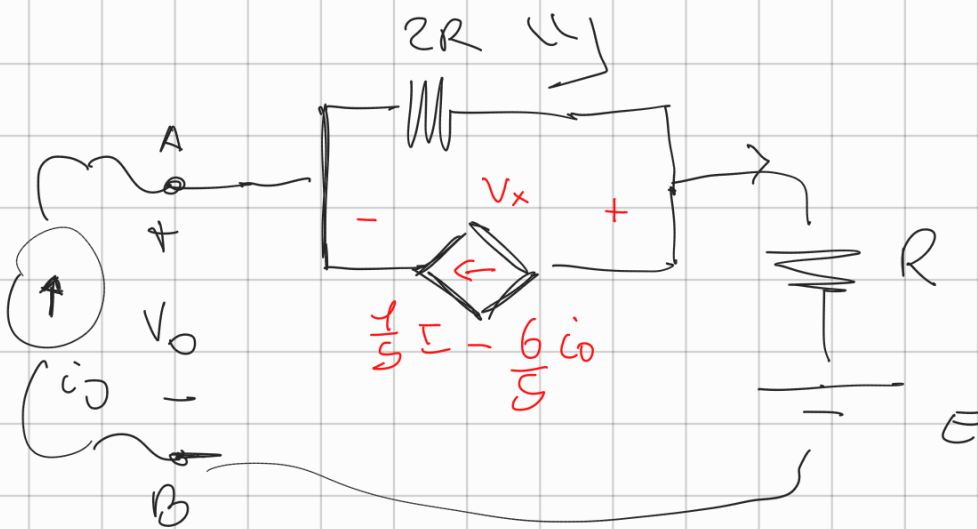
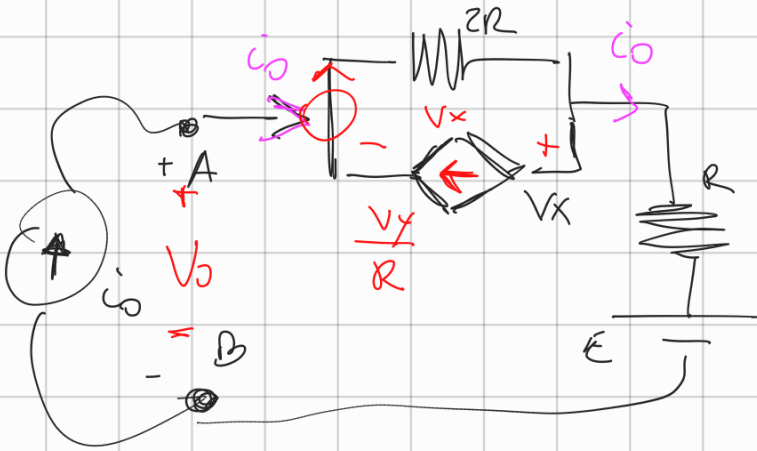
$$V_x = \frac{2RI}{5} - \frac{2Ri_0}{5}$$

$$V_x = R \frac{I}{2} - R \frac{i_0}{2}$$

$$V_y = -RI + \frac{3}{2} \left(R \frac{I}{2} - R \frac{i_0}{2} \right)$$

$$\bullet V_y = -RI + \frac{3}{4} RI - \frac{3}{4} Ri_0$$

$$V_y = -\frac{1}{4} I - \frac{3}{4} Ri_0$$

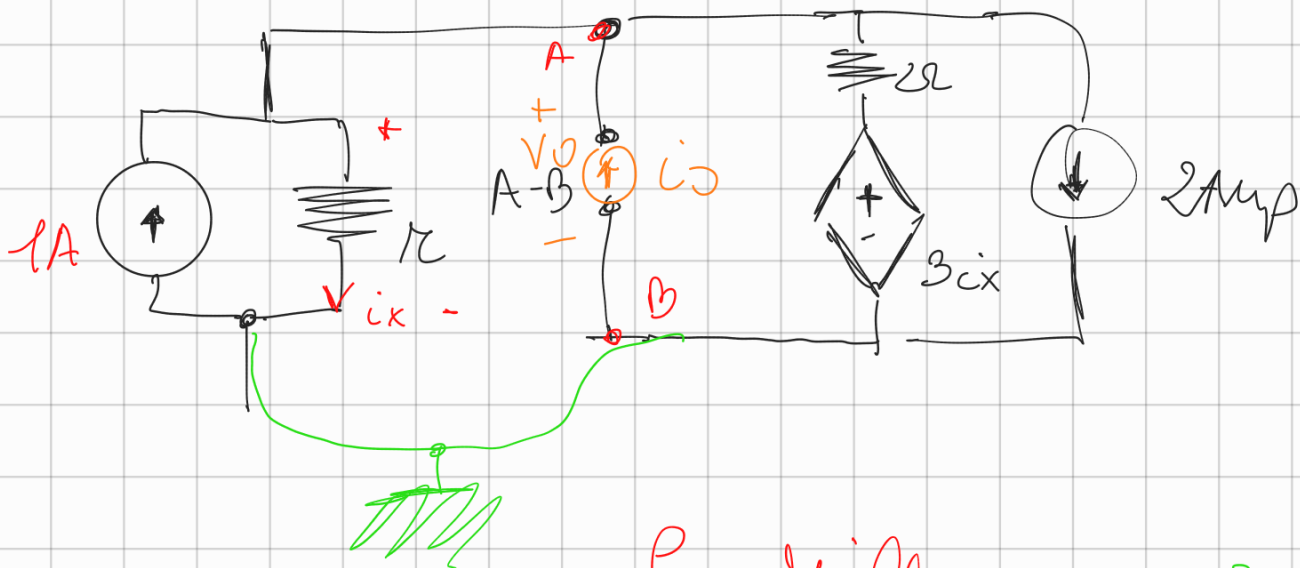


über kl $V_0 = -V_x + Ri_0 + E$

$$V_0 = -\frac{2}{5} R \frac{I}{2} + \frac{2}{5} R \frac{i_0}{2} + Ri_0 + E$$

$$= -\frac{2}{5} R \frac{I}{2} + \frac{3}{5} R \frac{i_0}{2} + E$$

Determine Equiv. Thresin A-B $\pi \in R$



Per Millman $g = \frac{1}{R}$

$$V_o =$$

$$\frac{-2 + \frac{3i_x + i_o}{2}}{\frac{2g}{2} + \frac{1}{2}} = \frac{-1 + \frac{3}{2}i_x + i_o}{\frac{2g+1}{2}}$$

$$V_o = \frac{-2 + 3i_x + 2i_o}{2g+1}$$

$$i_x = V_o \cdot g = \frac{-2g + 3i_x g + 2i_o}{2g+1}$$

$$(2g+1)i_x - 3i_x g = -2g + 2i_o$$

$$i_x(1-g) = -2g + 2i_o$$

$$i_x = \frac{-2g + 2i_o}{1-g}$$

$$V_0 = \frac{-2 + 3V_0g + 2i_0}{2g+1}$$

$$(2g+1)V_0 = -2 + 3V_0g + 2i_0$$

$$(-g+1)V_0 = -2 + 2i_0$$

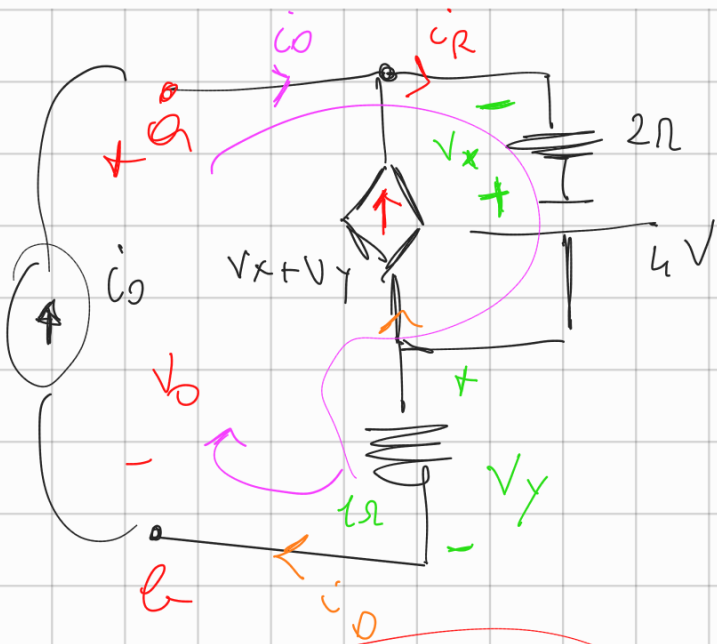
$$V_0 = \frac{1}{g+1} + \frac{2}{-g+1} i_0$$

$$g = 1$$

$$i_0 = 1$$

posso dire il
 circuito i_0 , mi dico
 che $i_0 = 1A$
 ~~~~~ No

equivalente a trovare il polo e l'angolo di fase



$$V_x = -i_R \cdot 2$$

$$V_y = i_0 \cdot 1 \Omega$$

$$V_0 = -V_x - 4V + V_y = 0$$

$$i_R = i_0 - 2i_2 + i_0$$

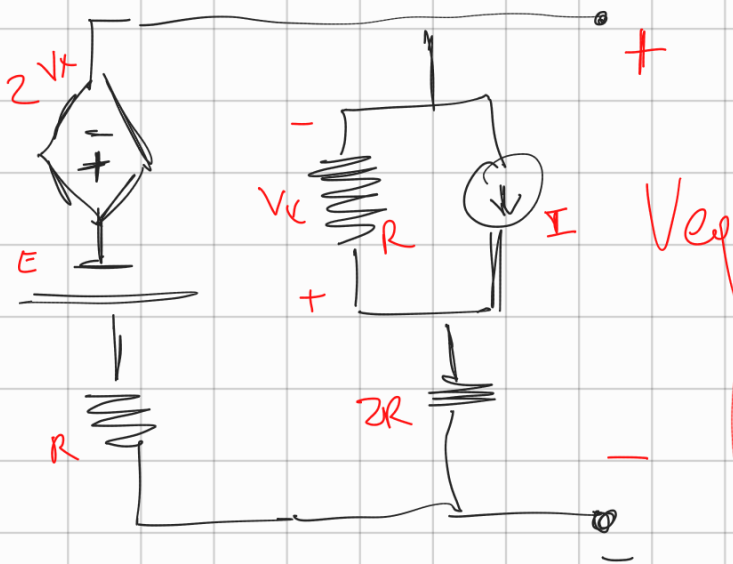
$$i_R = \frac{2}{3} i_0$$

$$V_x = -\frac{4}{3} i_0$$

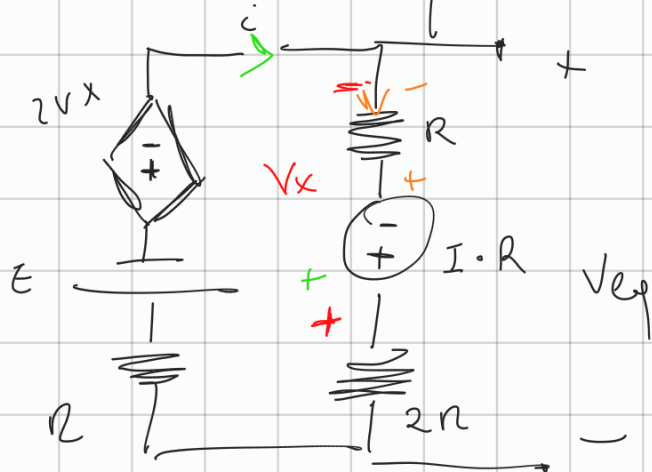
$$V_y = i_0$$

$$V_0 = +\frac{4}{3} i_0 - 4 + i_0$$

$$V_0 = \underbrace{\frac{7}{3} i_0}_{R_{eq}} - \underbrace{4}_{V_{eq}}$$



Determine  $V_{eq}$



$$V_x = IR - Ri$$

$$V_{eq} = Ri - RI + 2i$$

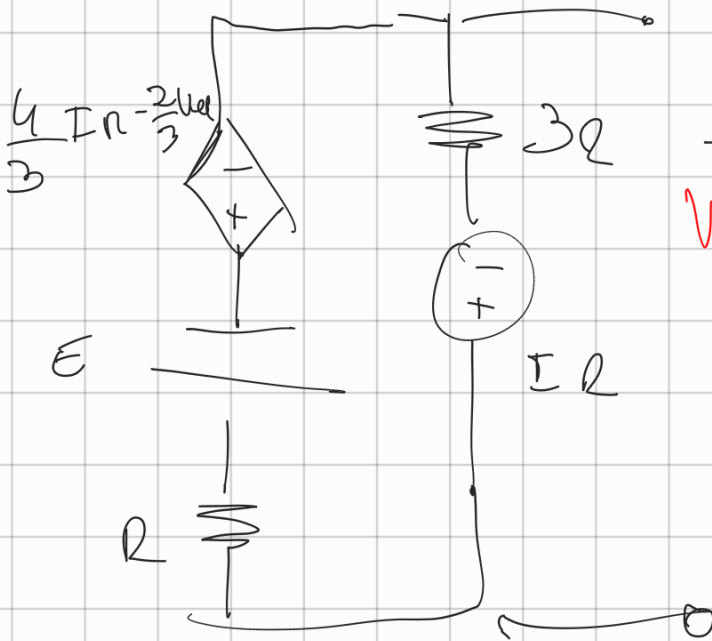
$$= 3Ri - RI$$

$$i = \frac{V_{eq} + RI}{3R}$$

$$V_x = IR - \frac{V_{eq} - RI}{3}$$

$$V_x = \frac{2}{3} IR - \frac{V_{eq}}{3}$$

ho trovato  
 $V_x$ , ma  
 devo  $V_{eq}$



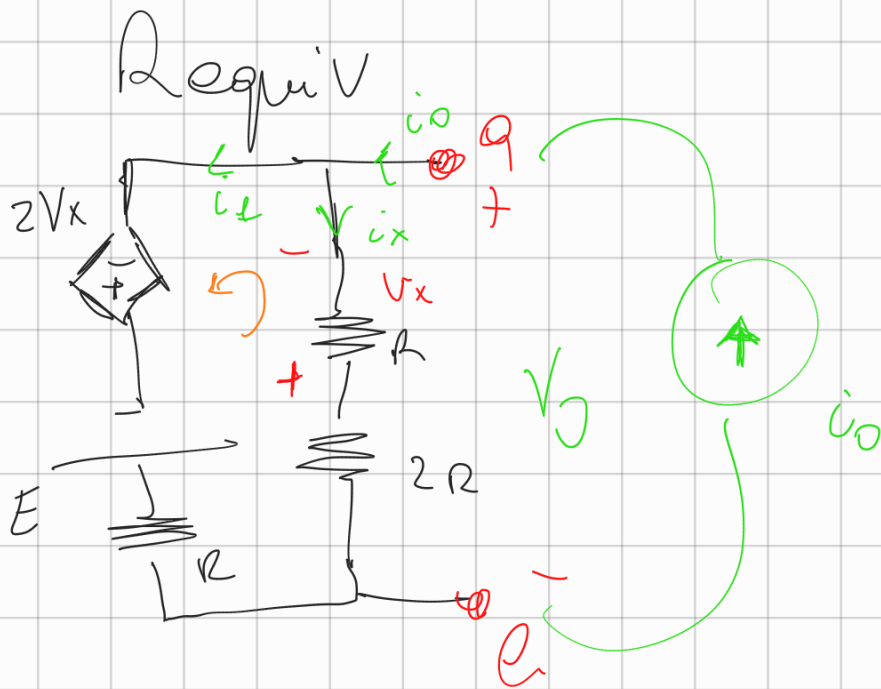
$$V_{eq} = \frac{-\frac{4}{3}IR + \frac{2}{3}V_{eq} - E - \frac{IR}{3R}}{\frac{1}{R} + \frac{1}{3R}}$$

$$= \frac{-\frac{4}{3}I + \frac{2}{3}\frac{V_{eq}}{R} - \frac{E}{R} - \frac{I}{3}}{\frac{4}{3R}} = 4IR + 2V_{eq} - 3E - IR$$

$$\bullet V_{eq} = -IR + \frac{1}{2}V_{eq} - \frac{3}{4}E - \frac{1}{4}IR$$

$$\frac{1}{2}V_{eq} = -\frac{5}{4}IR - \frac{3}{4}E$$

$$\Rightarrow V_{eq} = -\frac{5}{2} IR - \frac{3}{2} E$$



$$V_x = -i_x R \quad i_x = i_0 - i_1$$

$$V_x = (-i_0 + i_1) R$$

$$V_0 = -V_x + 2R i_x$$

$$-2V_x - E + R i_1 + 2R i_1 + R i_1 = 0$$

$$-2(-i_0 + i_1)R - E + 4R i_1$$

$$2i_0 R - 2i_1 R - E + 4R i_1 = 0$$

$$i_0 = -i_1 - \frac{E}{2} R$$

$$i_1 = -i_0 - \frac{\bar{E}}{2R}$$

$$i_x = i_0 + i_0 + \frac{\bar{E}}{2R}$$

$$i_x = 2i_0 + \frac{\bar{E}}{2R}$$

$$V_x = -2i_0 R - \frac{\bar{E}}{2}$$

$$V_0 = 2i_0 R + \frac{\bar{E}}{2} + 2Ri_0 + \bar{E}$$

$$V_0 = \underbrace{4Ri_0}_{\text{Rep}} + \underbrace{\frac{3\bar{E}}{2}}_{\text{Veg}}$$

No. -

Nullwert. -

$$V_0 = \frac{i_0 - 2 \frac{V_x}{R}}{\frac{1}{R} + \frac{1}{3R}} = \frac{i_0 - 2 \frac{V_x}{R}}{\frac{4}{3R}}$$

$$= \frac{3Ri_0 - 6V_x}{4} = \frac{3}{4} Ri_0 - \frac{3}{2} V_x$$

$V_0 =$

Lo trovato con un partitore di Tensione

$$V_X = \frac{-V_0 \cdot R}{3R}$$

segue part...

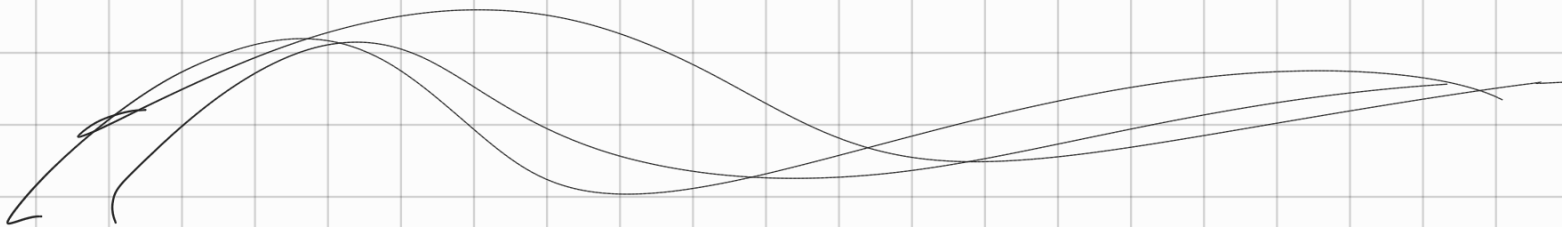
$$V_X = -\frac{V_0}{3}$$

$$V_0 = \frac{3}{4} R i_0 - \frac{3}{2} \left( -\frac{V_0}{3} \right)$$

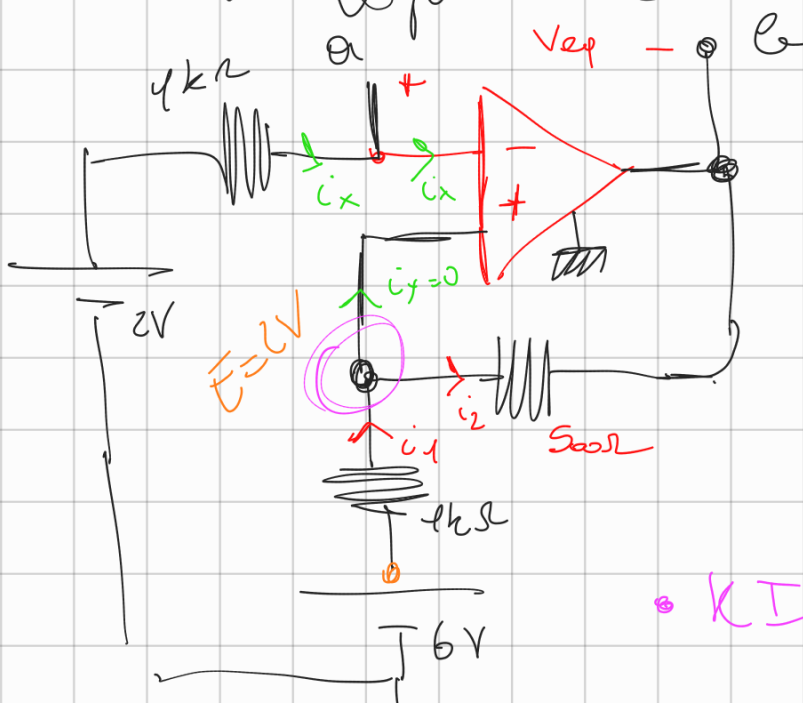
$$V_0 - \frac{V_0}{2} = \frac{3}{4} R i_0$$

$$\underline{V_0} = \frac{3}{2} R i_0$$

$$R_{eq} = \frac{V_0}{i_0} = \frac{3}{2} R$$



Theremin bridge al



Regime per Modi

$$V_{eq} = V_a - V_b$$

$i_X = 0$ , non passa corrente nel ramo

$$V_a = 2V$$

$$i_X = 0$$

• KI al nodo

$$i_1 = i_2$$

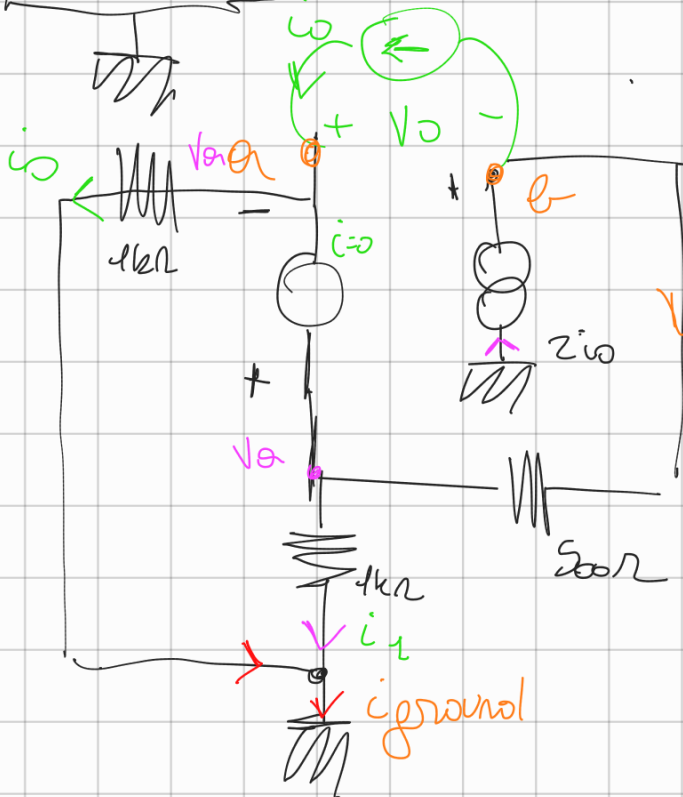
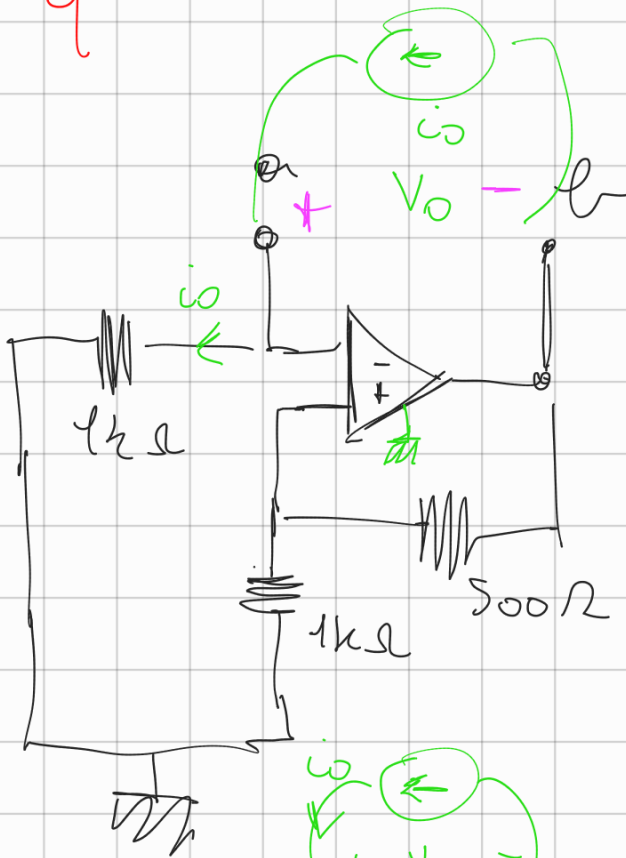
$$i_1 = i_2 = \frac{6 - 2}{1000} = 4 \cdot 10^{-3}$$

$$2 - V_o = 4 \cdot 10^{-3} \cdot 500 \Omega = 2$$

$$V_o = -4 \text{ V}$$

$$V_{eq} = 2 \text{ V}$$

$R_{eq}$



$$V_a = 1000 i_o$$

$$i_1 = \frac{V_a - 0}{1k\Omega} = i_o$$

$$i_o \cdot i_1 = i_o$$

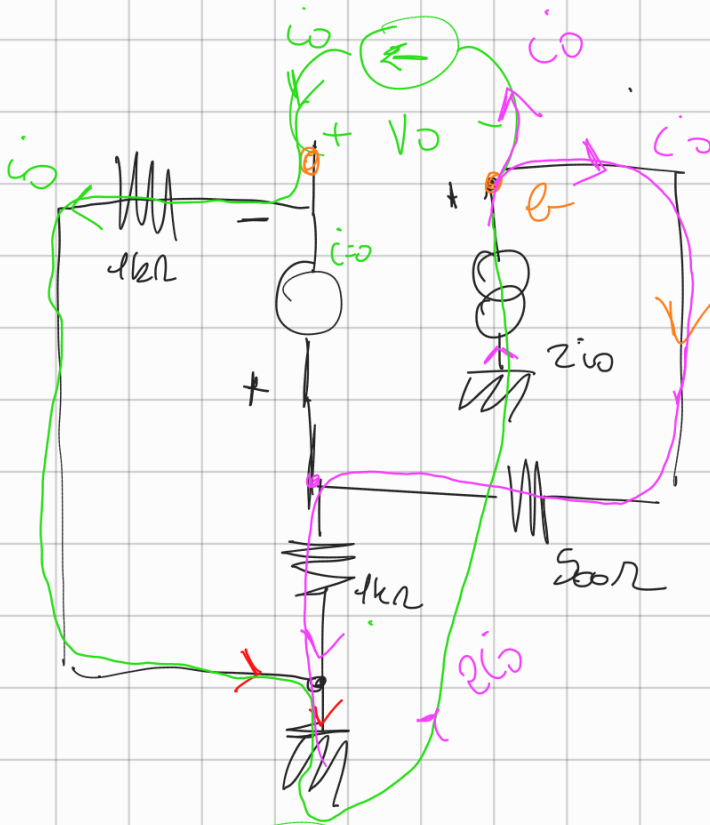
$$i_{ground} = i_1 + i_o = 2 i_o$$

$$V_o - V_a = i_1 \cdot 500$$

$$V_e = 1500 i_o$$

$$V_a - V_e = 1000 i_o - 1500 i_o = -500 i_o$$

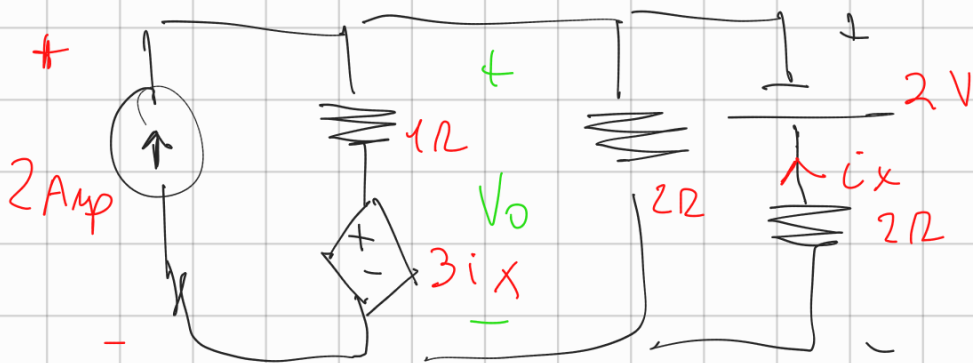
$$R_{eq} = -500 = \frac{V_o}{i_o}$$



FIGO

Verificone Tellegen





Proof ca Millman in fig 4 consider  $i_x$

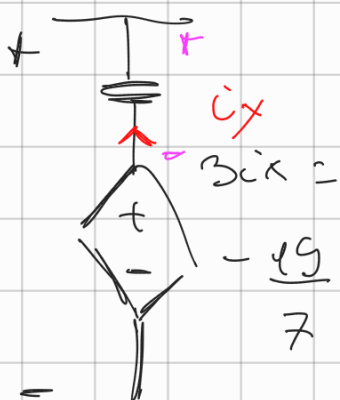
$$V_o = \frac{2 + 3i_x - 1}{1 + \frac{1}{2} + \frac{1}{2}} = \frac{1 + 3i_x}{2} = V_o$$

$$V_o = -2V - 2i_x$$

$$\frac{1}{2} + \frac{3i_x}{2} + 2 + 2i_x = 0$$

$$\frac{5}{2} + \frac{7}{2}i_x = 0 \quad \left\{ \quad i_x = -\frac{5}{7} A \right.$$

$$V_o = -2 + \frac{10}{7} = -\frac{4}{7} V$$



conv general  
 $V_o = -(i_y - 1) + 3i_x$

$$V_o = -\frac{15}{7} - i_x$$

$$i_y = -V_o + V_R \Rightarrow i_x = 3i_x - V_o$$

$$i_y = + \frac{4}{7} - \frac{15}{7} = - \frac{11}{7} \text{ A}$$



$$P_{\text{gen source}} = 2 \cdot V_0 = \frac{-8}{7} \text{ W erogen.}$$

$$P_{\text{gen source}} = \frac{-15}{7} \cdot -\frac{11}{7} = \frac{165}{49} \text{ W erogen.}$$

$$P_{\text{gen source}} = -2 \cdot i_x = \frac{10}{7} \text{ W erogen.} \quad \approx 1,42$$

$$P_{\text{overl. } R_1} = \frac{11}{7} \text{ A}^2 \cdot 1 = \frac{121}{49} \approx 2,45 \text{ W}$$

$$P_{\text{overl. } R_2} = \frac{V_0^2}{R} = \frac{816}{2 \cdot 49} \approx 8,16 \text{ W}$$

$$P_{\text{overl. } R_3} = i_x^2 \cdot 2 = \frac{25}{49} \cdot 2 \approx 1 \text{ W}$$

$$\text{Wongd. } \frac{178}{49} = \frac{178}{49} \text{ W overl. R.}$$

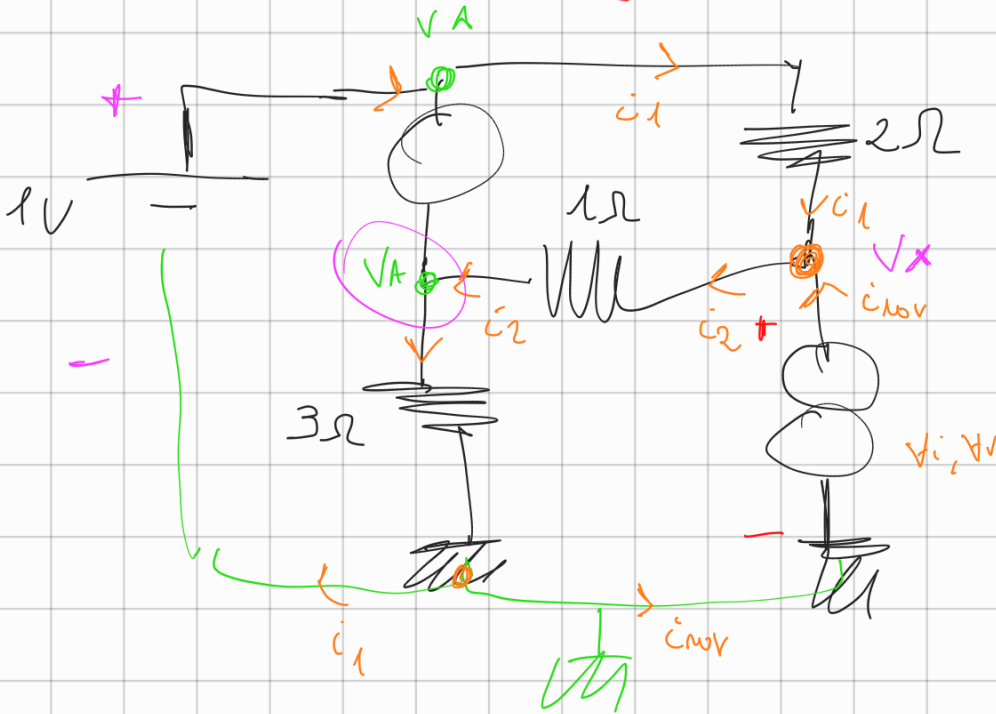


$$i_y = V_0 - 3i_x$$

$$V_0 = i_y + 3i_x$$

Verifica de KVL

$$V_A = 1V$$



da K1

$$\frac{V_A - 0}{3} = \frac{V_x - V_A}{1}$$

$$V_A = 1$$

$$\frac{1}{3} + 1 = V_x \Rightarrow V_x = \frac{4}{3}V$$

$$i_2 = \frac{1}{3}A$$

$$i_1 = \frac{V_A - V_x}{2} = \frac{1 - \frac{4}{3}}{2} = -\frac{1}{6}A$$

$$i_{nor} = i_2 - i_1 = \frac{1}{3} + \frac{1}{6} = \frac{3}{6} = \frac{1}{2}A$$

$$P_{\text{avg}} 1V = -\frac{1}{6} W$$

Si 8 Tar vica 120

$$P_{\text{res}} 2\Omega = \frac{1}{18} W$$

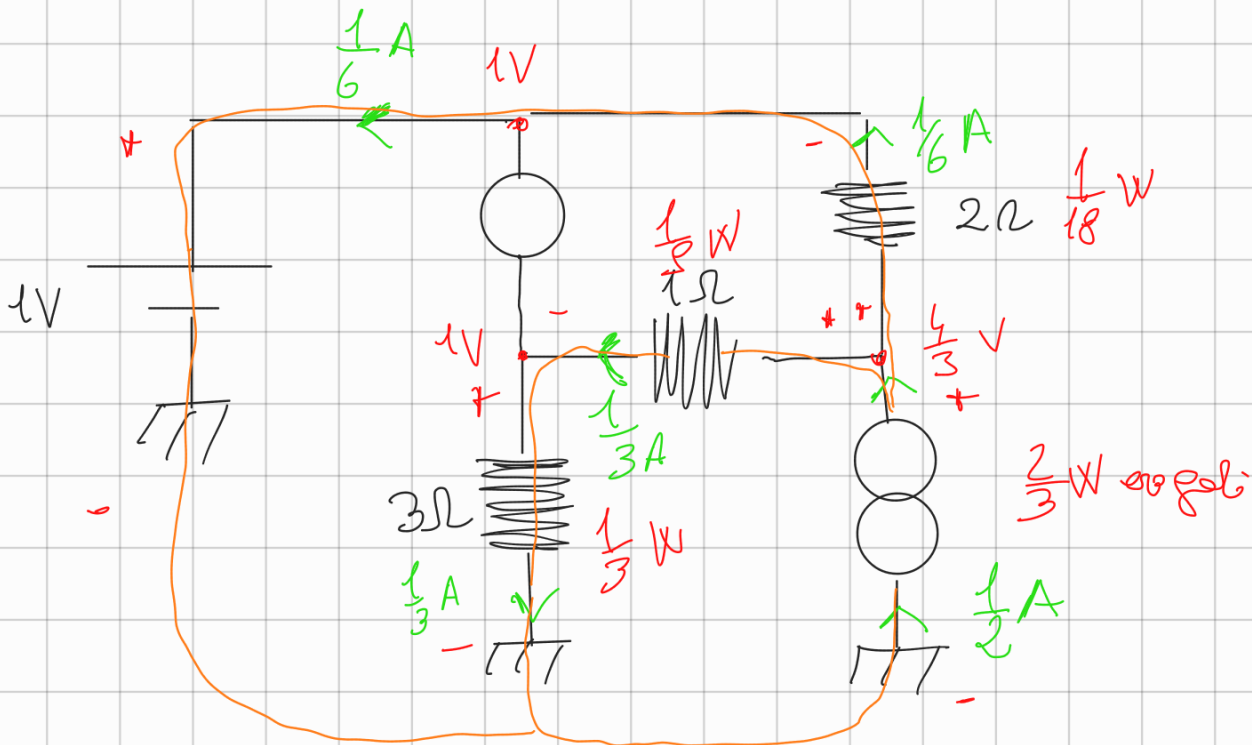
$$P_{\text{avg}} 10\Omega = \frac{4}{3} \cdot \frac{1}{2} = \frac{2}{3} W$$

$$P_{\text{res}} 1\Omega = \frac{1}{9} W$$

$$P_{\text{res}} 3\Omega = \frac{1}{3} W$$

$P_{\text{avg}} = P_{\text{available}}$

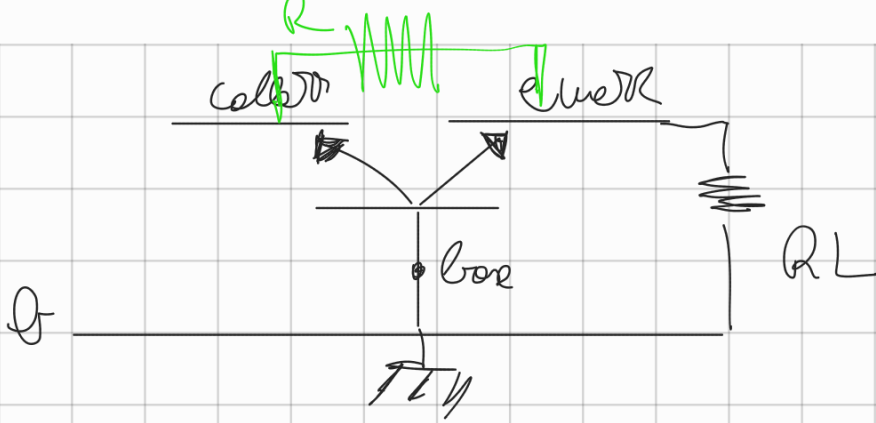
Verso reale concludo



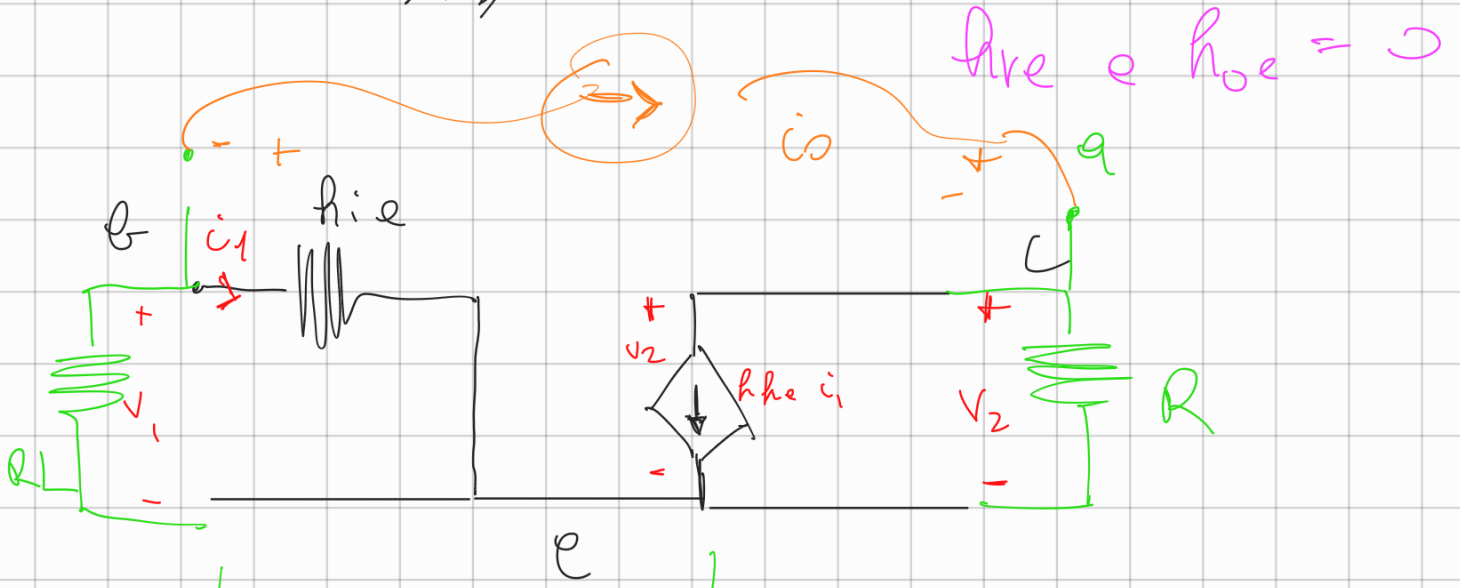
Req. Bypass ab usando modello a port.

In a conditione case con  $I_{\text{sc}} = 0 A$

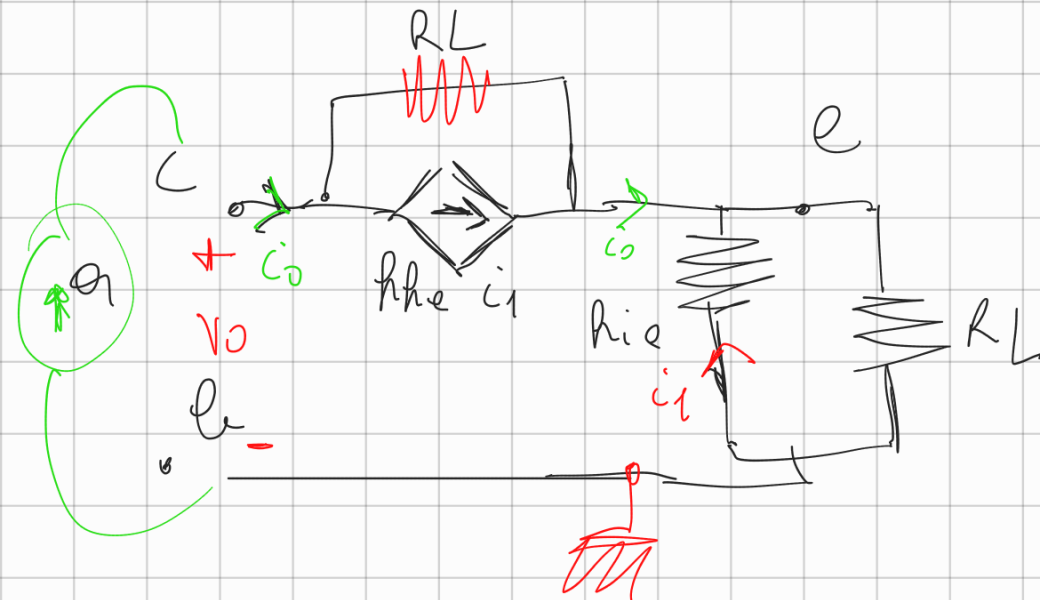
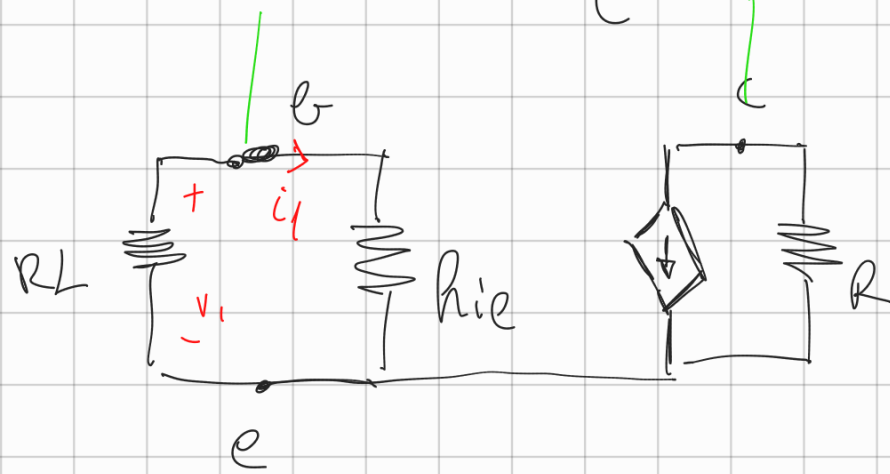
$$R_{\text{oe}} = 0 \Omega^{-1}$$



emitter e base  
collectoria  
 $R_L$



$h_{ie}$  e  $h_{oe} = \infty$



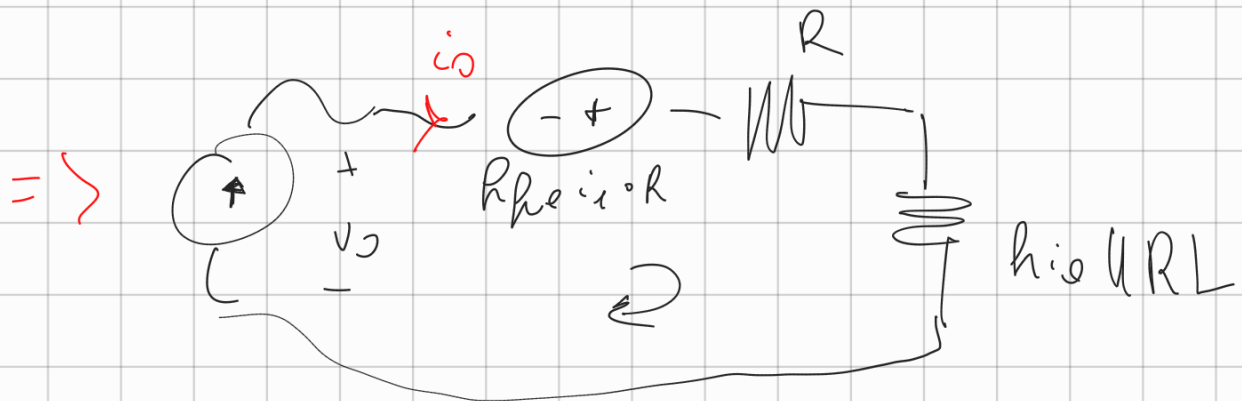
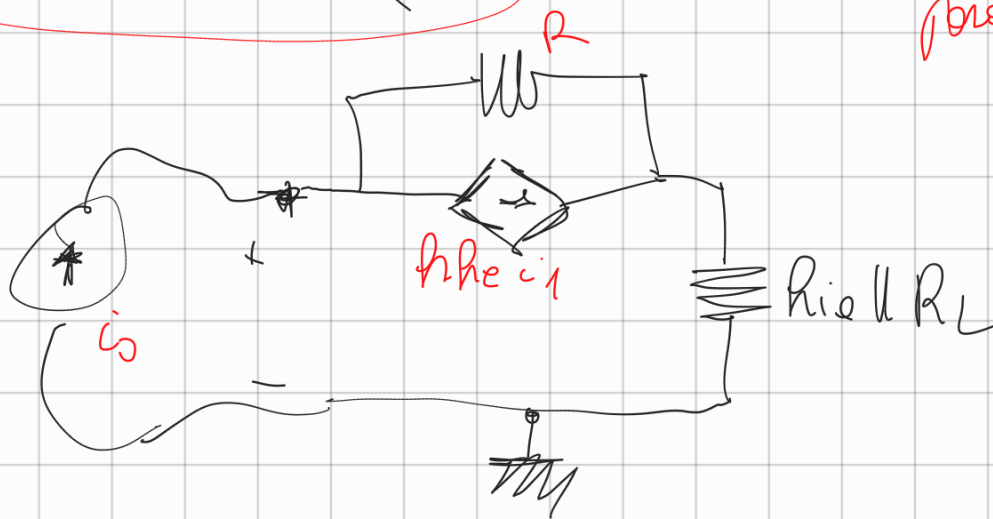
• Baso  $i_f$  con part. Pare corrisp

$$i_f = \underbrace{(-) i_o \cdot \frac{1}{h_{ie}}}_{\frac{1}{h_{ie}} + \frac{1}{R_L}} = \frac{i_o}{\frac{R_L + h_{ie}}{h_{ie} \cdot R_L}}$$

seguo opposto

$$i_f = \underbrace{(-) i_o \cdot R_L}_{R_L + h_{ie}}$$

po' questione controllo,  
processo di  
problema



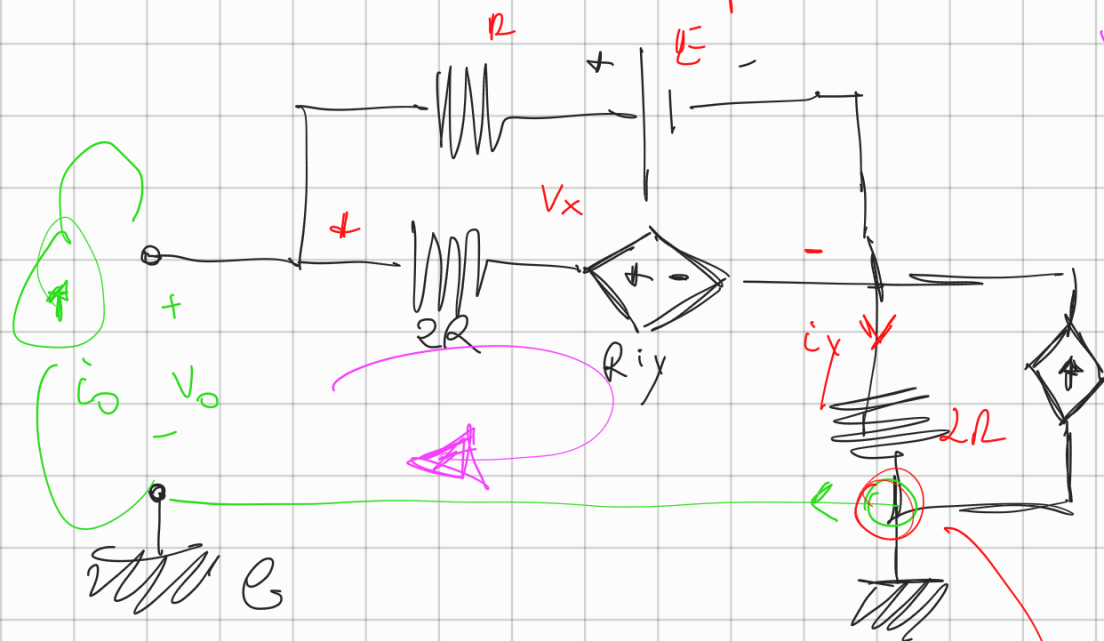
$$V_o = -h_{fe} i_f \cdot R + R i_o + i_o h_{ie} \parallel R_L$$

$$= \frac{h_{fe} R \cdot R_L}{R_L + h_{ie}} i_o + R i_o + i_o h_{ie} \parallel R_L$$

$$R_{eq} = \frac{V_o}{i_o} = \frac{h_{fe} R \cdot R_L}{R_L + h_{ie}} + R + h_{ie} \parallel R_L$$

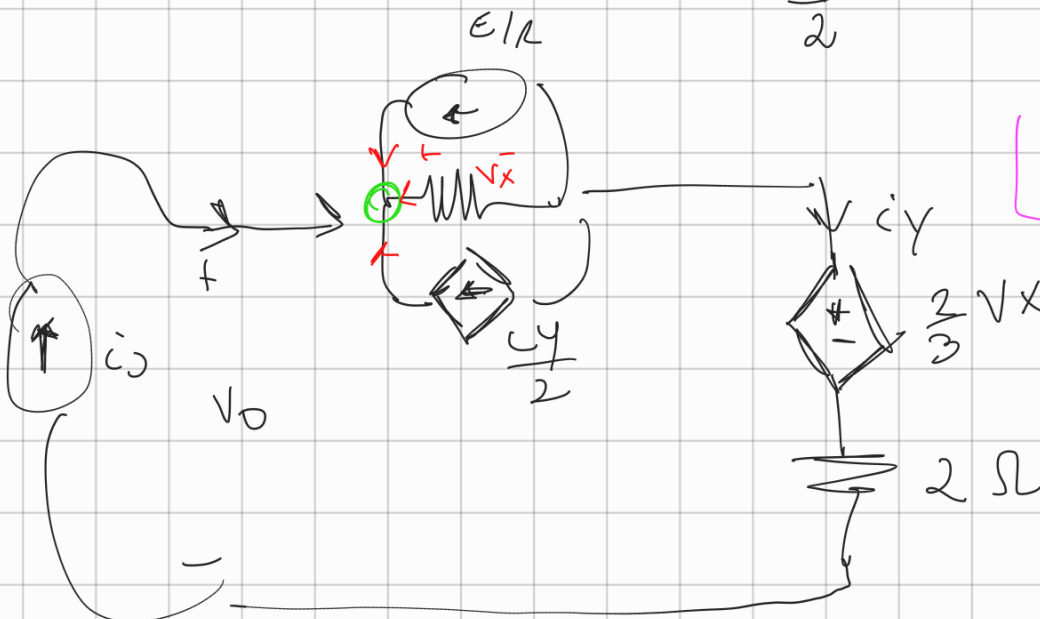
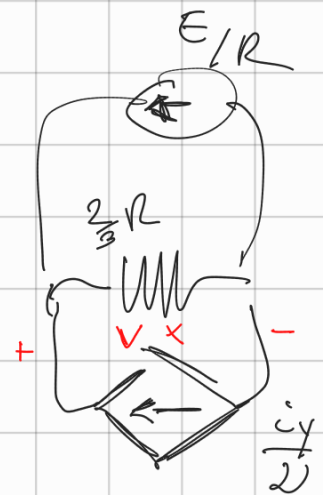
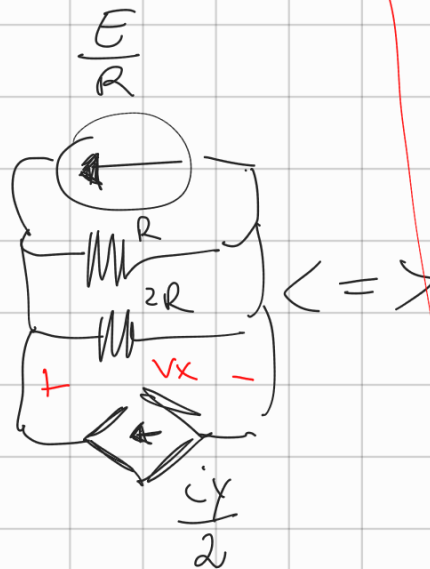
# Determinar Thevenin del Arreglo C con Metodo Rapido

$$V_o = V_{eq} + R_{eq} i_o$$



$$\frac{V_x}{3R}$$

→ Masano



$$i_o = i_y - \frac{V_x}{2R}$$

error pdf

$$\cancel{i_0} = - \frac{i_y}{2} - \frac{V_x}{\frac{2}{3}R} - E/R$$

da KV

$$V_0 = V_x + 2R i_y$$

$$i_0 = i_y - \frac{V_x}{\cancel{2}R}$$

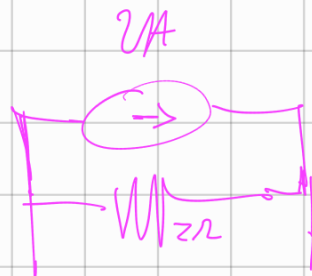
$$\Rightarrow i_y = i_0 + \frac{V_x}{\cancel{2}R}$$

$$\Rightarrow V_x = V_0 + 2R \left( i_0 + \frac{V_x}{\cancel{2}R} \right)$$

$$V_x = V_0 + 2R i_0 + \cancel{2} V_x$$

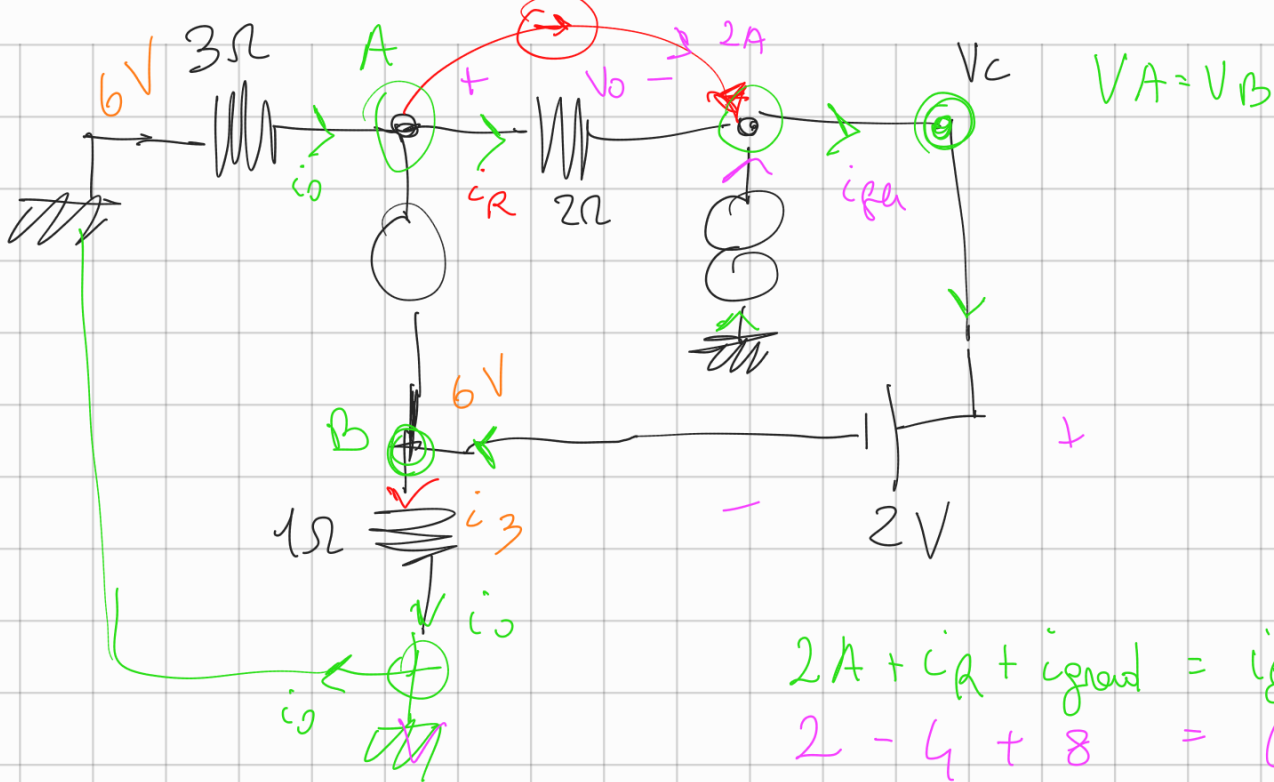
$$V_x = -V_0 - 2R i_0$$

Dotenwer Poten soll 0.0 e  
bei der ger. insip.



2A





$$2A + i_R + i_{grnd} = i_{grnd} = i_3$$

$$2 - 4 + 8 = 6A$$

$$-(V_C - V_B) = 2V$$

$$V_A = V_B$$

$$-V_A = 3 \cdot i_0 = -V_B$$

• KVL su A =>

$$i_0 = \overbrace{V_B - V_C}^{i_R} \cdot 2 + 2A$$

$$i_0 = -4 + 2 = -2A$$

$$i_R = -4A$$

$$-V_A = 3 \cdot -2A = 6V$$

$$V_A = V_B = 6V$$

$$i_3 = \frac{6 - 0}{1} = 6A$$

$$i_{grnd} - i_3 + i_0 = 0$$

$$i_{\text{gen}} = i_3 - i_0 = 8 \text{ A}$$

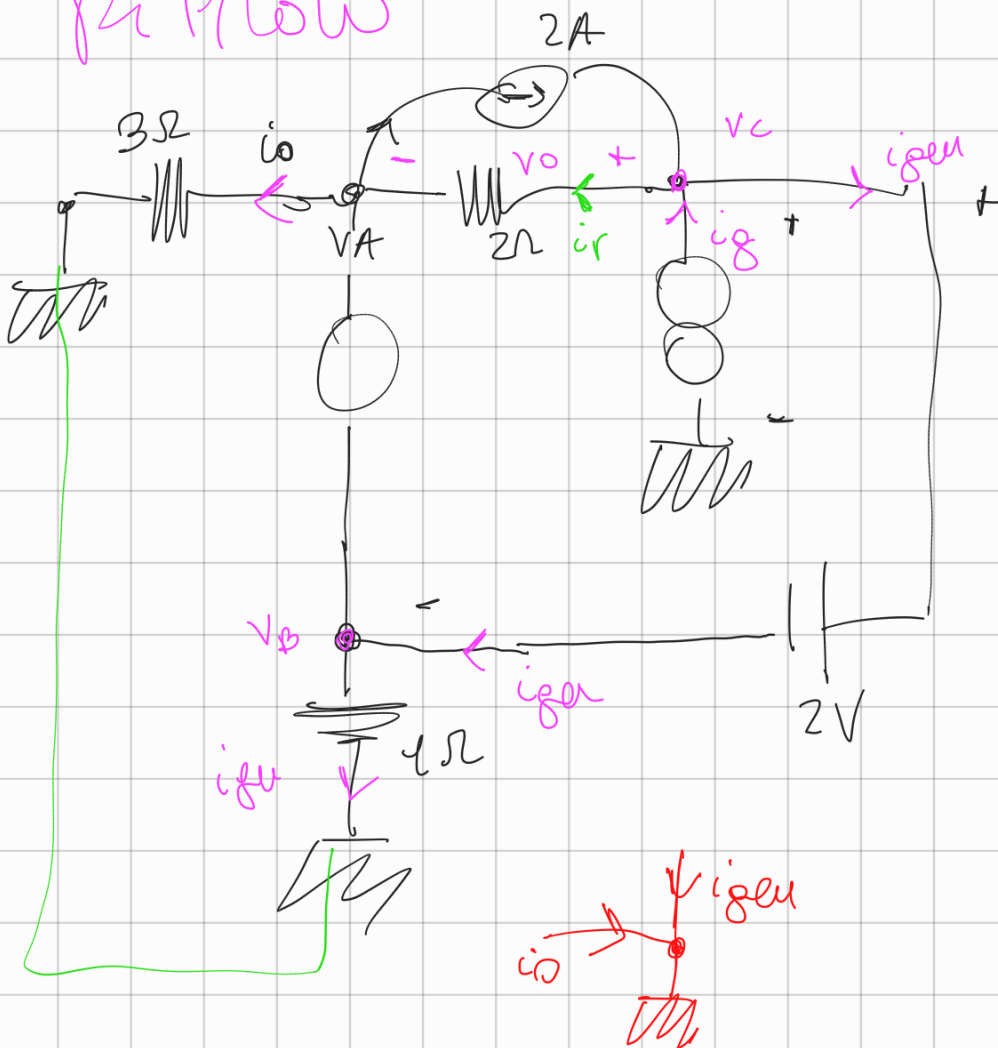
$$V_C = 2 \text{ V} + V_B = 8 \text{ V}$$

$$V_C - V_B = 2 \text{ V} \quad \checkmark$$

$$V_A = V_B = 6 \text{ V}$$

$$V_C = 8 \text{ V}$$

ph. Phow



$$V_C - V_B = 2 \text{ V}$$

$$V_A = 3 \cdot i_0 = V_B$$

$$V_C - V_A = V_C - V_B = 2\Omega \cdot i_r$$

$$i_r = \frac{2V}{2\Omega} = 1A$$

da ki su A

$$\Rightarrow V_A = 3 \cdot i_g = -3V$$

$$= V_B$$

$$\bullet i_o + 2A - i_r = 0$$

$$i_o = -2A + 1A = -1A$$

$$\bullet i_{gen} = \frac{V_B - 0}{1} = i_{gen} = -3A$$

$$\bullet i_{ground} = i_{gen} + i_o = -3 - 1 = -4A$$

$$V_C - V_B = 2\Omega \cdot i_r = 2V$$

$$V_C = 2V + V_B = 2V - 3V = -1V$$

$$V_C \cdot i_g = -1V \cdot -4A = 4W$$

$$P_{i_{gen}} = (V_C - V_B) \cdot 2A = 2 \cdot 2 = 4W$$

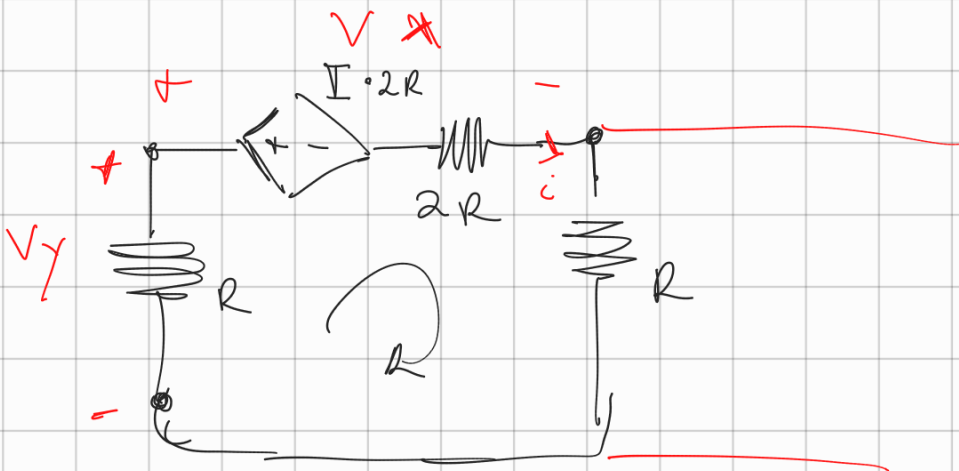
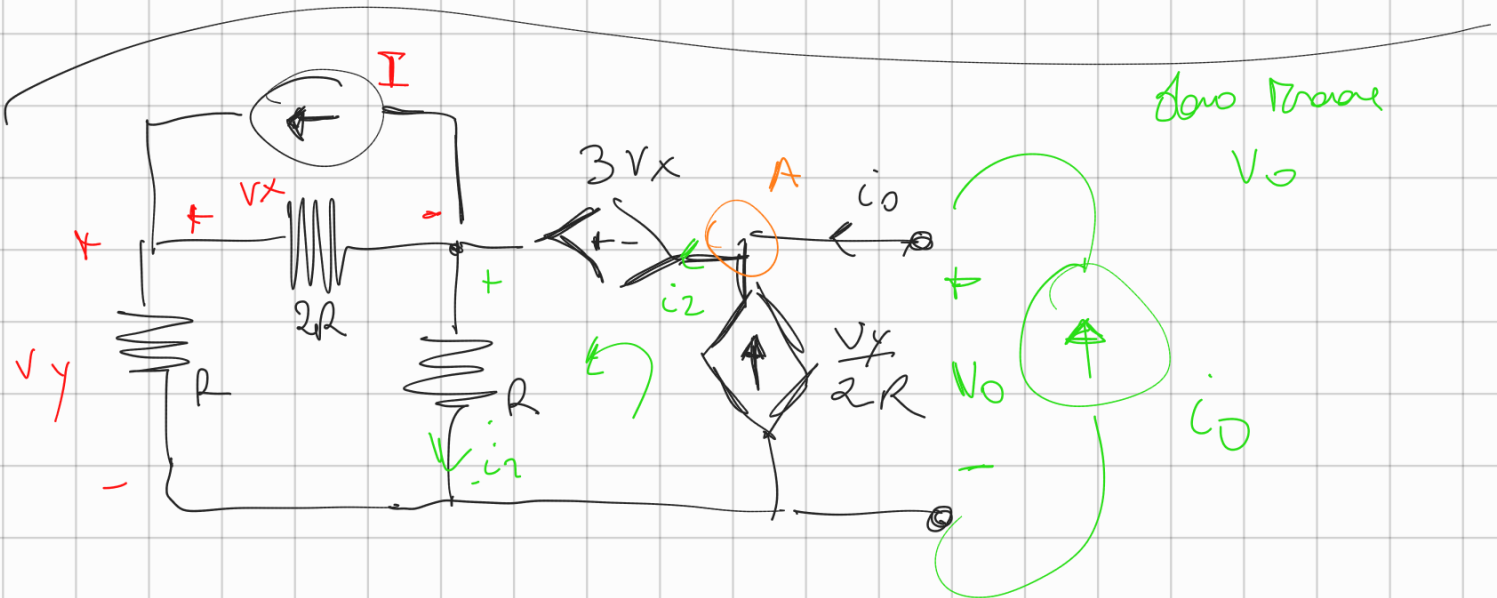
$$P_{gen V} = -(-3A \cdot 2) = 6W$$

$$P_{res. 3R} = 3W$$

$$P_{res. 2R} = 2W$$

$$P_{res. 4R} = 8W$$

Tellere Verific



$$\begin{cases} R i - V_y + V_x = 0 \\ V_x = I 2R + 2R i \end{cases}$$

$$\Rightarrow R i - V_y + 2R I + 2R i = 0$$

$$\begin{cases} 3Ri + 2RI = V_y \\ 2RI + 2Ri = V_x \end{cases}$$

$$\bullet V_y = -R \cdot i$$

• KV dla uglica 2

$$-3V_x - V_0 + Ri_2 = 0$$

da K1 dla uglica 2 so de

$$i_2 = i_0 + \frac{V_y}{2R}$$

$$V_0 = Ri_2 - 3V_x$$

$$V_0 = R\left(i_0 + \frac{V_y}{2R}\right) - 3V_x$$

$$V_0 = Ri_0 + \frac{1}{2}V_y - 3V_x$$

uso valor. constitutive

$$\begin{cases} 3Ri + 2RI = V_y \\ 2RI + 2Ri = V_x \end{cases}$$

$$\bullet V_y = -R \cdot i$$

$$3Ri + 2RI = -Ri \quad \text{uso rel. cond.}$$

$$\rightarrow 4Ri + 2RI = 0$$

$$4\cancel{R}i = -2\cancel{R}I$$

$$i = -\frac{1}{2}I$$

$$\bullet V_x = I2R + 2Ri$$

$$\rightarrow V_x = 2RI + 2R\left(-\frac{1}{2}I\right)$$

$$= 2RI - RI$$

$$V_x = RI \quad \checkmark$$

$$V_y = -R\left(-\frac{1}{2}I\right) = \frac{RI}{2} \quad \checkmark$$

da regola 2  $i_2 = i_0 + \frac{V_y}{2R}$

$$i_2 = i_0 + \frac{\frac{RI}{2}}{2R} = i_0 + \frac{I}{4} A$$

$$i_2 = i_0 + \frac{I}{4}$$

mi ricordo che

$$V_0 = R i_0 + \frac{1}{2} V_y - 3 V_x$$

$$V_0 = R i_0 + \frac{1}{2} \left( \frac{R}{2} I \right) - 3 (R I)$$

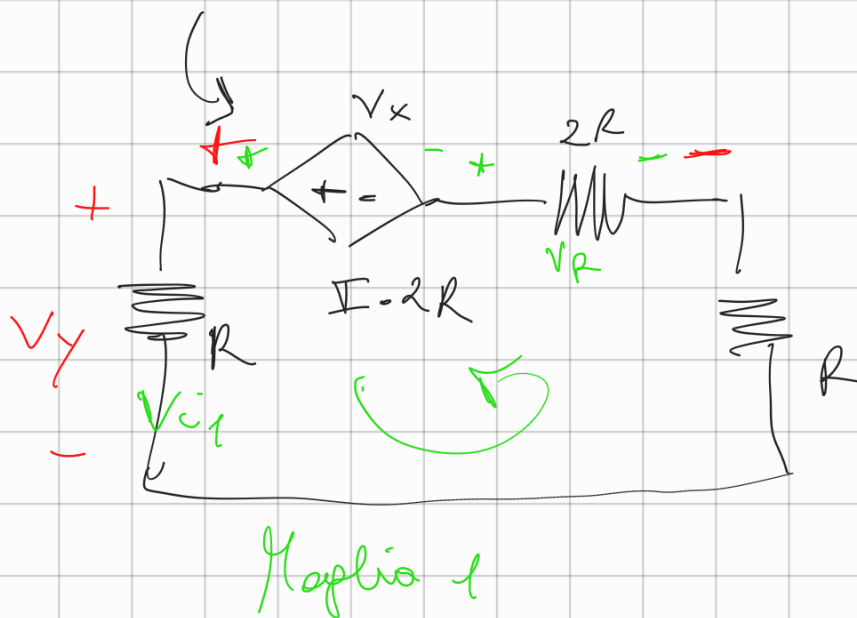
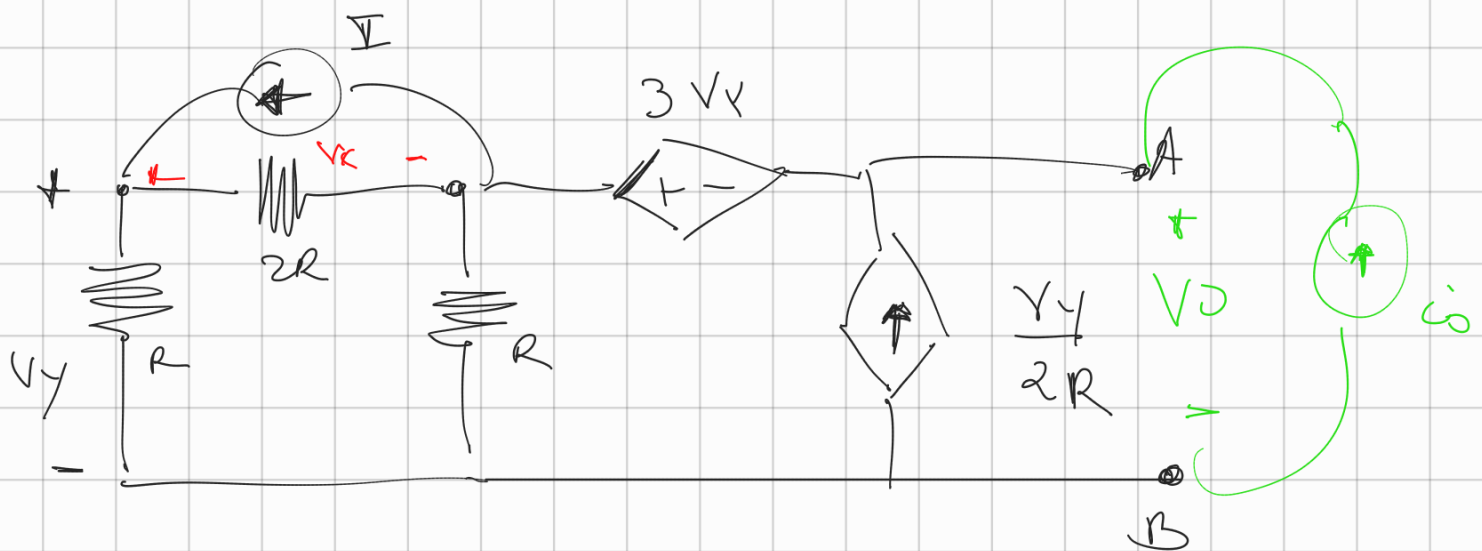
$$= R i_0 + \frac{R}{4} I - 3 R I$$

$$= R i_0 + \left( \frac{1}{4} - 3 \right) R I$$

$$V_0 = R i_0 - \frac{11}{4} R I$$

$\underbrace{\hspace{1cm}}_{\text{neg}}$ 
 $\underbrace{\hspace{1cm}}_{\text{neg}}$

RRRWWO



• introduco corrente  $i_1$  della Mappa 1

• da KVL  $\Rightarrow V_y + R i_1 - V_x = 0$

ho anche che  $V_y = R \cdot i_1$

e che  $V_x = 2RI - 2R i_1$

Allora la KI diventa

$$R \cdot i_1 + R i_1 + 2R i_1 + 2RI = 0$$

$$4R i_1 = -2RI \Rightarrow$$

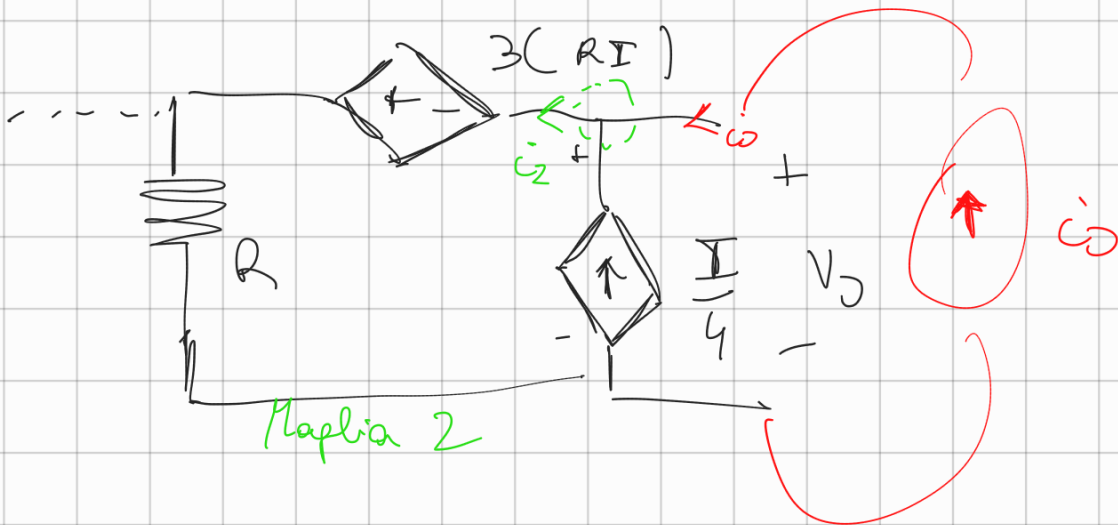


$$i_1 = \frac{I}{2}$$

$$V_y = \frac{R}{2} I$$

$$V_x = 2RI - RI = RI$$

il circuito segue



• introduco corrente  $i_2$  nella mappa 2

da KV

$$-3RI + Ri_2 - V_0 = 0$$

$$\Rightarrow V_0 = Ri_2 - 3RI \quad \checkmark$$

da KI

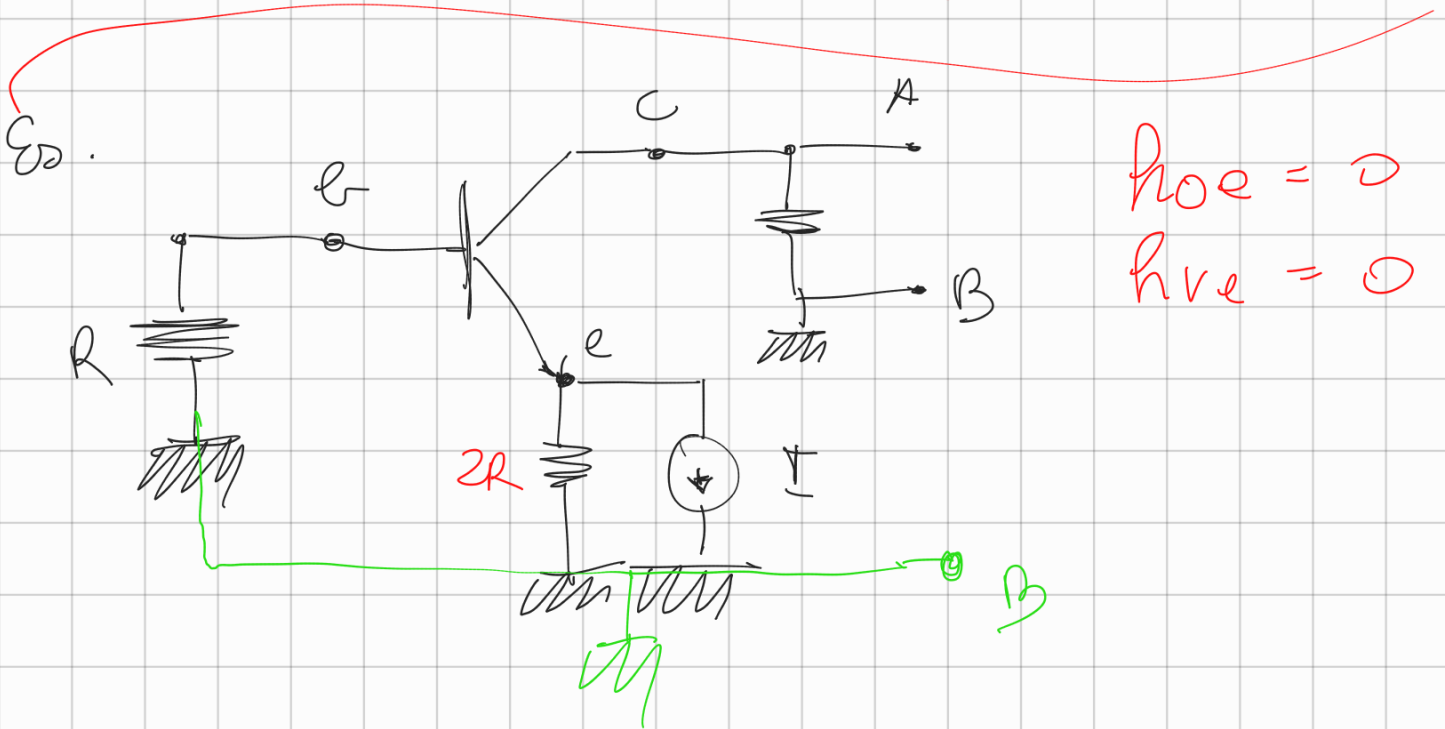
$$i_2 = i_0 + \frac{I}{4}$$

$$\Rightarrow V_o = R \left( i_o + \frac{I}{4} \right) - 3RI$$

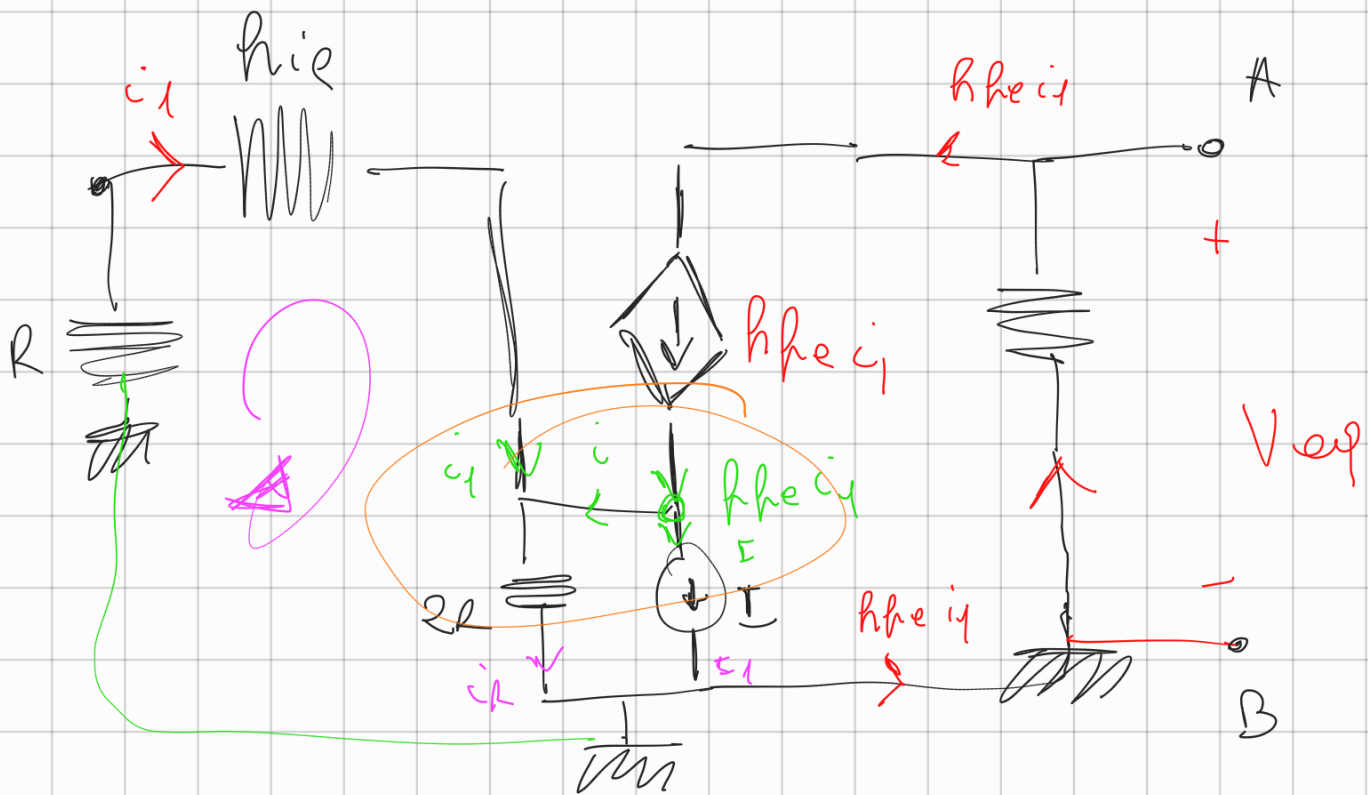
$$= Ri_o + \frac{RI}{4} - 3RI$$

$$= Ri_o + \left( \frac{1}{4} - 3 \right) RI$$

$$V_o = \underbrace{R}_{R_{eq}} i_o - \underbrace{\frac{11}{4} RI}_{V_{eq}}$$



uso Ca sbr



kelas. konfigurasi model simplifikasi

$$\begin{cases} V_1 = h_{ie} i_1 \\ i_2 = h_{fe} i_1 \end{cases}$$

$$\begin{cases} -h_{fe} i_1 + I + i = 0 \\ -i_1 - i + i_r = 0 \end{cases}$$

$$\begin{cases} i_r = i + i_1 \\ i = h_{fe} i_1 - I \end{cases}$$

$$\Rightarrow i_r = h_{fe} i_1 - I + i_1 = (h_{fe} + 1) i_1 - I$$

KI di Topin

$$i_1 + h_{fe} i_1 = I + i_r$$

KV a Mayla SK

$$i_e h_{ie} + 2R i_r + R i_1 = 0$$

$$(h_{ie} + R) i_1 + 2R i_r = 0$$

$$(h_{ie} + R) i_1 + 2R ((h_{fe} + 1) i_1 - I)$$

$$(h_{ie} + R + 2R h_{fe} + 2R) i_1 - 2R I = 0$$

$$i_1 = \frac{2R}{h_{ie} + R + 2R h_{fe} + 2R} I$$

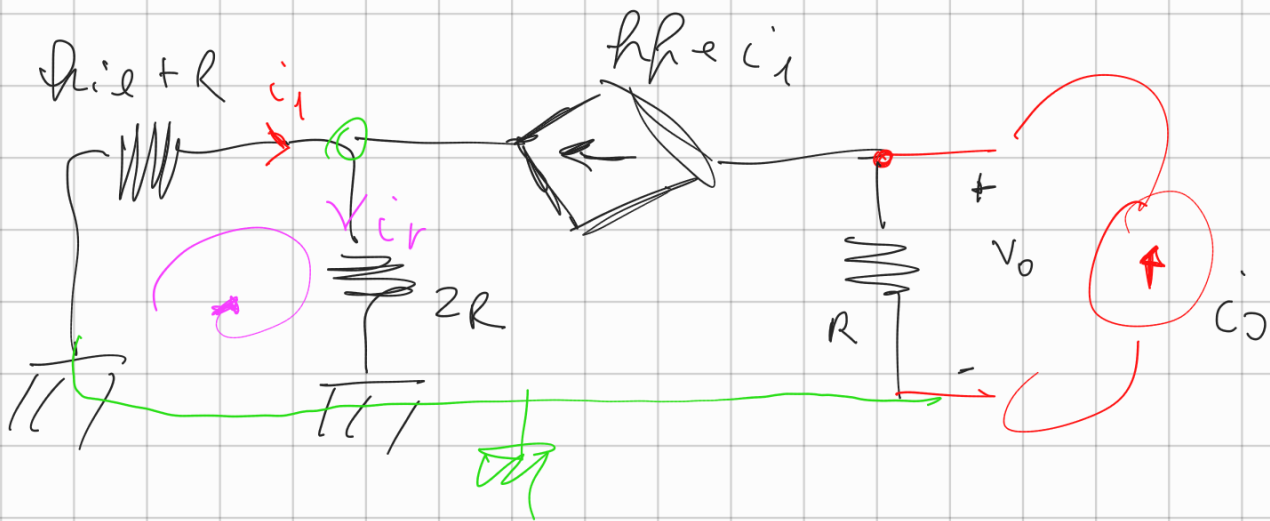
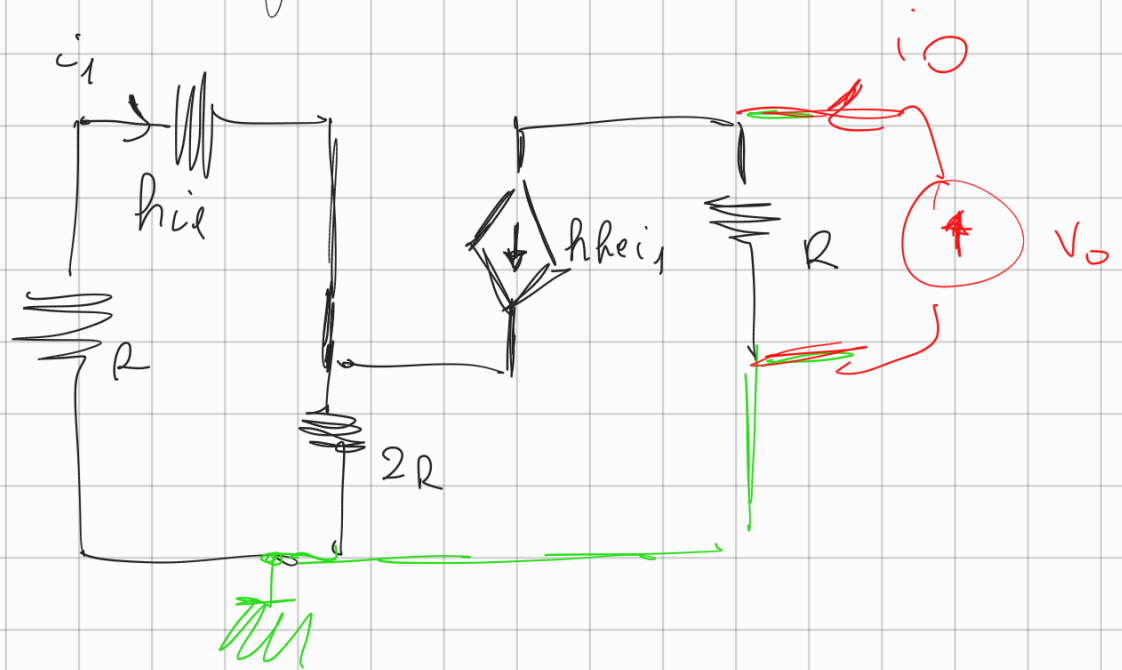
$$= \frac{2R}{2R \left( \frac{h_{ie}}{2R} + \frac{1}{2} + h_{fe} + 1 \right)} I$$

$$i_1 = \frac{1}{\frac{h_{ie}}{2R} + h_{fe} + \frac{3}{2}} I$$

Dabei  
gerade die  
Controlle

$$V_{eq} = R \cdot h_{fe} i_1 = \frac{- h_{fe} \cdot R}{\frac{h_{ie}}{2R} + h_{fe} + \frac{3}{2}} I$$

Req con Definire



da KT

$$i_r = i_1 + h_{fe} i_1 \Rightarrow i_r = (1 + h_{fe}) i_1$$

Proviamo  $i_1$  , grandezza controllata

$$(h_{ie} + R) i_1 + 2R i_r = 0$$

$$\Rightarrow (h_{ie} + R) i_1 + 2R (1 + h_{fe}) i_1$$

$$= \left\{ \begin{array}{l} c_j = 0 \end{array} \right.$$

# Metodo Rpi et

The diagram shows a circuit with a dependent current source  $I_x$  (represented by a circle with a downward arrow) in parallel with a resistor  $R$ . This combination is in series with another resistor  $R$ . The output voltage  $V_o$  is measured across the second resistor  $R$ . The circuit is connected to a bridge network on the left, which includes a resistor  $R_{ix}$  and a dependent current source  $I_x$  (represented by a diamond shape). The bridge network is connected to a voltage source  $V_o$  and a resistor  $R$ . The current  $I_x$  is indicated by an orange arrow. The output voltage  $V_o$  is indicated by a red arrow. The circuit is connected to a ground symbol at the bottom.

da KI  $i_r = I + i_x$

da KV alla maglia di  $S_x$

$$-R i_x + 2R i + R i_r + i_x \cdot R = 0$$

$$\bullet -i - i_0 = i_r \Rightarrow i = i_0 - i_r$$

$$\Rightarrow -R i_x + 2R (i_0 - i_r) + i_x \cdot R = 0$$

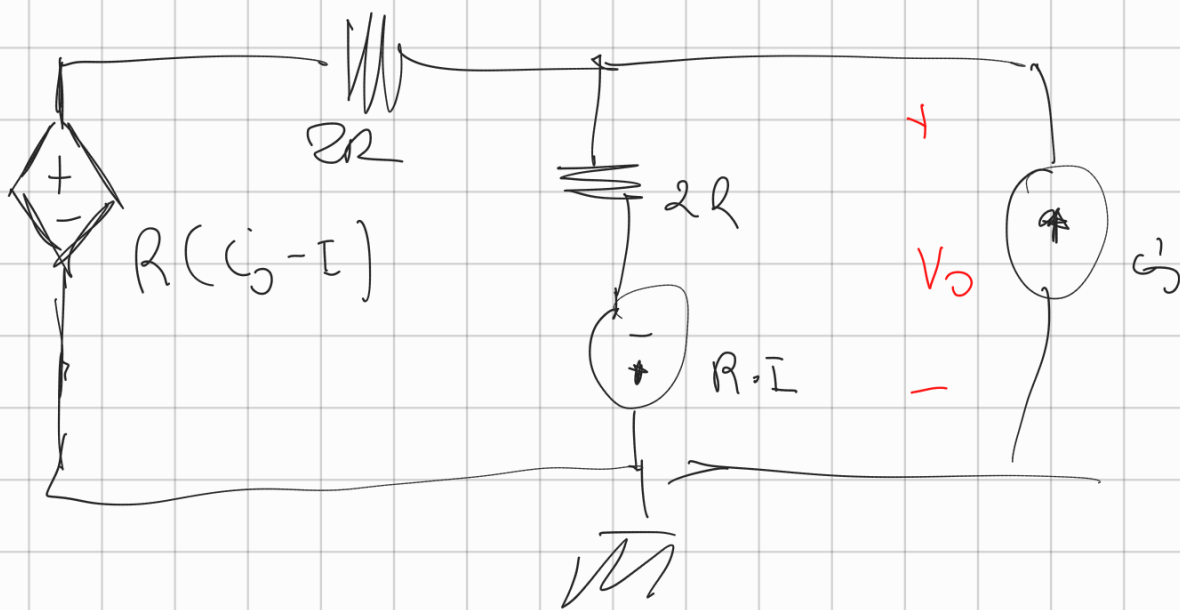
$$-R i_x + 2R i_0 - 2R (I + i_x) + i_x \cdot R = 0$$

$$i_x (-R - 2R + R) + 2R i_0 - 2RI = 0$$

$$-2R i_x + 2R i_0 - 2RI = 0$$

$$i_x = i_0 - I \quad A$$

Busbar ora



$$V_o = \frac{R(i_o - I)}{2R} - \frac{R \cdot I}{2R} + i_o$$


---


$$\frac{1}{2R} + \frac{1}{2R}$$

$$V_o = \frac{R}{2} (i_o - I) - \frac{R}{2} I + R i_o$$

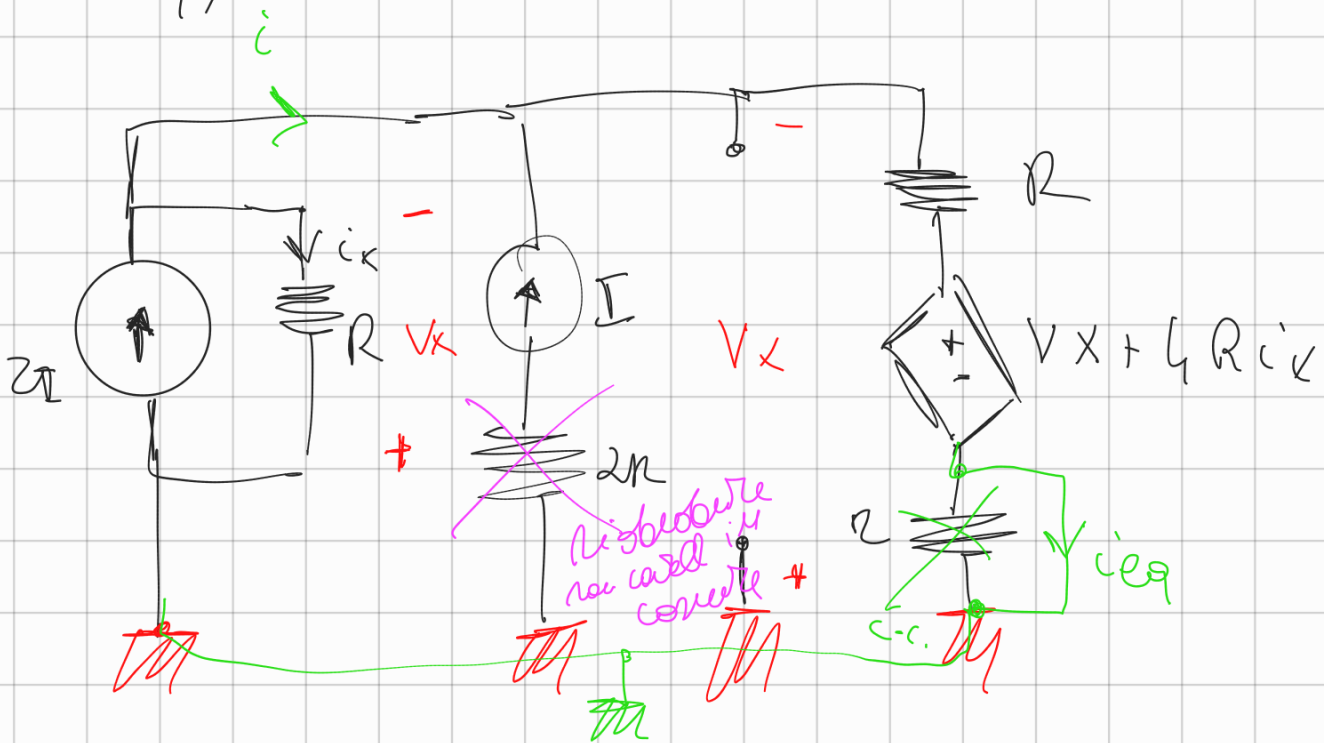
$$= \left( \frac{R}{2} + R \right) i_o - \left( \frac{R}{2} + 1 \right) I$$

$$V_o = \underbrace{\frac{3}{2} i_o}_{R_{eq}} - \underbrace{\frac{3R}{2} I}_{V_{eq}}$$



equiv. notation

1. Coq, coqute coqute 10 C.



$$V_X = - R C_X$$

M. Luan

$$V_X = \frac{\frac{2I \cdot R}{R} + I + \frac{V_X + 4R(-\frac{V_X}{R})}{R}}{\frac{1}{R} + \frac{1}{R}}$$

$$\frac{2IR + IR - 3V_X}{2}$$

$$V_X = IR + \frac{R}{2}I - \frac{3}{2}V_X$$

$$\frac{5}{2}V_X = \frac{3R}{2}I$$

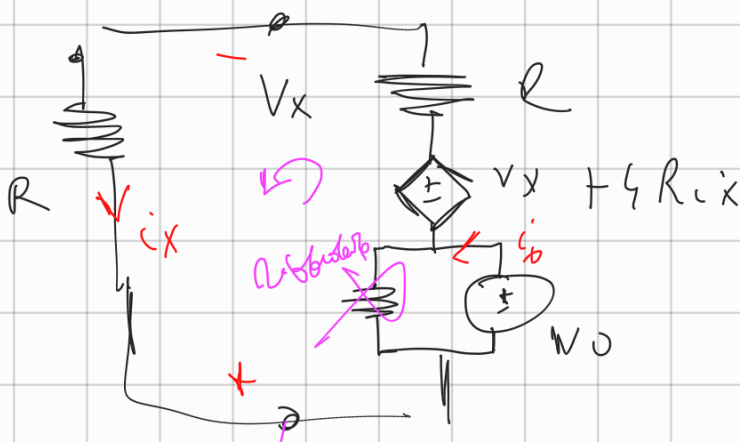
$$V_X = \frac{3R}{5}I$$

$$i_X = -\frac{3}{5}I$$

$$i_{M1} = 2I + i_X = 2I - \frac{3}{5}I = \frac{7}{5}I$$

$$i_{M2} = \frac{7}{5}I + I = \frac{12}{5}I$$

$G_{eq}$ , elemento con  $V_0$  e  $I_{eq}$   
gen isolp



in

$$i_x = i_o$$

$$V_x = -5R i_o$$

da KV

$$V_x = -V_o - V_x + 4R i_o - R i_o$$

$$5R i_o = 2V_x - V_o$$

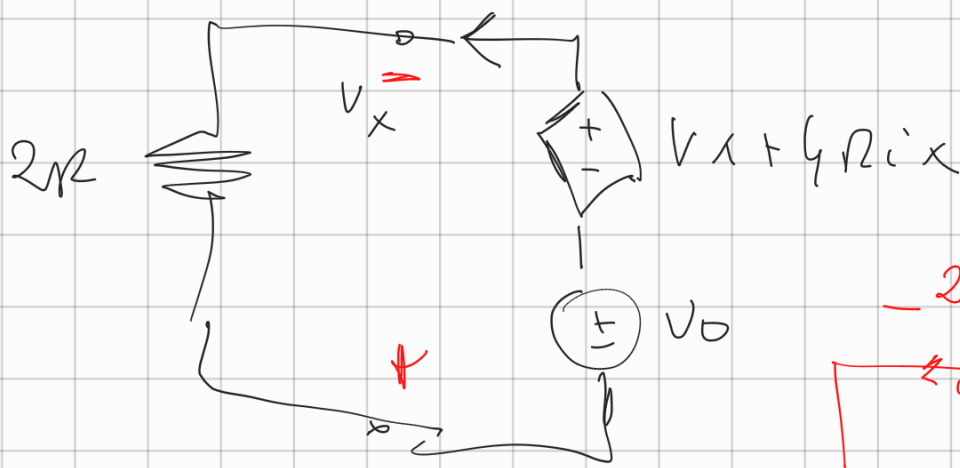
$$5R i_o = -2R i_o - V_o$$

$$7R i_o = V_o$$

$$i_o = \frac{V_o}{7R}$$

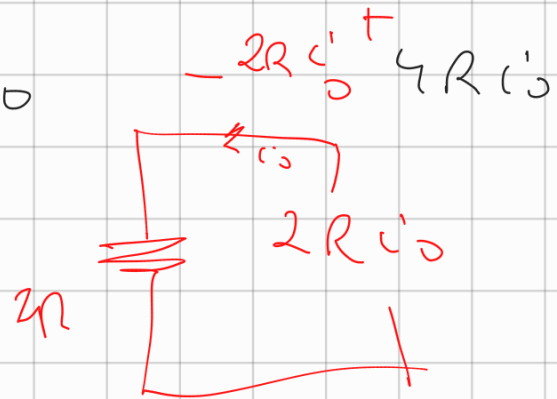
$$R i_o - V_o = V_x + 4R i_o + R i_o$$

$$R i_o - V_o + R i_o + 4R i_o + R i_o$$



$$i_x = i_o$$

$$V_x = -2R i_x$$



Req =

$$\frac{2R i_o}{2R} \quad i_o = i_o$$

Circuit is complete.

in Power

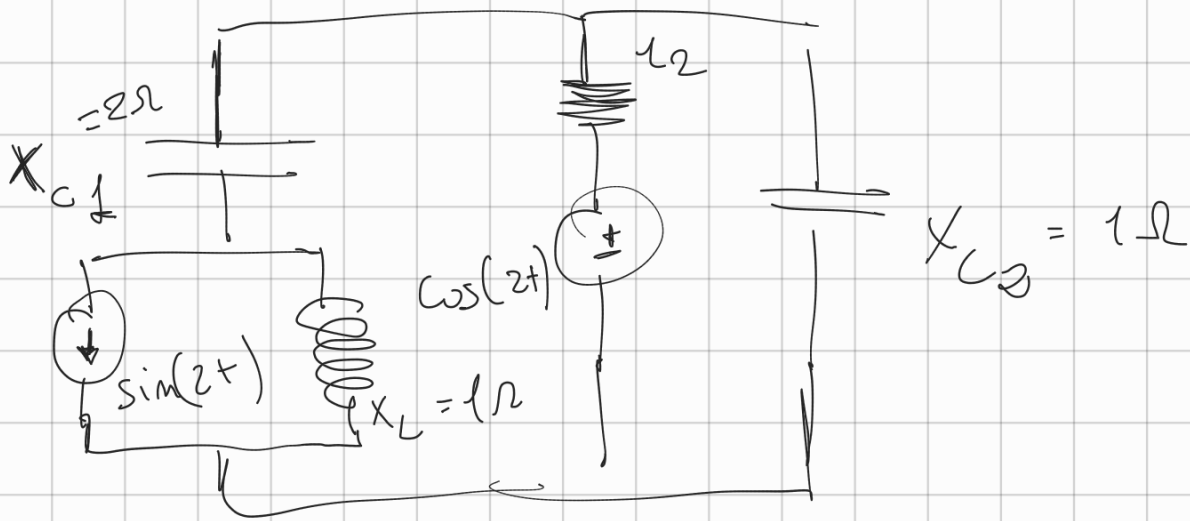
$$V_{eq} = 0, \text{ Req}$$



Verification Boucherot

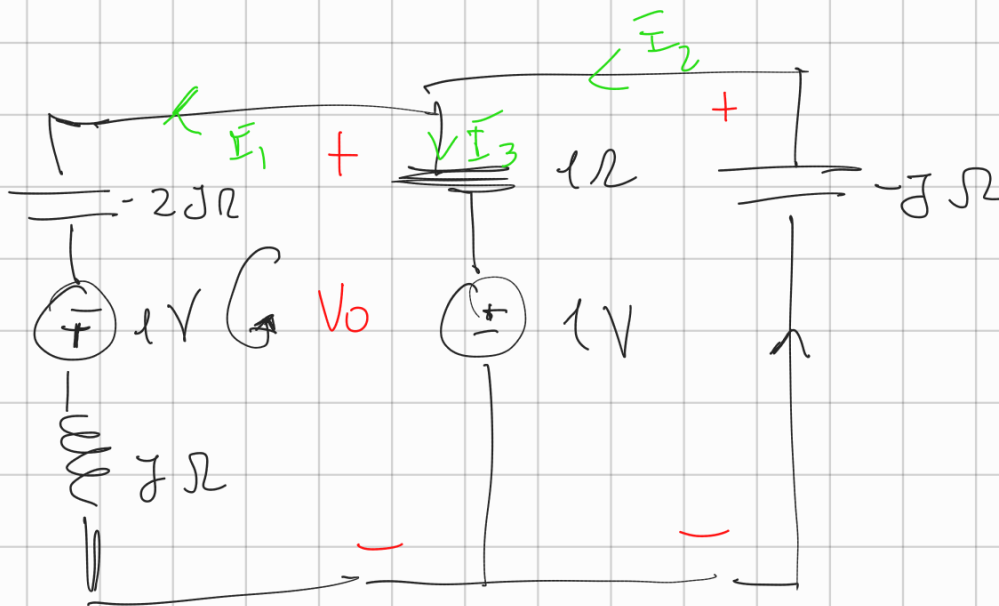
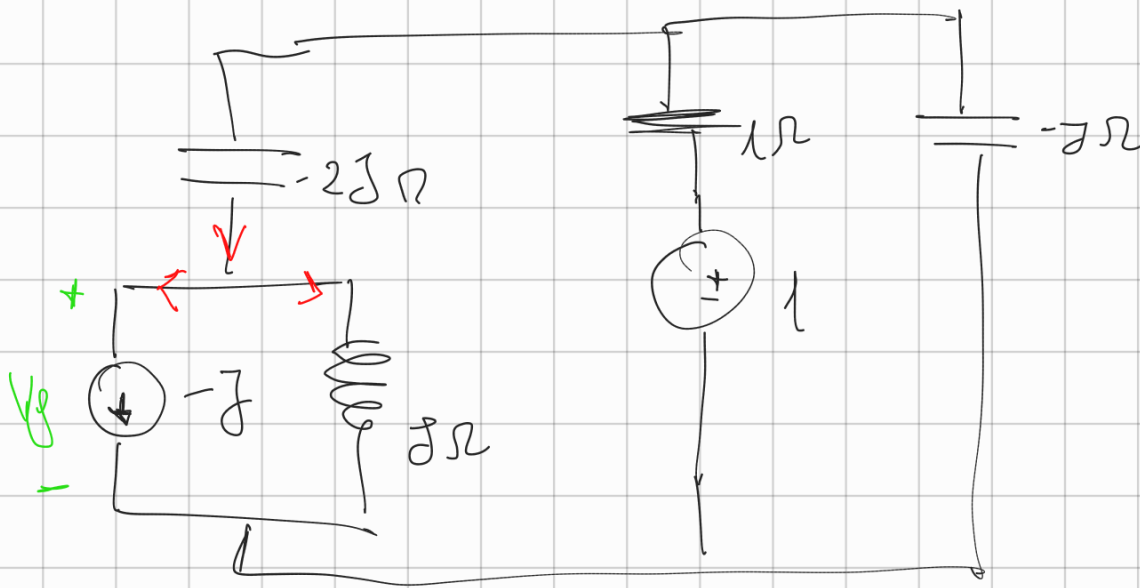
$$\sum P_{\text{at source}} = \sum P_{\text{at load}}$$

$$\sum Q_{\text{gen}} = \sum Q_{\text{d. rec'd}}$$



→ Circuito equivalente

$$Z_C = -jX_C$$



$$V_0 = -j + 1$$

$$\frac{1-j}{1+2j} \begin{matrix} (1-2j) \\ (1-2j) \end{matrix}$$

$$\frac{1}{-j} + 1 + \frac{j}{-j} = j + 1 + j$$

$$\frac{1-2j-j-2}{5}$$

$\Rightarrow$

$$- \frac{1+3j}{5} V = v$$

da kV

$$= 0.37 e^{j243^\circ} = V_0(t)$$

$$V_0 = -j \cdot \bar{I}_1 - 1V$$

$$\bar{I}_1 = -V_0 - 1V$$

$$= \frac{1+3j}{5} - 1 = -\frac{4}{5} + \frac{3j}{5} = \bar{I}_1$$

$$= \frac{3}{5} + \frac{4j}{5} = \bar{I}_1$$

$$\bar{V}_0 = 1 \cdot \bar{I}_2 + 1V \Rightarrow$$

$$\bar{I}_2 = \bar{V}_0 - 1 = -\frac{6}{5} + \frac{j}{3} A$$

$V_{ge}$  corretto

$$V_0 = -2J \cdot \bar{I}_1 + V_g$$

$$\bar{V}_g = V_0 + 2J \bar{I}_1 =$$

$$= \frac{-1}{5} + \frac{2J}{5} + 2J \left( \frac{3}{5} + \frac{4}{5} J \right)$$

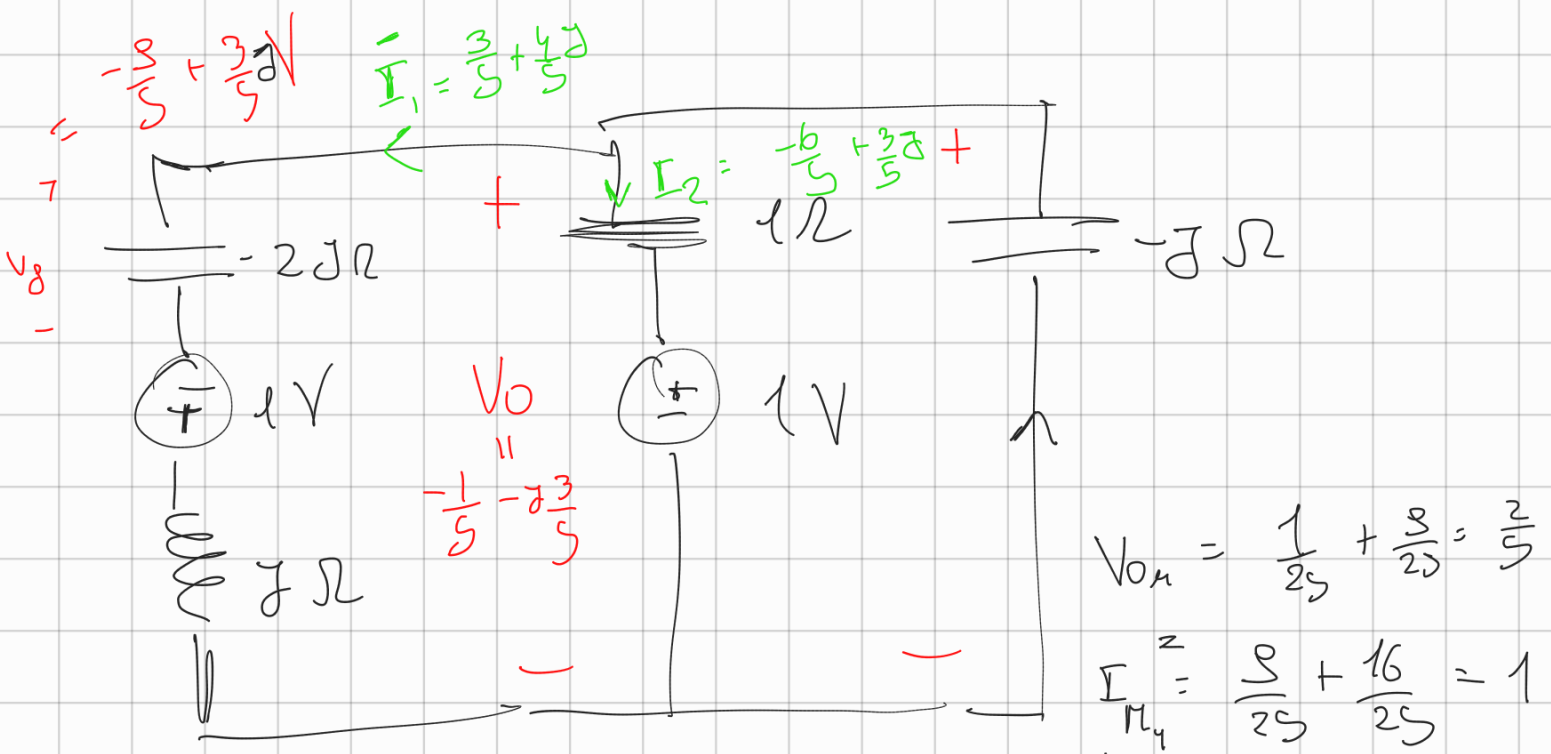
$$= \frac{-1}{5} - \frac{2}{5} - \frac{3J}{5} + \frac{6J}{5}$$

$$= \frac{-3 + 3J}{5} \quad V = \bar{V}_g$$

Teo Buchart, corsos.  
della Reteleco Corsos

$$\sum \bar{P}_k = \sum P + JQ_k = 0$$

il circuito è chiuso



$$Q_{C_1} = -\frac{1}{2} I_{th}^2 X_C = -\frac{1}{2} \cdot 2 = -1 \text{ VAR}$$

$$Q_{C_2} = -\frac{1}{2} V_{th}^2 X_C = \frac{1}{2} \cdot \frac{2}{5} \cdot 1 = -\frac{1}{5} \text{ VAR}$$

$$Q_L = \frac{1}{2} \frac{V_g^2}{X_L} = \frac{8 \text{ VAR}}{5} (?)$$

$$(V_{g_{th}}^2 = \frac{80}{25} \cdot \frac{1}{2} = \frac{8 \text{ VAR}}{5} ?)$$

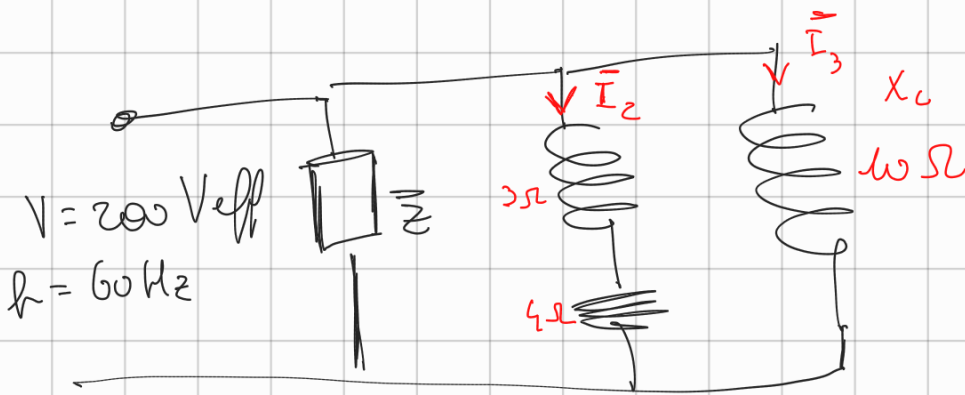
$$\begin{aligned}
 P_{\text{Gen Con}} &= \frac{1}{2} \bar{V}_g \cdot I_1^* \\
 &= \left( -\frac{8}{10} + \frac{3}{10}j \right) \cdot \left( \frac{3}{5} - \frac{4}{5}j \right)
 \end{aligned}$$



$$= -\frac{3}{10} + \frac{9}{10} j$$

$$P_{\text{Gen Tasse}} = \frac{1}{\bar{Z}} 1V \cdot \vec{I}_2^* = -\frac{6}{10} + \frac{3}{10} j$$

$$P_{\text{resistor}} = \frac{1}{2} I_{2R} \cdot R = \frac{9}{10} W$$



$$I_{\bar{Z}_{att}} = 5 A_{eff} \quad (\text{modulo})$$

$$I_{\bar{Z}_{res}} = 10 A_{eff}$$

Riflesso  $AA = 0,5$   
INDUTTIVO

$$P_{\bar{Z}} = 200 \cdot 5 = 1000 W$$

$$Q_Z = 200 - 10 = 2000 VAR$$

Lo Generatore pu' resist.

$$\bar{Z}_2 = 4\Omega + j3\Omega \Rightarrow Z_2 = 5$$

$$I_2 = \frac{V_{eff}}{Z_2} = 40 A_{eff}$$

$$Q_{X_{L1}} = I_2^2 \cdot X_L = 4800 \text{ VAR}$$

$$P_R = I_2^2 \cdot R = 6400 \text{ W}$$

$$I_3 = \frac{V_{eff}}{10} = 20 A_{eff}$$

$$\bar{Z}_3 = 0 + j10 \Rightarrow Z_3 = 10$$

$$Q_3 = 400 \cdot 10 = 4000 \text{ VAR}$$

$$P_{Tot} = 1 + 6,4 = 7400 \text{ W}$$

$$Q_{Tot} = 2 + 4,8 + 4 = 10800 \text{ VAR}$$

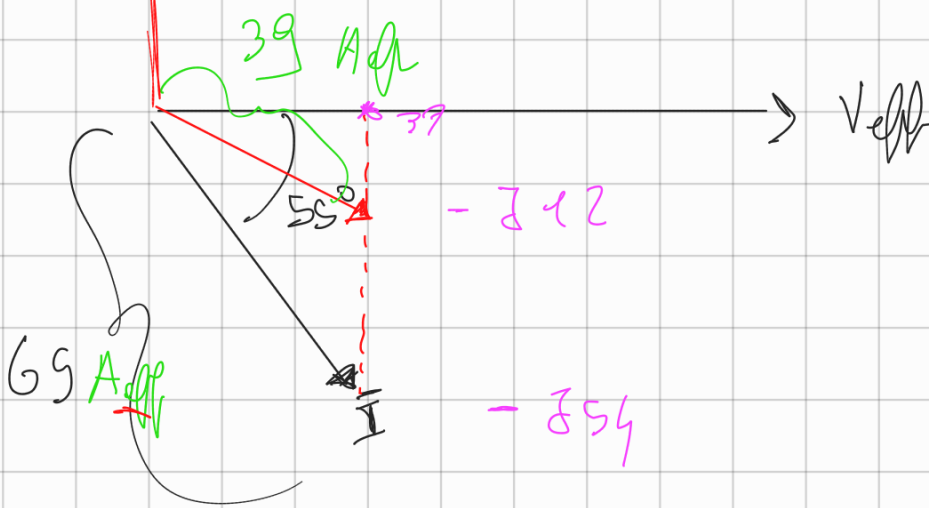
$$R_{eff} = \frac{10800 \cdot \frac{1}{8}(18,2) \cdot P_{Tot}}{314 \cdot 200^2} = 55,4 \text{ f}$$

$$P_{\text{tot}} = V_{\text{eff}} \cdot I_{\text{attiva, eff}} \Rightarrow I_{\text{attiva, eff}} = 37 \text{ A eff}$$

$$Q_{\text{tot}} \Rightarrow V_{\text{eff}} \cdot I_{\text{reatt, eff}} \Rightarrow 54 \text{ A eff}$$

sta nel 4° quadrante & cos

$$\bar{I} = 37 \text{ (circled)} - j 54, \quad I = 65,45$$



$$Q_{\text{tot sopo}} = P_{\text{tot}} \cdot \text{tg}(\overset{18,2}{\varphi_{\text{corr}}}) = 2432 \text{ VAR}$$

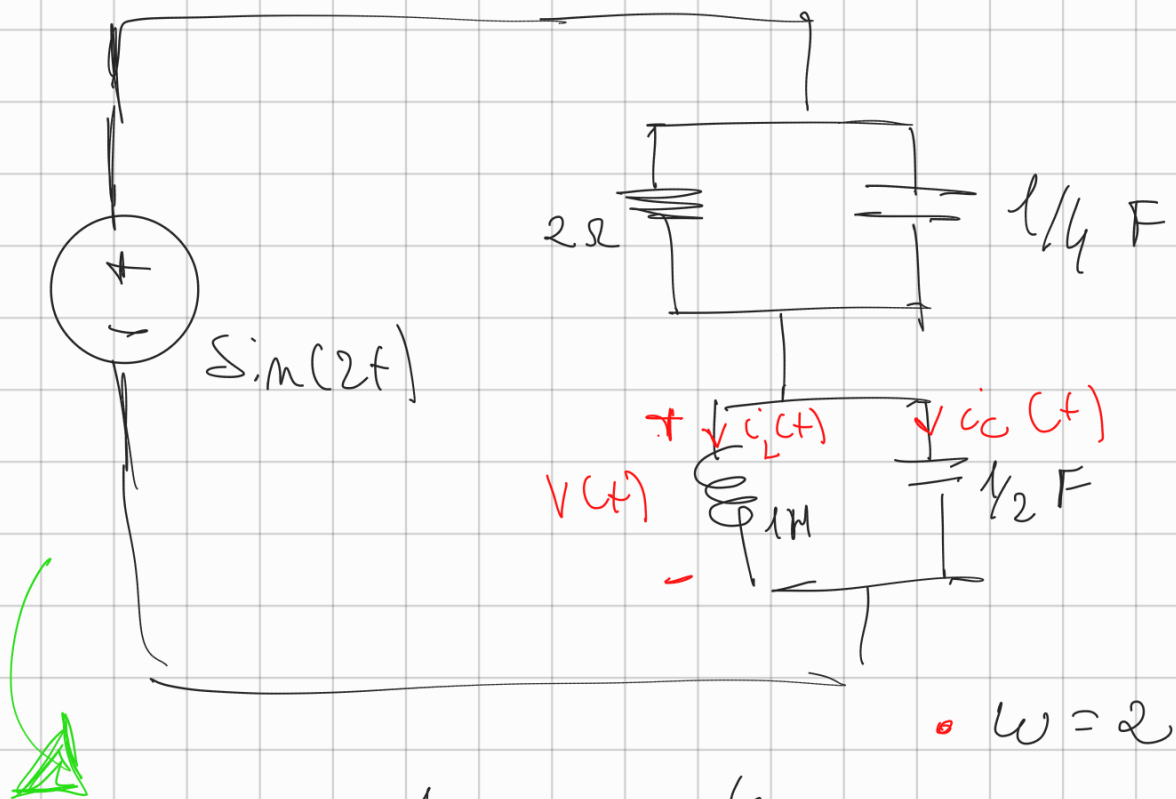
$$I_{\text{sopo reatt}} = \frac{Q_{\text{sopo}}}{V_{\text{eff}}} = 12,16 \text{ A eff}$$

$$I_{\text{sopo}} = \sqrt{37^2 + 12^2} = 39 \text{ A eff}$$

Corrente residua dopo rifasamento

$$I_{\text{residua}} = I_{\text{min}} - I_{\text{sopo}} = 854 - 312 = 542$$

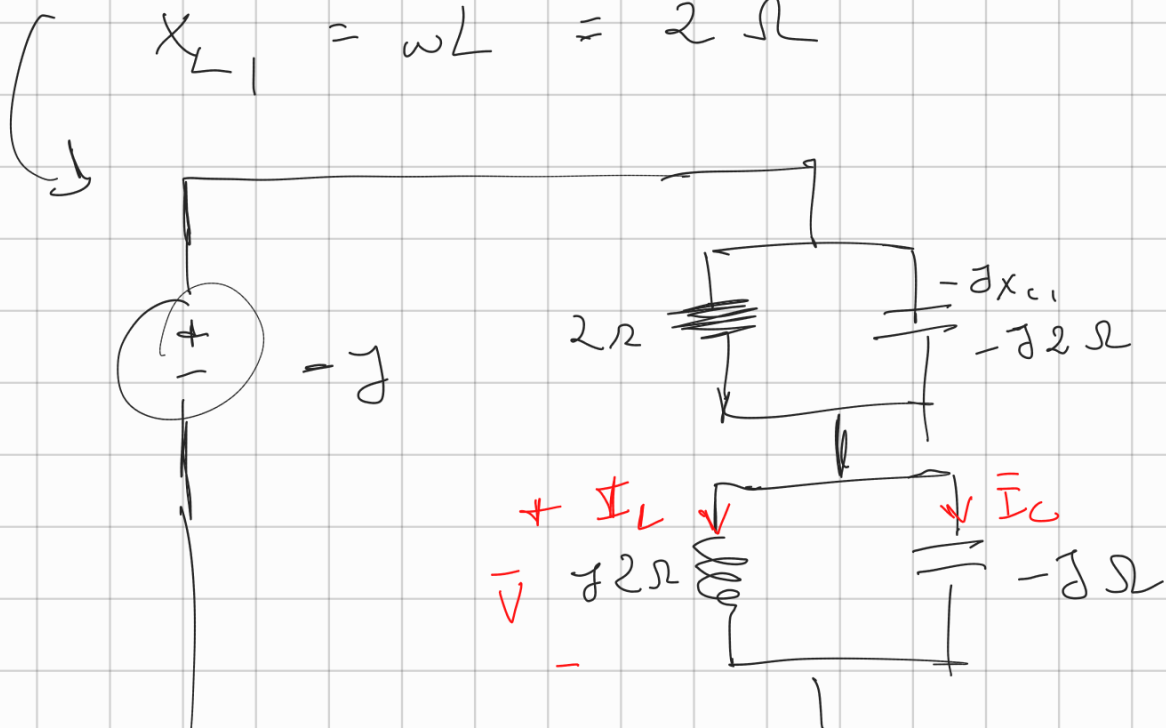
Determine  $\bar{V}$ ,  $\bar{I}_L$ ,  $\bar{I}_C$ , and  $\phi$

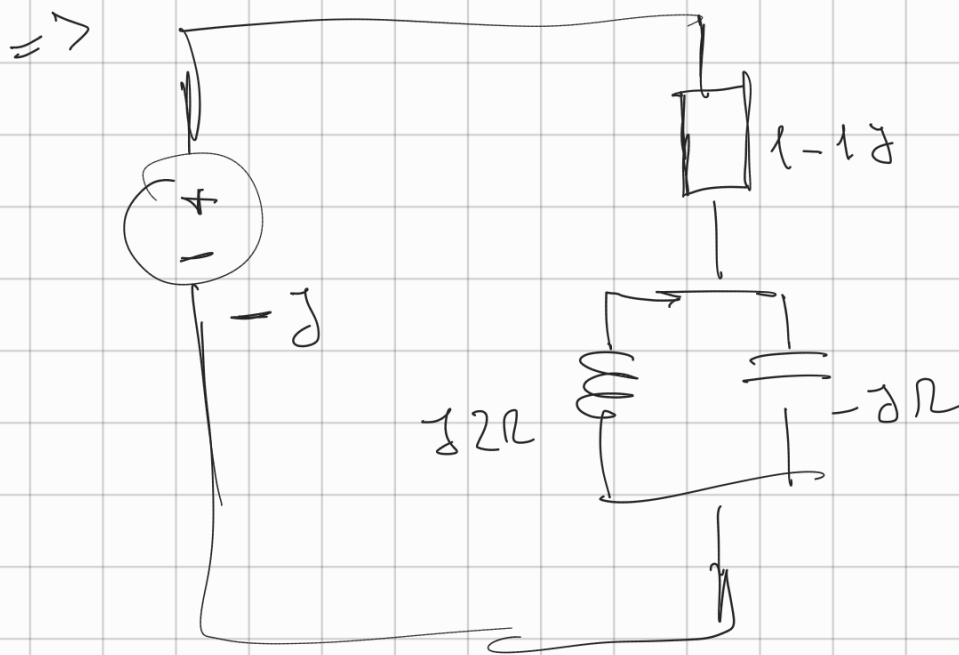


$$X_{C1} = \frac{1}{\omega C_1} = \frac{1}{2} = 0.5 \Omega$$

$$X_{C2} = \frac{1}{\omega C_2} = 1 \Omega$$

$$X_{L1} = \omega L = 2 \Omega$$



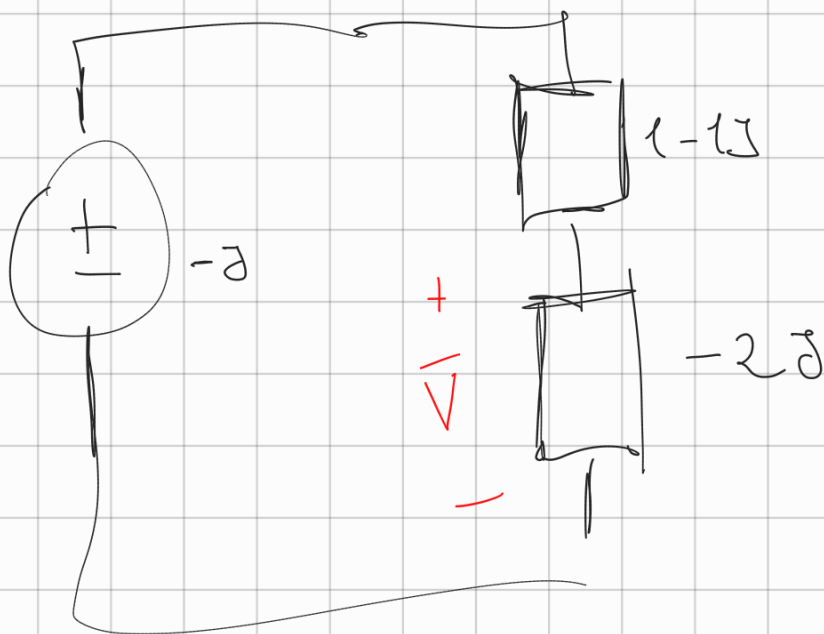


$$2\Omega - j2$$

$$\frac{-4j (2+j2)}{2-j2 (2+j2)}$$

$$= \frac{8-8j}{8}$$

$$= 1-j1$$



$$3j \parallel -j = \frac{2}{3j-j} = -2j$$

$$\bar{V} = \frac{-j - 2j}{1-j1-2j} = \frac{-2 (1+3j)}{1-3j (1+3j)}$$

$$= \frac{-2-6j}{1+9}$$

$$= \frac{-1}{5} - \frac{3}{5}j$$

$$\Rightarrow \bar{V} = 0.632 \angle -26.3^\circ$$

$$\overline{I}_L = \frac{\overline{V}_L}{\overline{Z}_L} = \frac{-1 - 3j}{5 + j2} \quad \omega = 2 \quad = V(t) = 0,63 \cos(\omega t - 108^\circ) \quad \checkmark$$

$$\frac{-1 - 3j}{10 + j} = \left( \frac{-1 - 3j}{10} \right) \cdot -j$$

$$\boxed{-\frac{3}{10} + \frac{j}{10} = \overline{I}_L} \Rightarrow i_L(t) = 0,31 e^{161^\circ}$$

$$i_L(t) = 0,31 \cos(2t + 161^\circ)$$

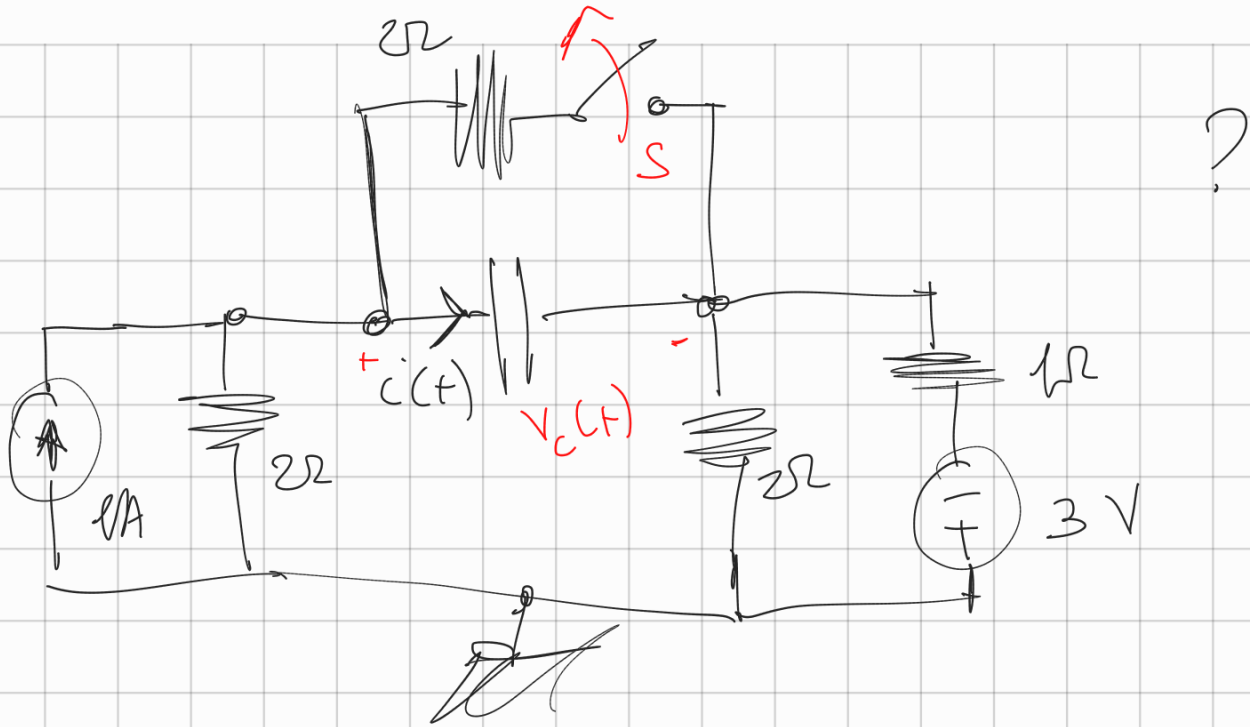
$$\frac{1}{\frac{10}{3}}$$

$$\overline{I}_L = \frac{\overline{V}_L}{\overline{Z}_{L2}} = \frac{-\frac{1}{5} - \frac{3}{5}j}{-j}$$

$$= \frac{-1 - 3j}{-5j} = \frac{1 + 3j}{5} \cdot -j$$

$$\overline{I}_C = \frac{3 - j}{5} \Rightarrow i_C(t) = 0,63 e^{-j18^\circ}$$

$$\frac{1}{\frac{5}{3}}$$



2 Regimi

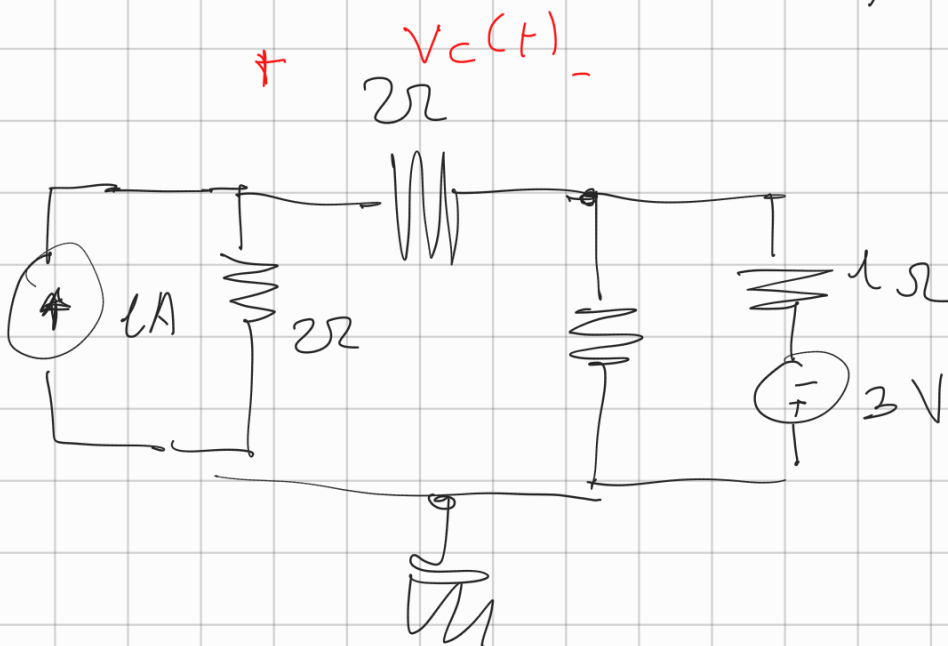
$i_C(t)$

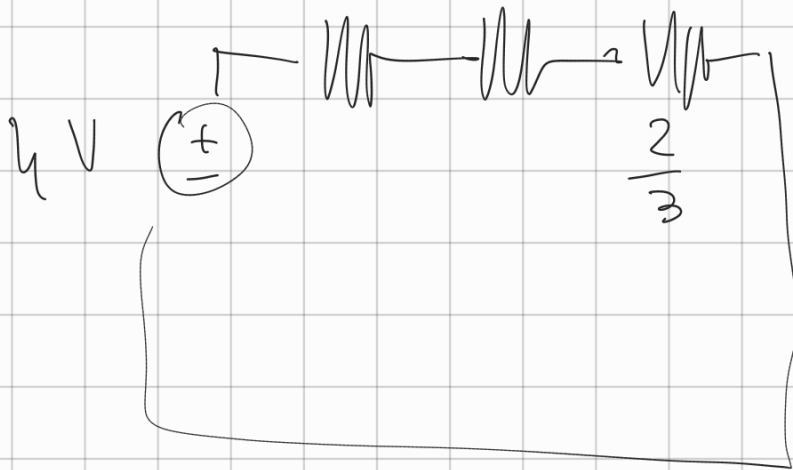
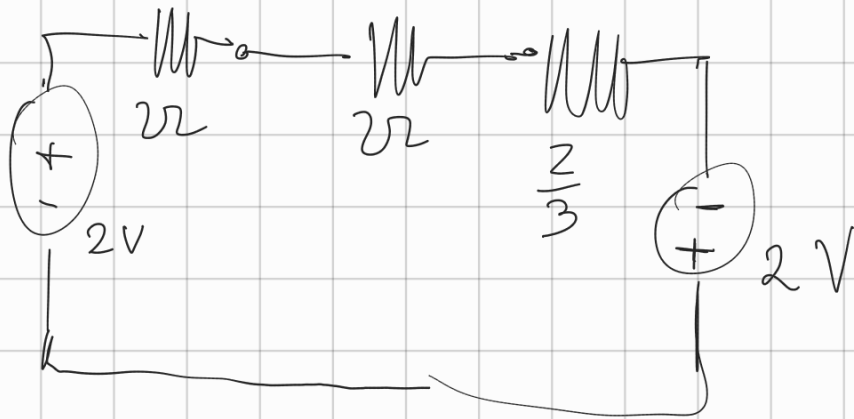
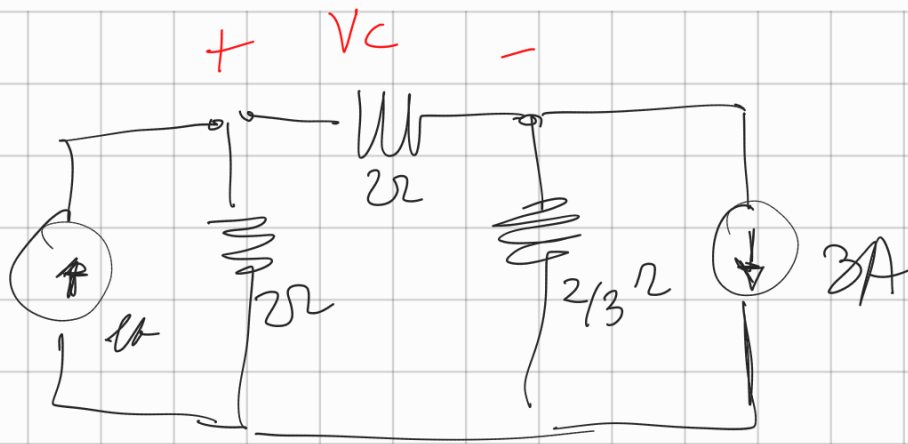
regim Stao      autoalimenta

C carica a 0  
ero' uca  
Risposta completa

$V_C(0^-)$      $t=0$      $V_C(0^+)$   
 $V_C(t)$  e  
 corrente

analisi circuito a  $t = 0^-$ , trova  $V_C(0^-)$   
 C a regime, e' u  
 C.A



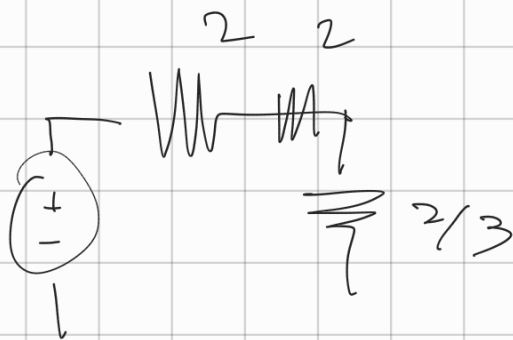
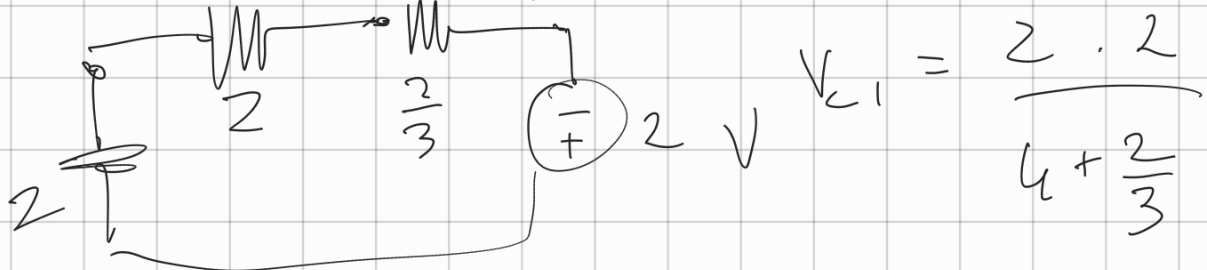
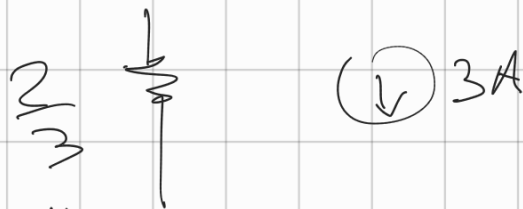
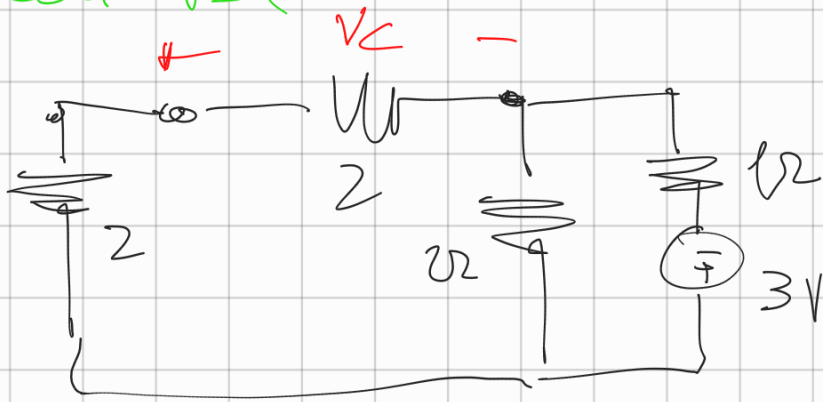


$$V_c(0^-) = \frac{4V \cdot 2}{4 + \frac{2}{3}} = \frac{24}{14} = \frac{12}{7} V$$

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



Calcola  $P_S$



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

C carico  $\rightarrow$  Regime stazionario, risposta del Tiro

$$i(t) = i(0)e^{-\frac{t}{\tau}} + i(\infty)(1 - e^{-\frac{t}{\tau}})$$

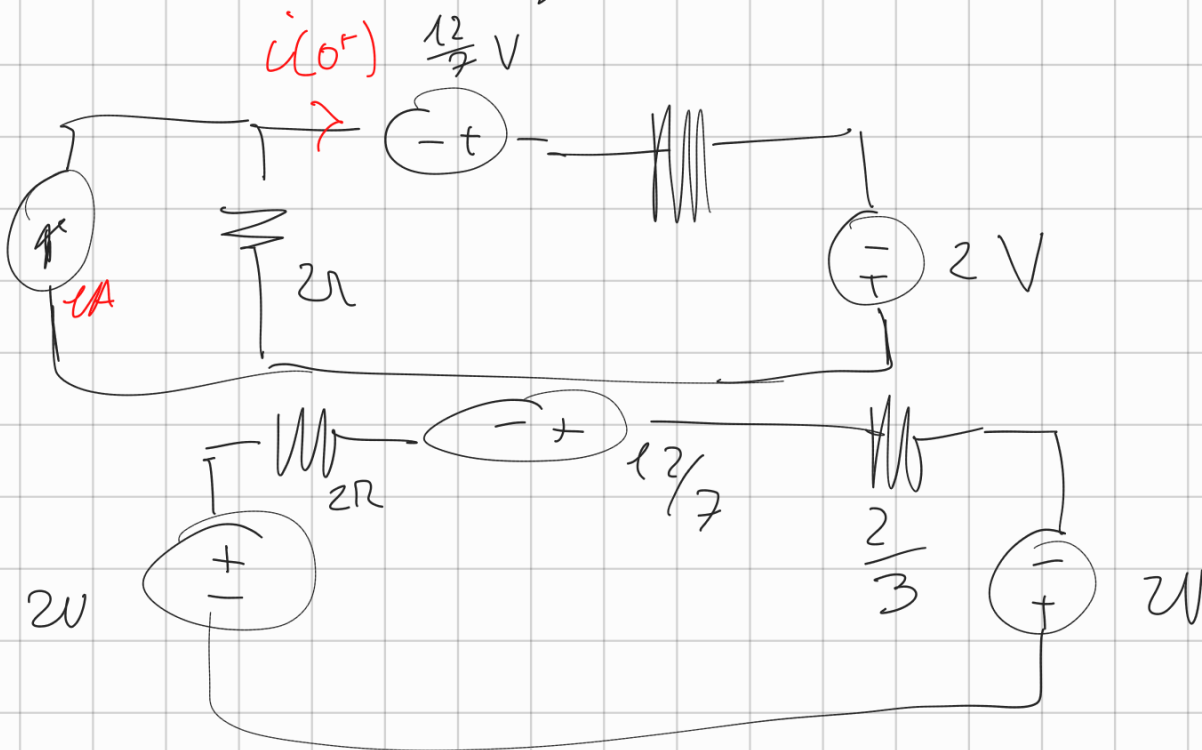
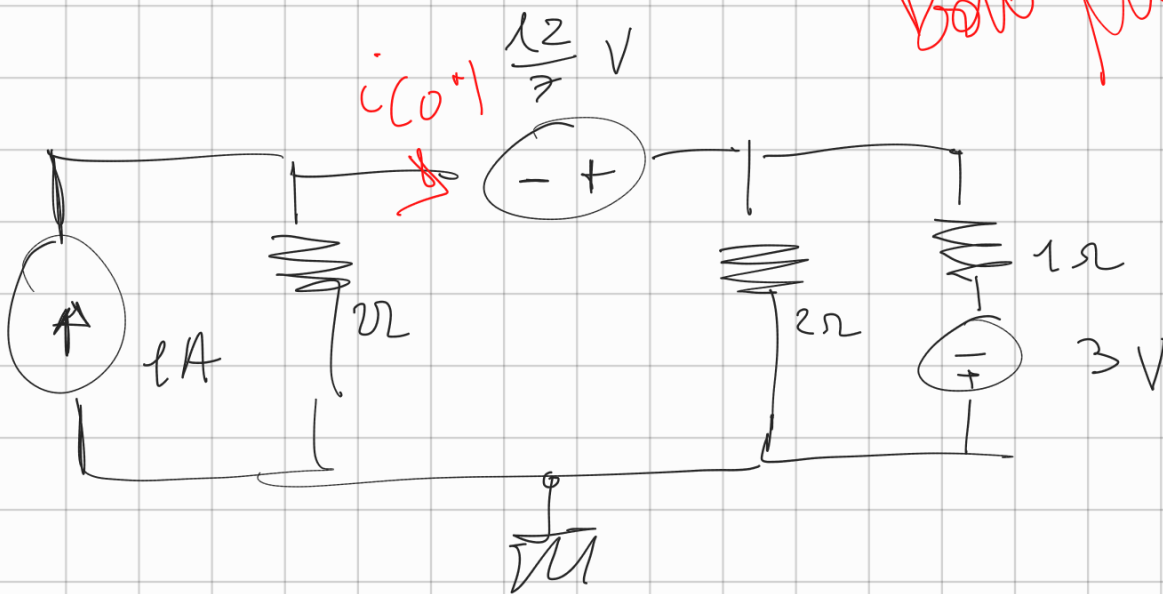
$$i_{lib}(t) = i(0)e^{-\frac{t}{\tau}} \quad i_{pr}(t) = i(\infty)e^{-\frac{t}{\tau}} + i(\infty)(1 - e^{-\frac{t}{\tau}})$$

Seo Bravore  $i(0), i(\infty) \in \tau = L \cdot R_{eq}$

C conico  $\frac{12}{7} V$

15 Tautonea on 0<sup>+</sup>

*risposta completa*  
*sono pure i lib e pr I For*



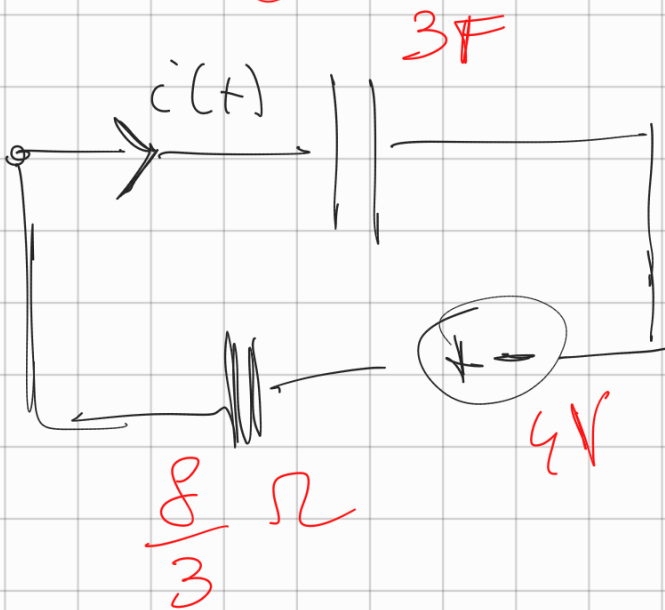
$$4V + \frac{12}{7}V = \frac{40}{7}V$$

$$2 + \frac{2}{3} = \frac{8}{3} \Omega_{eq}$$

$$i(0^+) = \frac{V}{R} = \frac{\frac{40}{7}}{\frac{8}{3}} = \frac{15}{7}A$$

$t = 0^+$

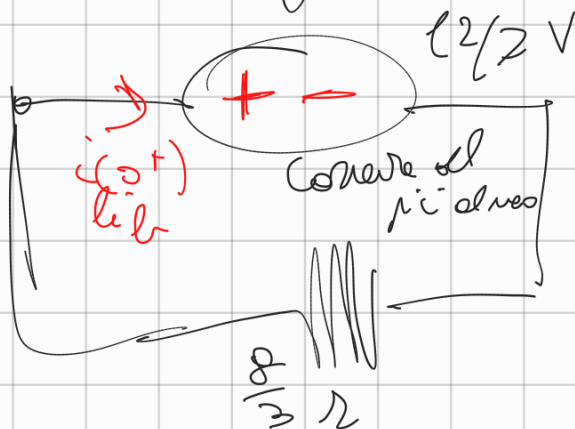
Circuito a  $t = 0^+$



due tracce  
 $i_{lib}(0^+)$   
 $i(\infty)$   
 $e R_{eq}$

$$R_{eq} = \frac{8}{3} \Omega$$

$i_{lib}$ , per "spezzare"



$$\frac{12}{7} \cdot \frac{3}{8} = -\frac{14}{8}$$

con generatore

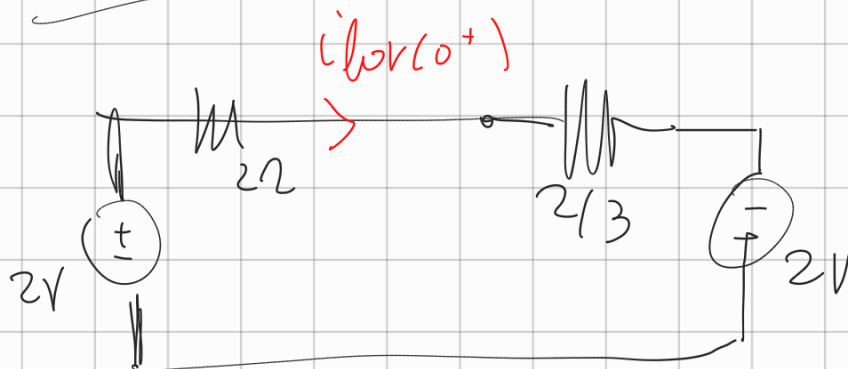
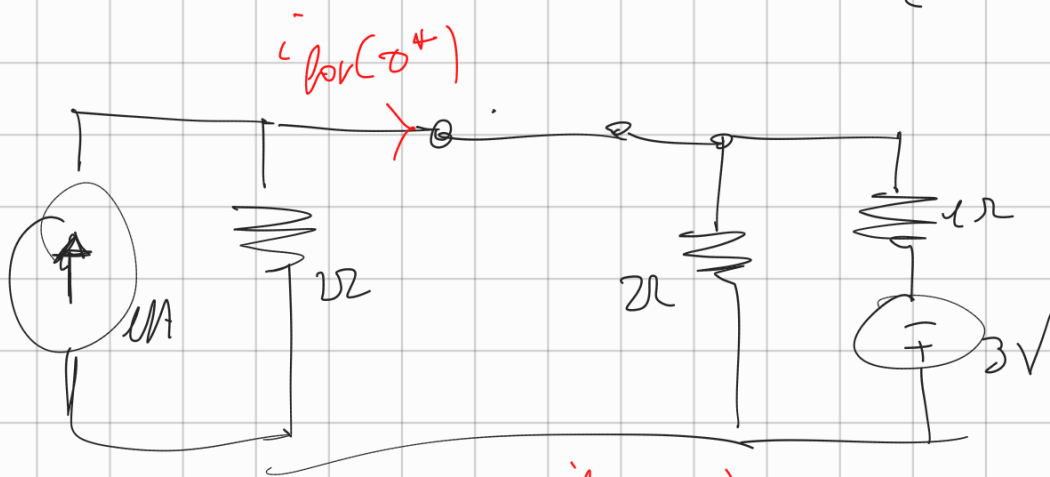
$$i_{for}(\infty) = 0 \quad \leftarrow \text{d'una un C. a}$$

$$\tau = \frac{8}{3} \cdot C = 8 \text{ sec}$$

$$i_{for}(t) = i_{for}(0^+) e^{-\frac{t}{\tau}} + i_{for}(\infty) (1 - e^{-\frac{t}{\tau}})$$

$i_{for}$  < scarico, piovono a zero

(Switch a  $0^+$  e un C.)



$$\tau = 8 \text{ sec, serie uguale}$$

$$\frac{8}{3}$$

$$4 \cdot \frac{3}{8} = \frac{3}{2} \text{ A}$$

$$4 \text{ V}$$

$$i_{for}(0^+) = \frac{3}{2} \text{ A}$$

$$i_{for}(\infty) = 0 \text{ A}$$

$$i_{for} = \frac{3}{2} e^{-\frac{t}{8} \text{ sec}}$$

$$i_{lib}(t) = \frac{-14}{9} e^{-\frac{t}{8} \text{ sec}}$$

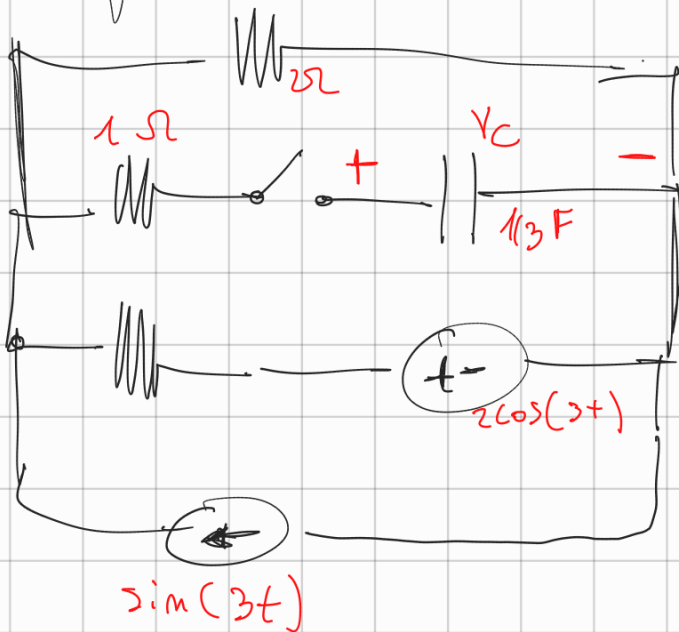
$$i_{regime} = \emptyset$$

Stato del Circuito a  $t=0^-$

in modo da sia in regime sinusoidale

degli induttori di

Che il circuito sia 0



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

reg. sinus  
1

reg. sinus.  
2



$$V(\text{trans}(0)) = -V_{\text{regime sinusoidale}}(0)$$

il  
de  
Breschi's step for Fourier  
coefficient of constant

•  $V_C(0^+)$  e' la cond'n. iniziale

la tensione sul condensatore deve  
piu' essere a regime sinusoidale

Prima la tensione sul condensatore,  
e sono in fase con

$$V_C(0^+) = V_C \text{ regime}$$

$$V_C \text{ regime} = V_H \cos(\omega t + \varphi)$$

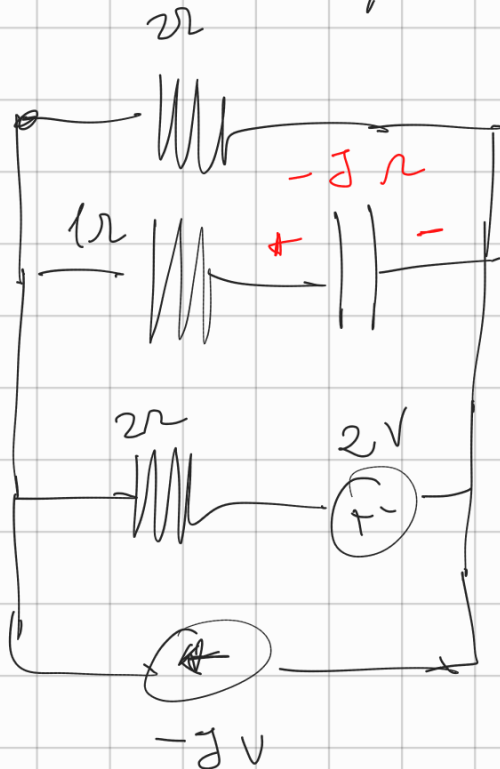
$$V_C(0^+) = \operatorname{Re} [\bar{V}_C e^{j\omega t}]_{t=0}$$

$$\operatorname{Re} [\bar{V}_C] = \operatorname{Re} [ ] =$$

$$V_C(0^-) = V_C(0^+) = \operatorname{Re} [\bar{V}_C]$$

# Determinare circuito Sottocirco

a  $t > 0$  per trovare il Tono  $V_c$



$$C = \frac{1}{3} \text{ F}$$

$$X_C = \frac{1}{\omega C} = 1 \text{ } \omega = 3$$

Millman

$$\frac{-j + \frac{2}{2}}{\frac{1}{2} + \frac{1}{1-j} + \frac{1}{2}} = \frac{-j + 1}{\frac{2(1-j) + 2}{2 - 2j}}$$

$$= \frac{1-j}{\frac{1-j+1}{1-j}} = \frac{(1-j)(1-j)}{2-j}$$

$$= 1-j-j+1 = \frac{-2j}{2-j} \cdot \frac{(2+j)}{(2+j)}$$

$$= \frac{-4j + 2}{5} = \frac{2}{5} - \frac{4}{5}j$$

= Potenza. Tenere

$$\bar{V}_C = \frac{\bar{V} \cdot -1j}{1-j} = \frac{(2-4j)(5+5j)}{5-5j} \cdot \frac{5+5j}{5+5j}$$

$$= \frac{10 + 10j - 20j + 20}{50}$$

$$= \frac{30}{50} - \frac{10j}{50} = \frac{3}{5} - \frac{1}{5}j$$

$$\bar{V}_C = -\frac{1}{5} - 2\frac{3}{5}V$$

$$V_C(0^-) = -\frac{1}{5}V$$

Se lo stato è a regime,  
non sarà esserci un  
transitorio



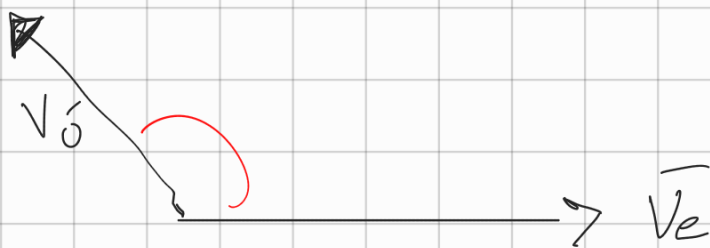
$$V_{reg} \sin(\omega t) = V_c(\omega)$$

C t.c.  $\bar{V}_c$  shows  $\angle 120^\circ$

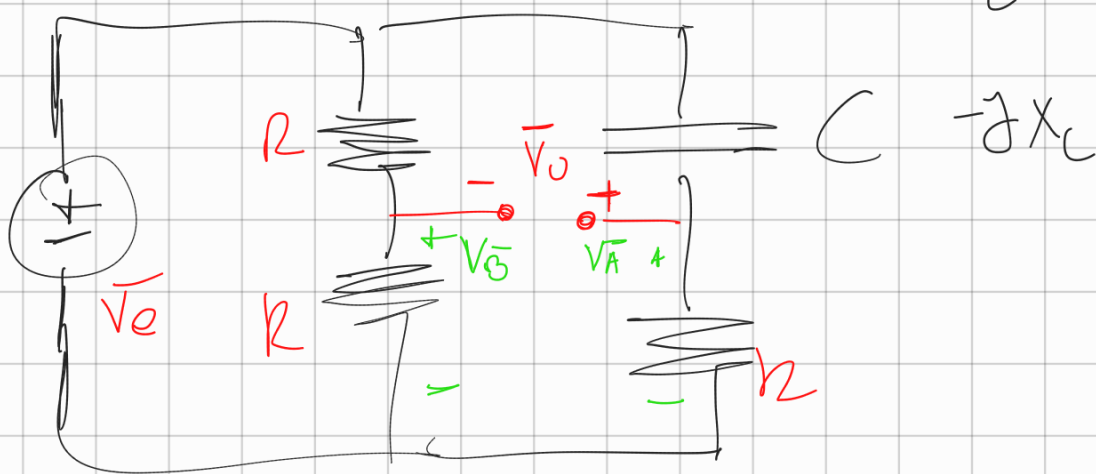
in anticipo rispetto a  $\bar{V}_e$

$$f = 60 \text{ kHz} \quad R = 1 \text{ k}\Omega$$

2M



$$X_c = \frac{1}{\omega C}$$



$$\bar{V}_c = \bar{V}_B - \bar{V}_A \Rightarrow$$

$$\bar{V}_B = \frac{\bar{V}_c \cdot R}{2R} = \frac{\bar{V}_c}{2} \quad V$$

$$\overline{V_A} = \frac{\overline{V_e} \cdot R}{R - j \frac{1}{\omega C}}$$

$$\overline{V_u} = V_e \left( \frac{10k}{10k - j 31,4k} - \frac{1}{2} \right)$$

$$= V_e \left( \frac{10k R}{628kC - j} - \frac{31,4kC}{62,8kC} \right)$$

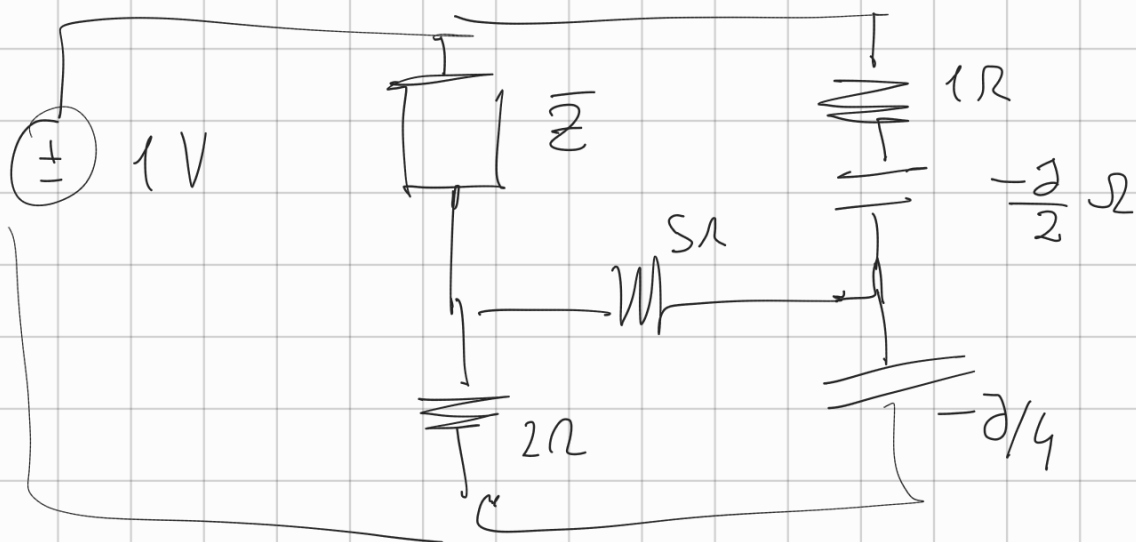
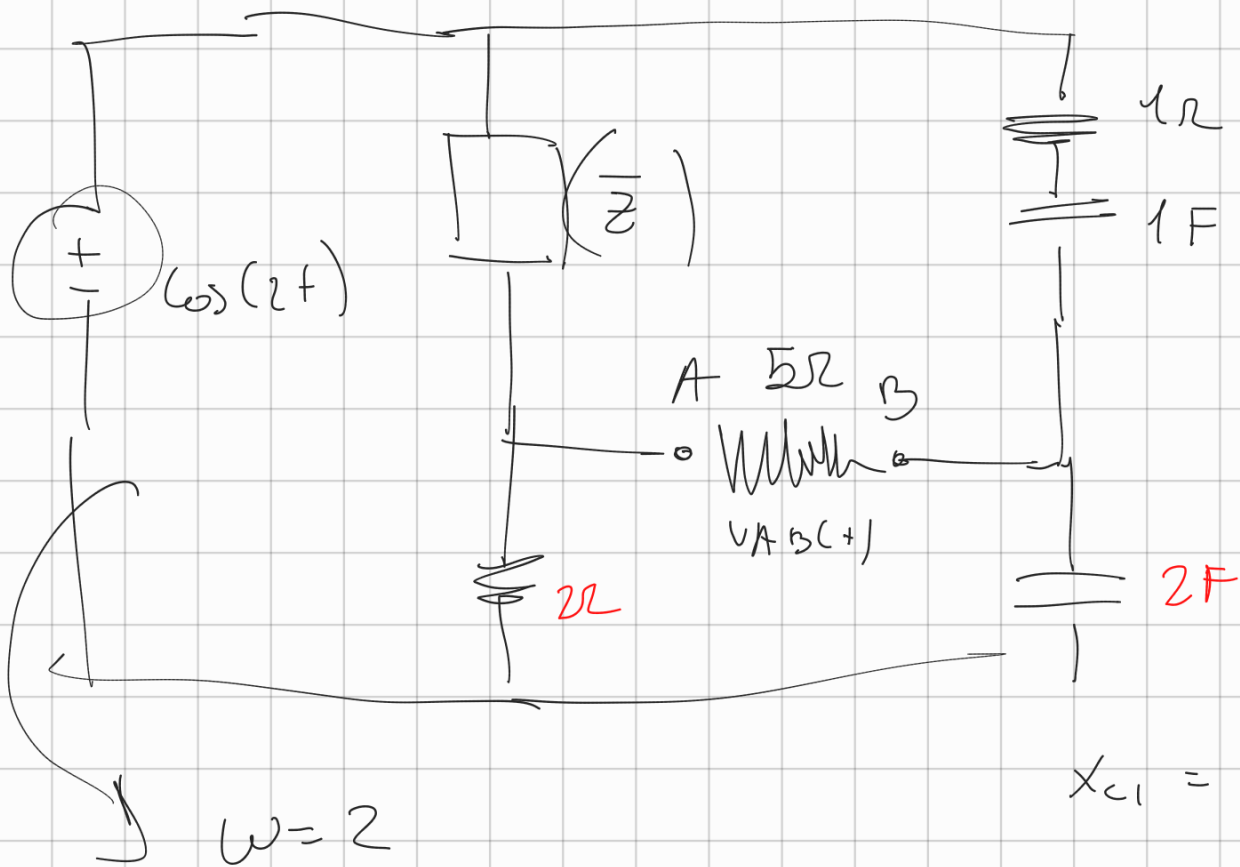
$$\overline{V_u} = \frac{-\overline{V_e}}{2} \frac{1 - j\omega RC}{1 + j\omega RC}$$

c.t.c.

$$\Rightarrow \varphi_{\overline{V_u}} = \varphi_{V_e} + \varphi \left( -\frac{1}{2} \frac{1 - j\omega RC}{1 + j\omega RC} \right)$$

$$\varphi_{V_u} - \varphi_{V_e} = 120$$

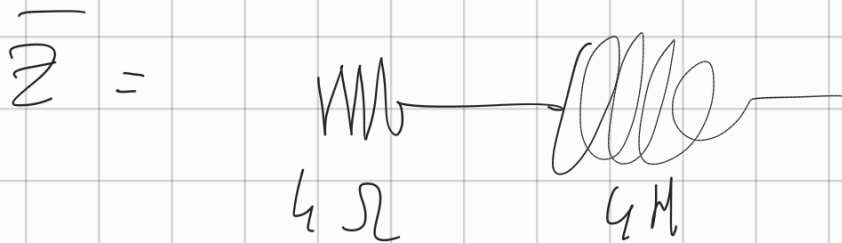
$\bar{z}$  t.c.  $V_{AB}(+) = 0$



Parte liberio de

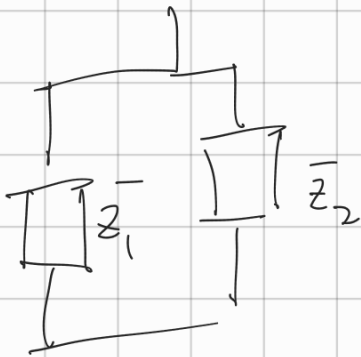
$$\bar{z} \cdot -j/4 = 2 \cdot \left( 2 - \frac{j}{2} \right)$$

$$\bar{z} = \frac{2-j}{\frac{-j}{4}} = 4j(2-j) = 8j+4$$



$$\omega L = 8$$

$$L = 4$$



$$= \frac{1}{\frac{1}{\bar{z}_1} + \frac{1}{\bar{z}_2}}$$

So  $\bar{z} = 8j+4$

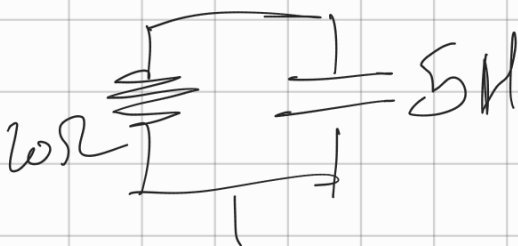
$$\bar{y} = \frac{4-j8}{80}$$

$$= \frac{1}{20} - \frac{1}{10}j$$



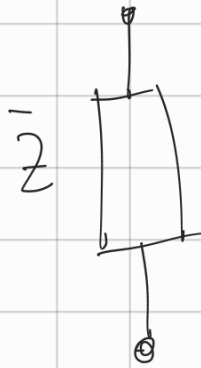
$$z_1 = R$$

$$z_2 = j\omega L$$



$$\frac{1}{R} + \frac{1}{j\omega L} = \frac{1}{20} - \frac{1}{10}j$$

$$L = 9 \mu$$



$$\bar{P} = 10 \text{ kVA}$$

$$\cos(\varphi_z) = 0.8 \text{ in ritardo}$$

$$V_{\text{eff}} z = 220 \text{ V}$$

$$P ? \quad Q ? \quad I_{\text{eff}} ?$$

$$\bar{z} ?$$

$$P = \bar{P} \cdot \cos(\varphi_z) = 8000$$

$$Q = \bar{P} \sin(\varphi_z) = \bar{P} \sin(36.86) = 5680$$

$$V_{\text{eff}} \cdot I_{\text{eff}} = A \Rightarrow I_{\text{eff}} = 45.45$$

$$z = \frac{V}{I} = 4.85$$

$$\bar{z} = 4.85 e^{j 36.86^\circ}$$

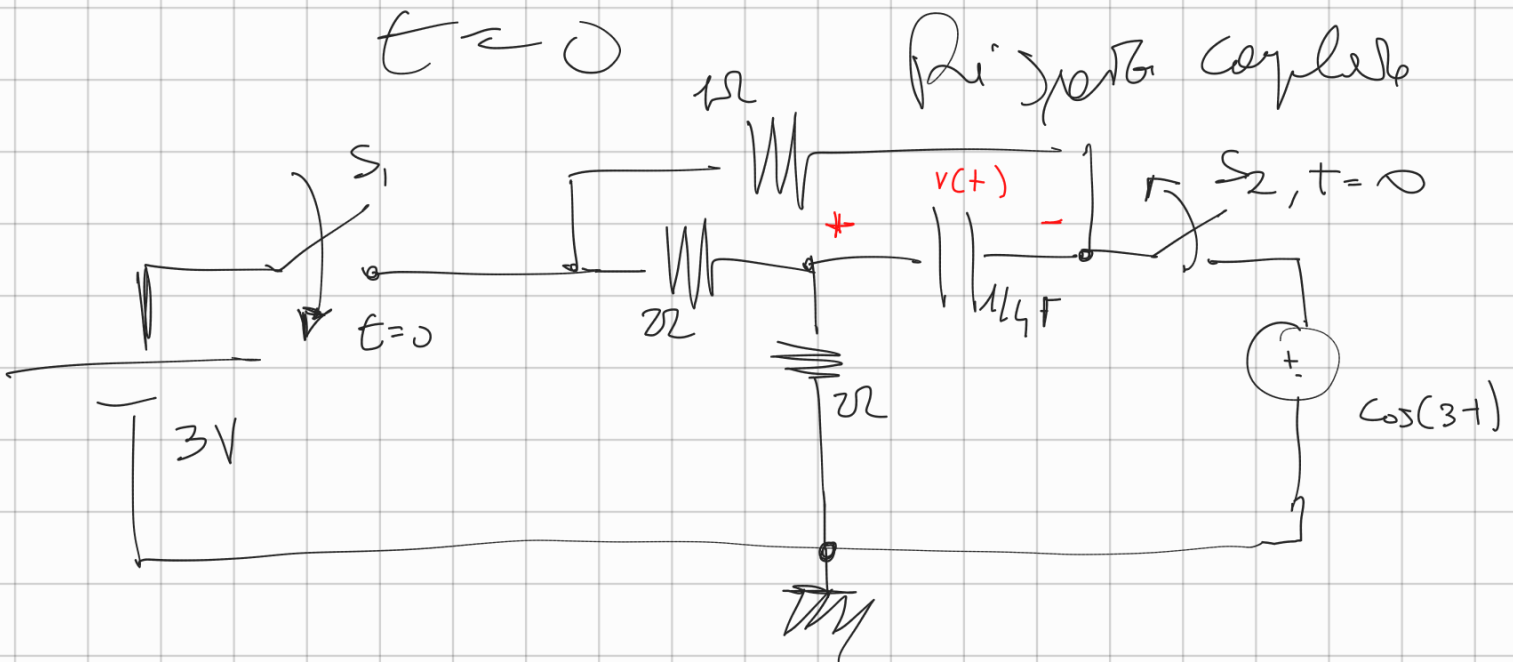
$$P = 5 + 78 \text{ V/A}$$

8 inst. picture,

$P = S W$        $Q = \mathcal{L} VAR$

$$I = \sqrt{Z_S + G_4} = 8.43 \text{ VA}$$

$$P(+)=P(A)=14,43$$



$w = 3$

regime IIM      risk  
correlat

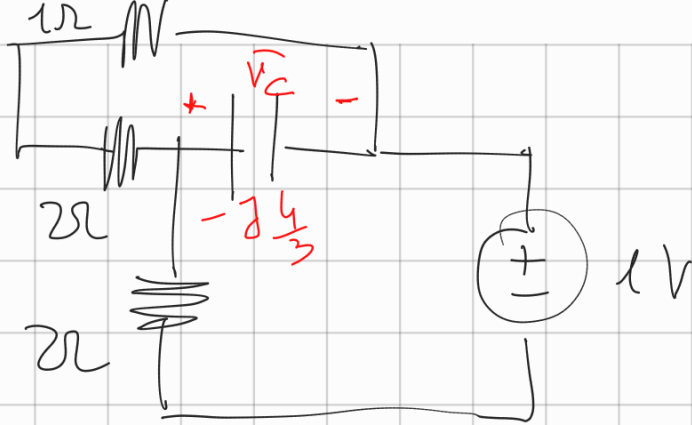
event  
critical  
 $t = 0$

regime STen.

$$\sum_{j=0}^n v_j(t)$$

Cinco, a  $t=0$  gulch. Braille

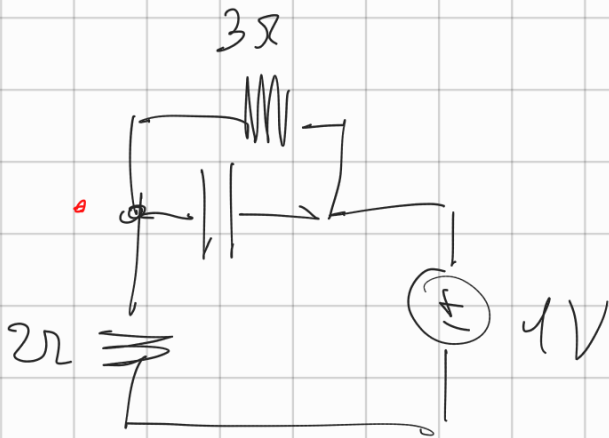
$$V(c^+) = \text{Re} [\overline{V_c}]$$



$$\omega = 3$$

$$X_C = \frac{1}{\omega C} = \frac{4}{3}$$

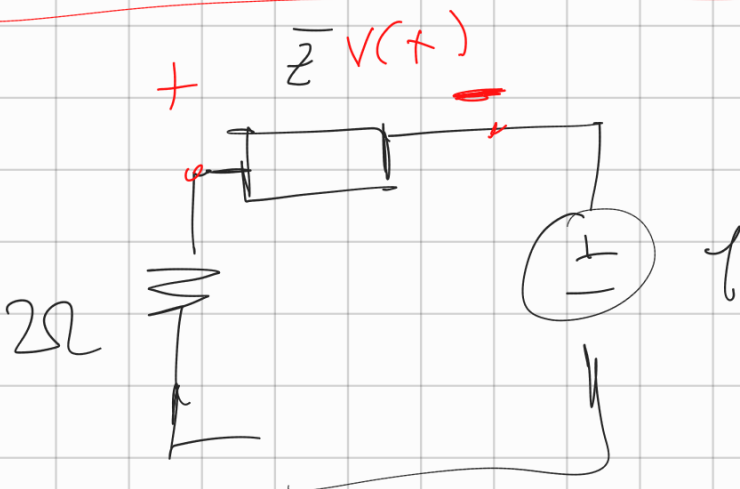
$$3 \parallel -j\frac{4}{3}$$



$$\frac{-j4}{3 - \frac{j4}{3}} = \frac{-12j}{9 - 4j}$$

$$\frac{-12j}{9 - 4j} \frac{(9 + 4j)}{(9 + 4j)} = \frac{-108j + 48}{81 + 16}$$

$$\frac{48 - 108j}{87} = \bar{z}$$



$$\frac{48}{87} +$$

$$\frac{48 - 108j}{87}$$

$$\frac{1 \cdot \overline{z}}{\overline{z} + 2i} = \frac{\overline{z}}{\overline{z} + 2i}$$

$$\frac{48 - 108i}{87}$$

---

$$\frac{242 - 108i}{87}$$

$$= \frac{48 - 108i (242 + 108i)}{(242 - 108i)(242 + 108i)}$$

$$= \frac{11616 + 9184i - 26136i + 11664}{58564 + 11664}$$

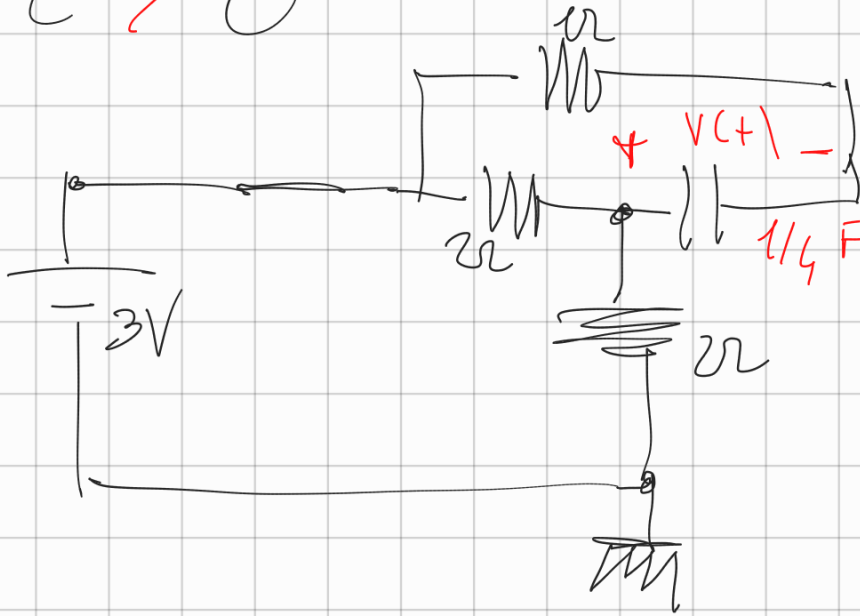
$$= \frac{23280}{70228} + \dots$$



$$V_C(0^-) \approx -0,32 \text{ V}$$

$$= V_C(0^+)$$

$t > 0$



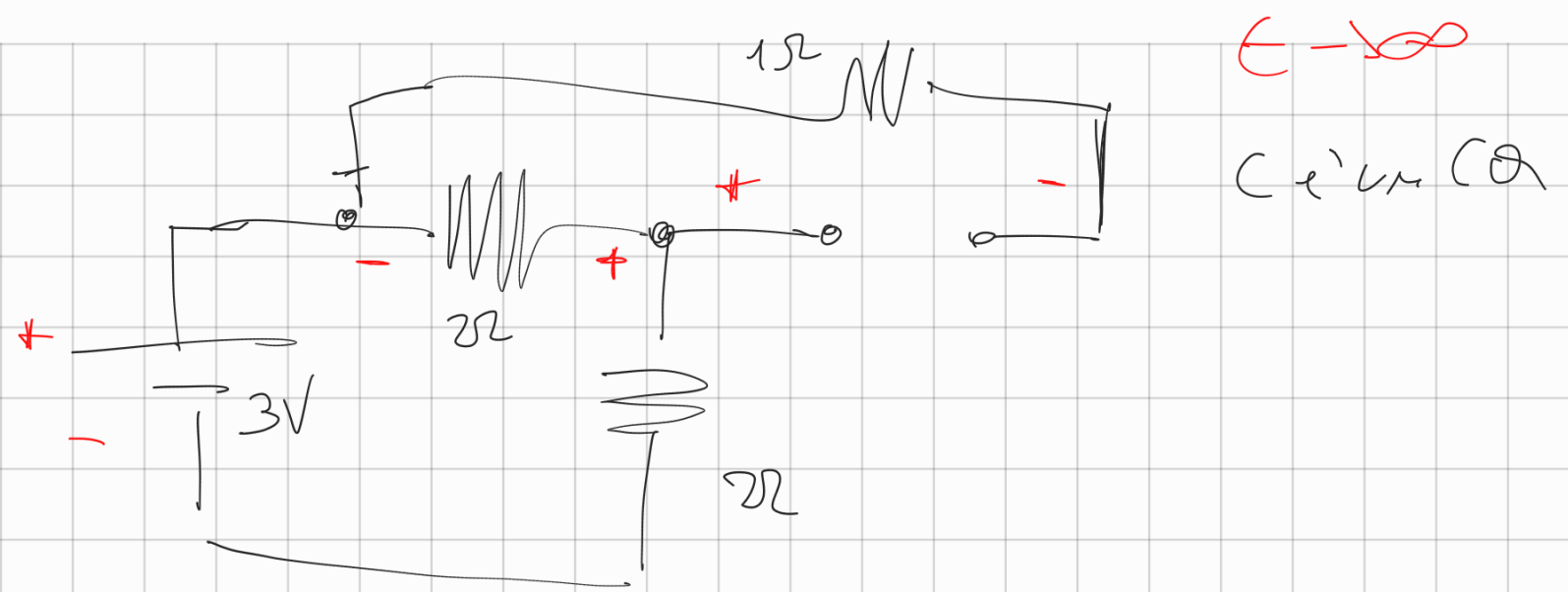
Risposta completa in regime Staz

$$V_C(t) = V_C(\infty) + [V_C(0) - V_C(\infty)] e^{-\frac{t}{\tau_{eq}}}$$

per  $V_C(0)$ , considero circuito a  $0^-$

$V_C(\infty)$

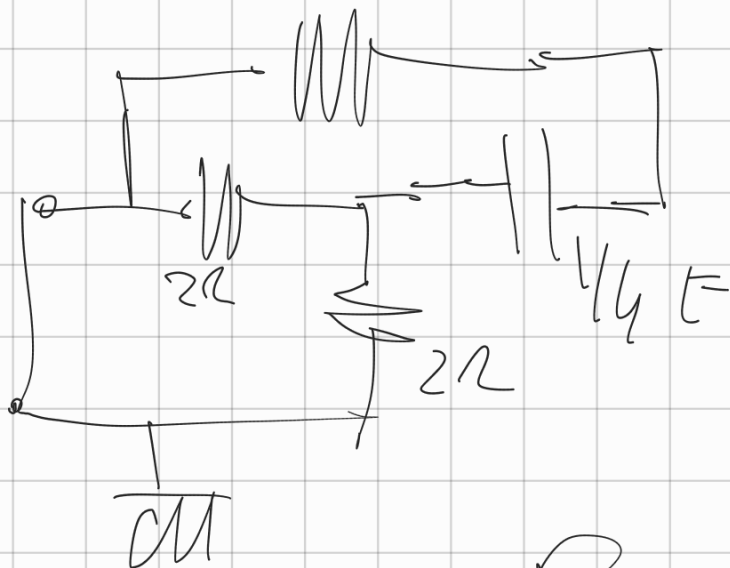
$V_C(0)$  lo ho già



$$\frac{3V \cdot 2}{4} = \frac{6}{4} = -\frac{3}{2} V$$

$\hat{u}$  è uguale a  $V$  perché

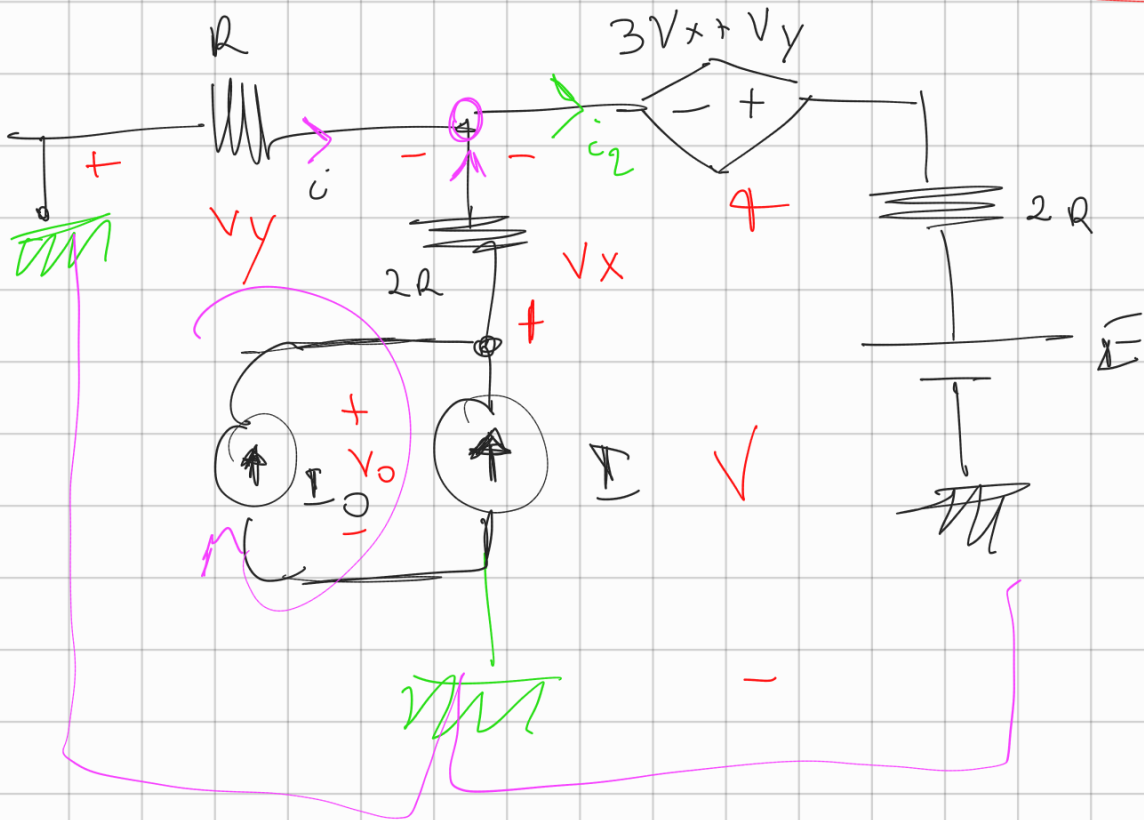
lo considero in c.c. allora



$$R_{eq} = 2 \Omega$$

$$\tau = C \cdot R_{eq} = \frac{1}{2} \text{ sec}$$

$$V_c(t) = -\frac{3}{2}V + \left[ -0,33 + \frac{3}{2} \right] e^{-2t} \quad t \geq 0$$



da k V

$$V_y + V_x + V_o = 0$$

$$V_y = R i$$

$$V_x = 2R \cdot (I + i_0)$$

$$R \cdot i - 2R I - 2R i_0 + V_o = 0$$

$$i = \frac{2R I - 2R i_0 + V_o}{R}$$

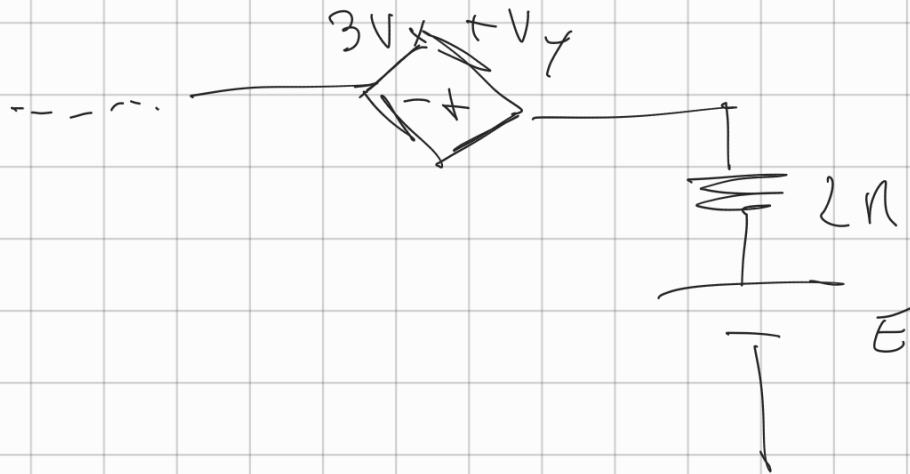
$$i = 2I - 2i_0 + \frac{V_0}{R}$$

$$V_y = 2RI - 2Ri_0 + V_0$$

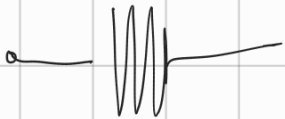
$$V_x = -2R(I + i_0)$$

$$\Rightarrow \Delta kI$$

$$i + (I + I_0) = i_2$$



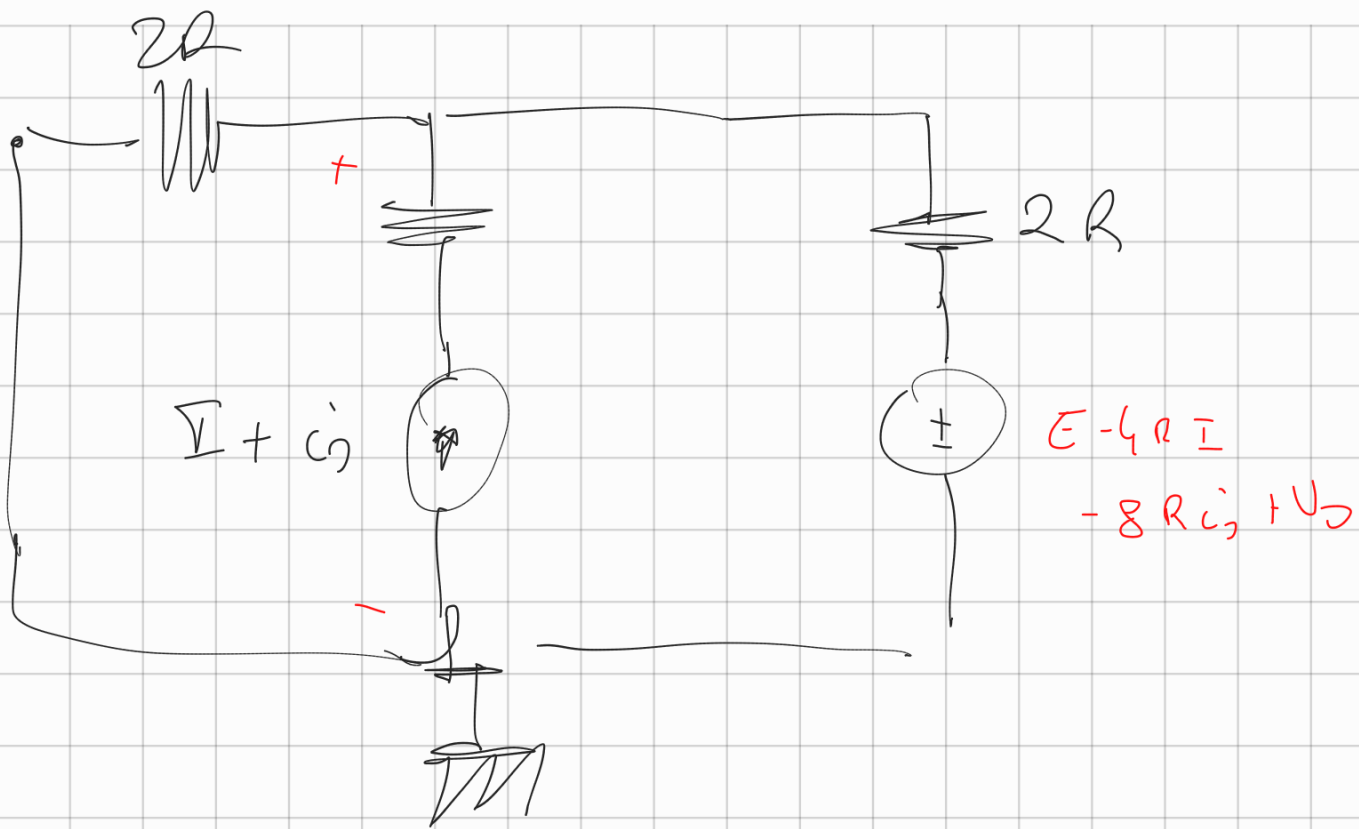
$\Rightarrow$



$$\begin{pmatrix} + \\ - \end{pmatrix} E - 3V_x + V_y =$$

$$E - 6RI - 6Ri_0 + 2RI - 2Ri_0 + V_0$$

$$= E - 4RI - 8Ri_0 + V_0$$



Millman

$$I + i_0 + \frac{(E - 4RI - 8Ri_0 + V_0)}{2R}$$

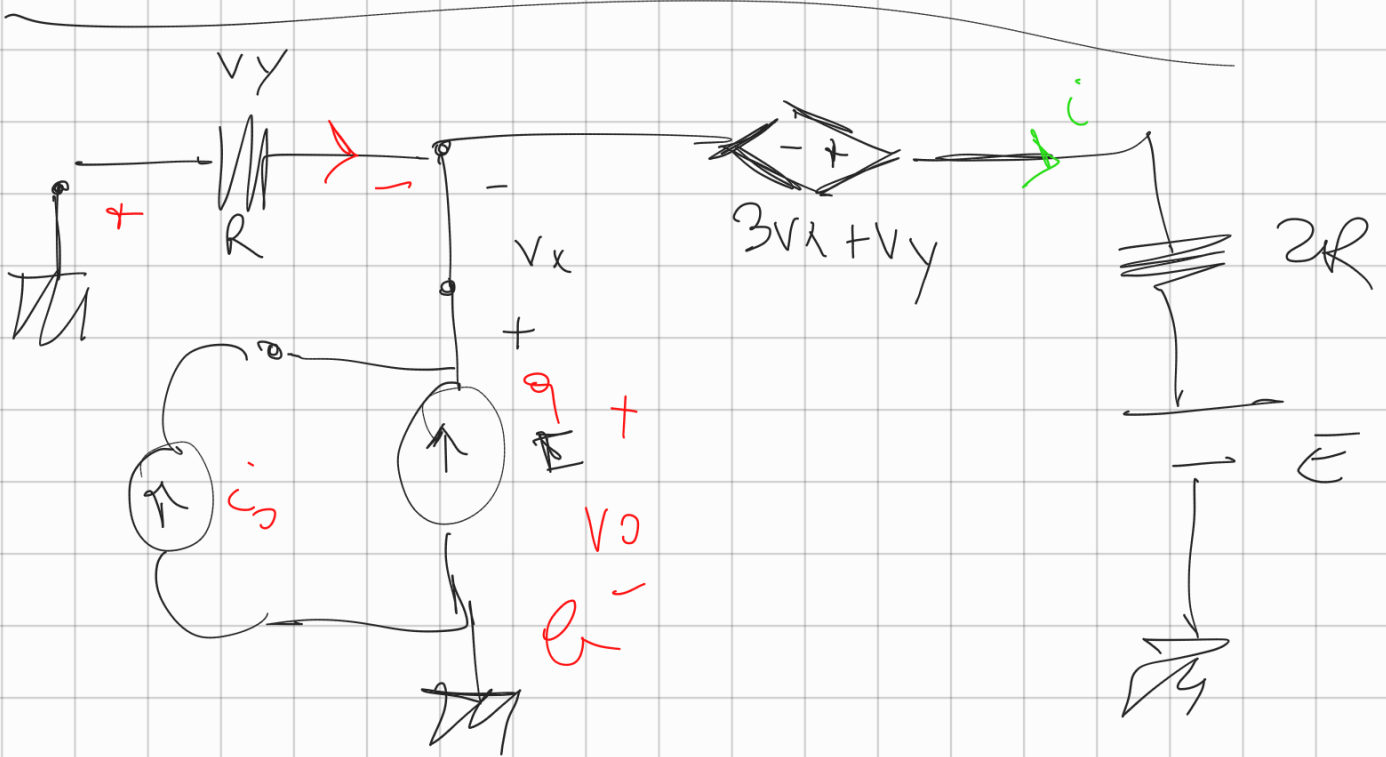
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$$\frac{1}{2R} + \frac{1}{2R}$$

$$V = IR + i_0 R + \frac{E - 2RI - 4Ri_0 + V_0}{2}$$

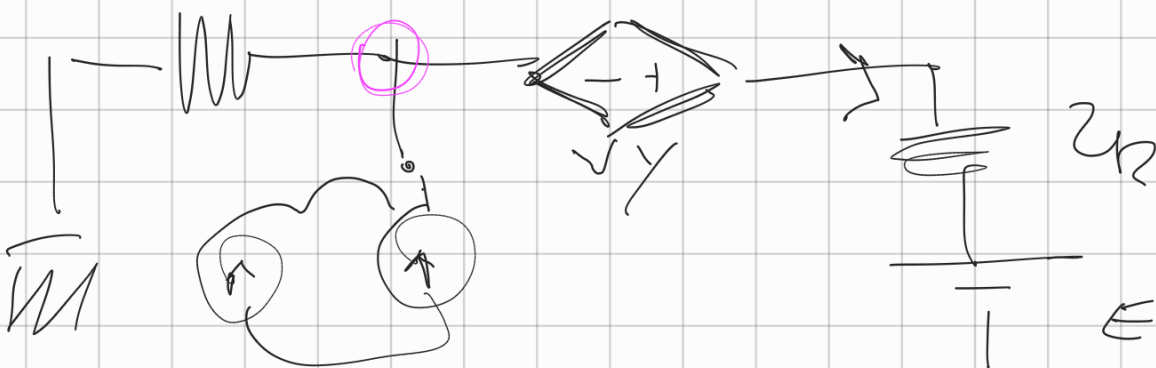
$$V = -V_x + V_0$$

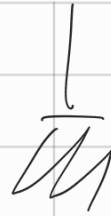
$$\begin{aligned}
 V_x &= -IR - i_o R - \frac{E}{2} + 2RI + 4Ri_o \\
 &= IR - 3Ri_o - \frac{E}{2}
 \end{aligned}$$



$$V_x = 0$$

$$V_y = R \cdot (I + i_o)$$





$$-V_0 - \cancel{V_0} + 2R i + \bar{E} = 0$$

$$i = \cancel{\frac{V_0}{2R}} - \frac{\bar{E}}{2R} + \cancel{\frac{V_0}{2R}}$$

$$V_Y + V_0 = 0$$

$$V_Y = -V_0$$

$$V_Y = R \cdot \left( -\frac{\bar{E}}{2R} - \bar{I} - i_0 \right)$$

$$-\bar{E} - R\bar{I} - i_0 R$$

$N_0$

$$f = 50 \text{ Hz}$$

$$X_L \Rightarrow 2 \text{ kVAR}$$

$$P_{\text{attiva}}$$

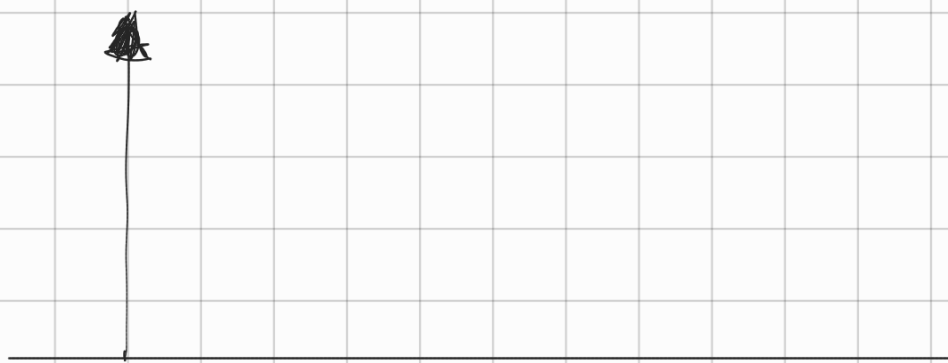
Q reattiva e potenza di riserva di cui

il efficiente risparmio a 0.8

$$Q_{X_L} = 2 \text{ kVAR}$$

$$Q = V_{\text{eff}} \cdot I_{\text{eff}} = 2 \text{ kVAR}$$

$$X_L = 10 \Omega$$



$$Q = I_{\text{eff}}^2 \cdot 10 \Rightarrow I_{\text{eff}} = 14,14 \text{ A}$$

$$P_{V_{5\Omega}} = 14,14^2 \cdot 5 = 1000 \text{ WATT}$$

$$A = \sqrt{1000^2 + 2000^2} = 2236 \text{ VA}$$



$$V_{eff} = 158 \text{ V}$$

No a transfered

parallel, proceed can Brown impedance

$$I = \frac{V}{Z}$$

$$\bar{Z} = 10 \Omega + j5 \Omega$$

$$Z = 11.18$$

$$I = 14.15 \text{ A}_{eff}$$

$$P_{10\Omega} = 2002 \text{ W}$$

$$Q_{5\Omega} = 1001 \text{ VAR}$$

$$P_G = 3000 \text{ W}$$

$$Q_G = 3000 \text{ VAR}$$

$$A_G = 4242 \text{ VA}$$

$$I_{AB} = 26.85 \text{ A}_{eff}$$

$$Q_{2\Omega} = 1441 \text{ VAR} \quad P_{1\Omega} = 720 \text{ W}$$

$$P_{AB} = 3720 \text{ W}$$

$$Q_{AB} = 4442 \text{ VAR}$$

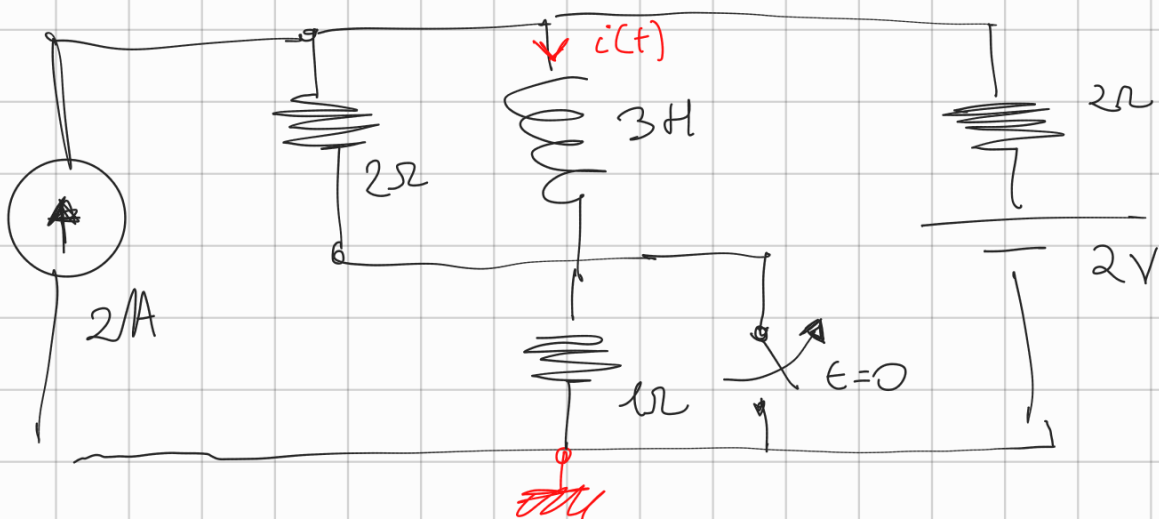
$$A_{AB} = 9784 \text{ VA}$$

$$\varphi_z = 25.85^\circ$$

$$V_{AB} = 215 \text{ Veff}$$

$$C_{\text{con}} = \frac{4442 - 3720 \cdot (0.489)}{314 \cdot 215^2} =$$

$$= 181 \mu\text{F}$$

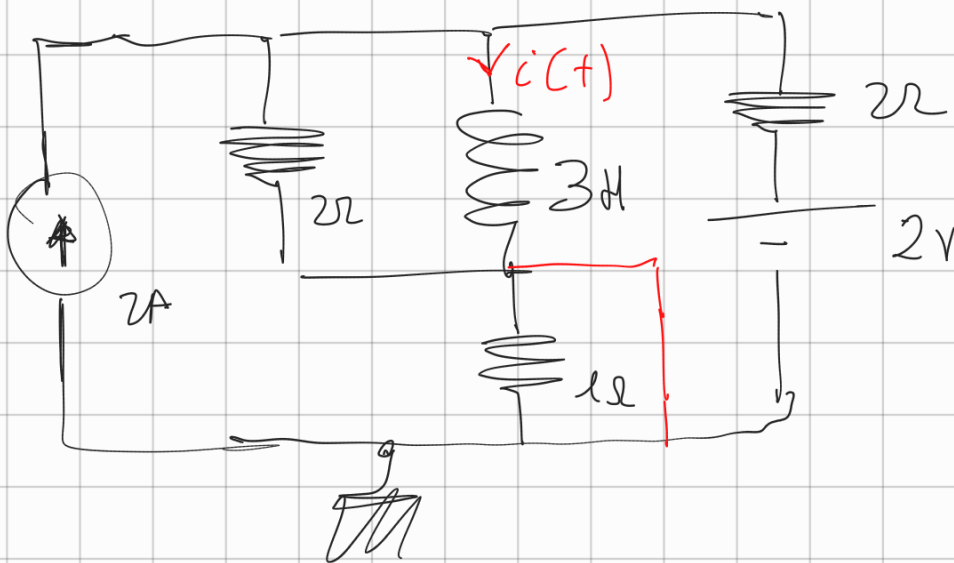


- Determinare forte l'ba, potenza, derivata e di regime osservati

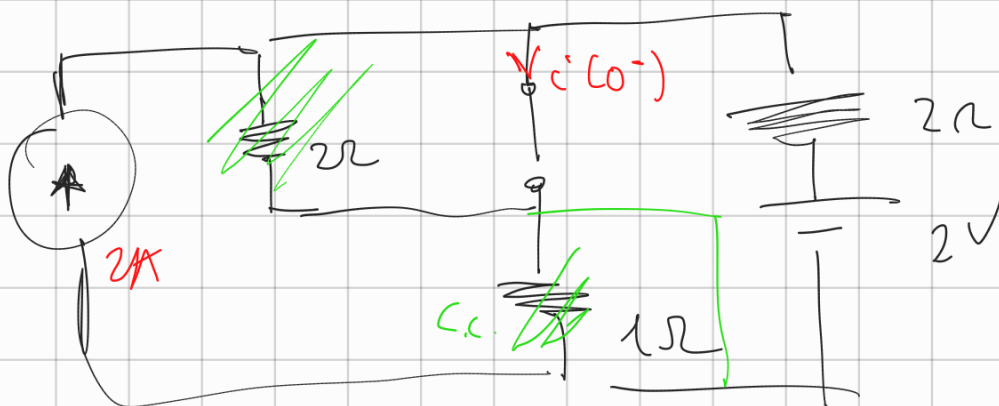
reg. stoc. 1      nuovo capitolo      reg. stoc. 2

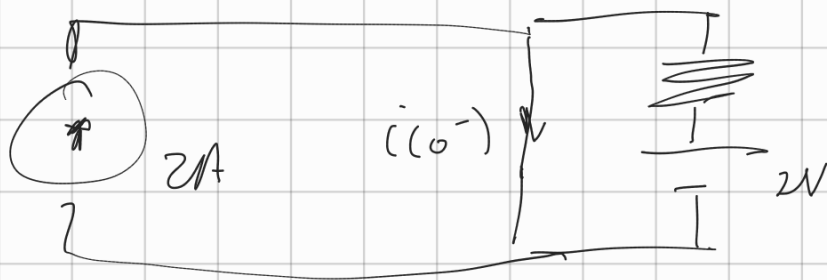
$i(0^-)$        $t=0$        $i(0^+)$

$i(t)$ , variabile di stato



- Due Borne c'è a  $0^-$ , il circuito è a regime stoc.
- $L \rightarrow C.C.$





$i(0^-)$  è dato dal regime prima di chiudere



$$\frac{3A \cdot 4}{4 + \frac{1}{2}} = \frac{3}{\frac{3}{2}} = 2A$$

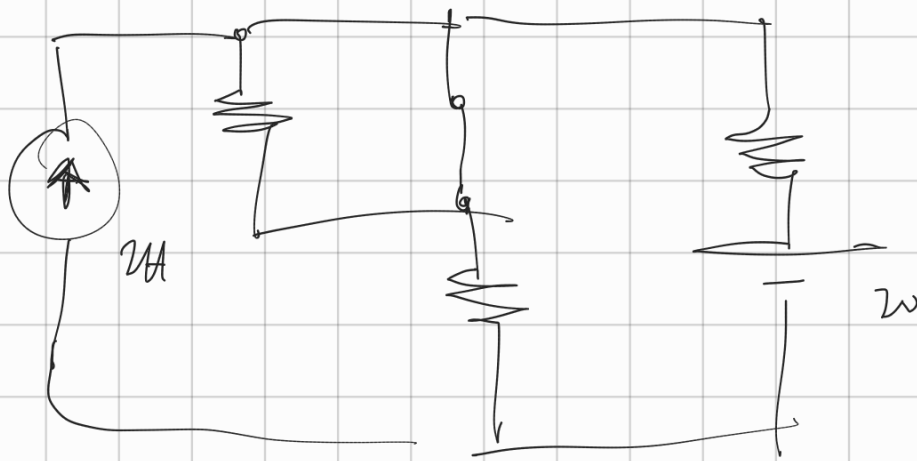
•  $i(0^-) = i(0^+) = \cancel{2A} \text{ } 3A$  // circuito non reg.

$i$  continuo a  $t = 0^+$   $t > 0$

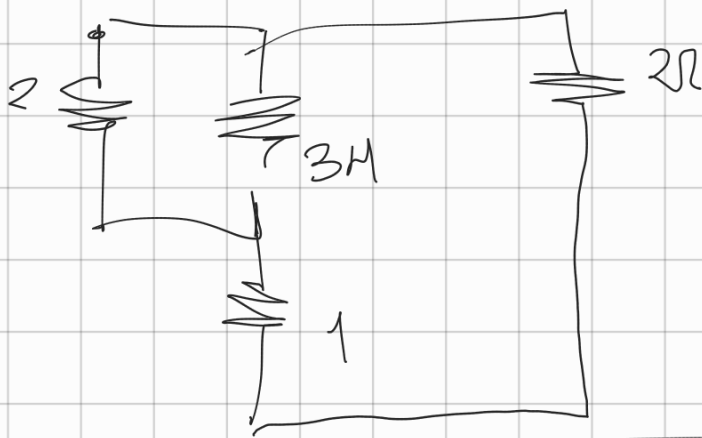
$$i(t) = i(0^+)e^{-\frac{t}{\tau}} + i(\infty)(1 - e^{-\frac{t}{\tau}})$$

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

$$i(\infty) = 2A$$

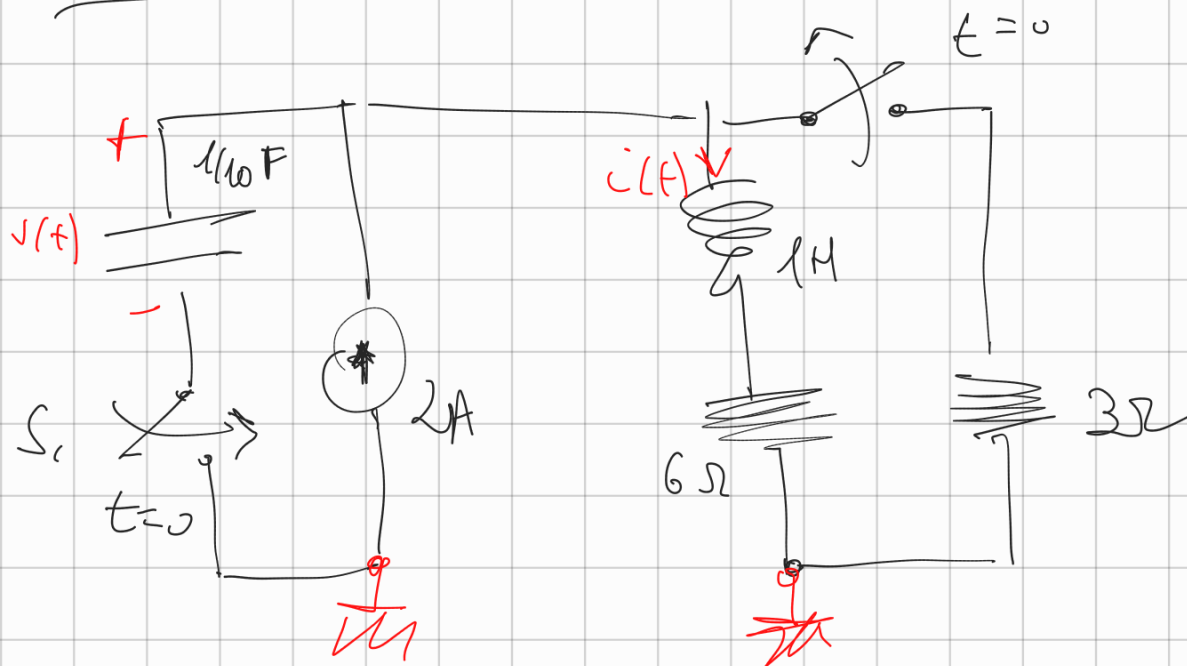


↪ determine enclosed I here a  $\odot^+$ ,  $\angle \omega$



$$R_{eq} = 3 \parallel 2 = \frac{6}{5}$$

$$\gamma = \frac{L}{R} = \frac{3.5}{6} = \frac{7}{12}$$

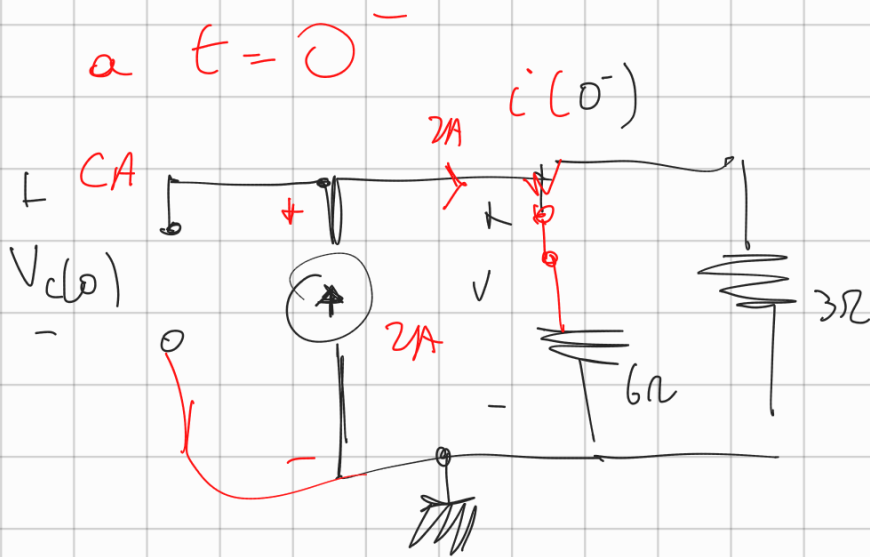


Ver. 8/20  $v_c(t)$ ,  $i'(t)$

regime 1

regime 2

|                                       |                                       |
|---------------------------------------|---------------------------------------|
| $t = 0^-$<br>$V_C(0^-)$<br>$i_L(0^-)$ | $t = 0^+$<br>$V_C(0^+)$<br>$i_L(0^+)$ |
|---------------------------------------|---------------------------------------|



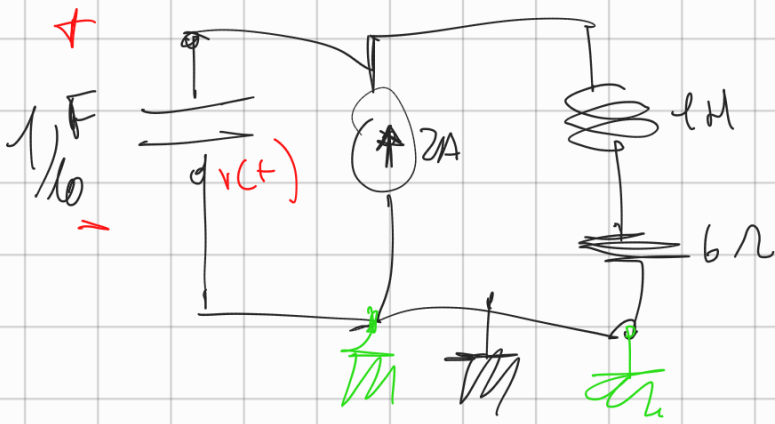
$i(0^-)$  partil. cour

$$i(0^-) = \frac{2A \cdot \frac{1}{6}}{\frac{1}{6} + \frac{1}{3}} = \frac{\frac{1}{3}}{\frac{3}{6}} = \frac{6}{3} = 2A$$

$$i(0^-) = i(0^+) = \frac{2}{3} A$$

$$V_C(0^-) = 2V \text{ detum}$$

$t > 0$



Per vedere in che cosa serve, fare  
i generatori

Sono in serie

$$R_{eq} = 6 \Omega$$

$$\alpha = \frac{R_s}{2L} = \frac{6}{2} = 3$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow \omega_0^2 = \frac{1}{LC} = 10$$

$$R_s ? R_c \quad R_c = 2 \sqrt{\frac{L}{C}} = 2\sqrt{10}$$

$R_s < 6,32$ , caso sottosmorzato

$$\beta = \sqrt{\omega_0^2 - \alpha^2} = \sqrt{10 - 9} = 1$$

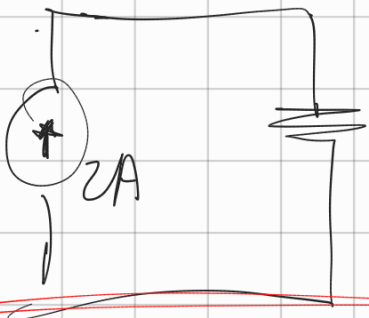
$$s_{1,2} = -3 \pm j$$

$$i(t) = k_1 e^{-3t} \cos(t) + k_2 e^{-3t} \sin(t)$$

TRANSITORIO  
COMPLETO

$i(\infty)$  2 regime

$i(\infty)$



$$i(\infty) = 2A$$

Per  $k_1$  e  $k_2$ , istantanea a  $0^+$  e applico C in  $\infty$

$$V_C(0^+) = 2V$$

$$i_L(0^+) = \frac{2}{3}A$$



Comunque,  $i_L(0^+)$  è un'istantanea



$$\begin{cases} i(t) = k_1 e^{-3t} \cos(t) + k_2 e^{-3t} \sin(t) + 2A \\ i_L(0^+) = \frac{2}{3} A \\ \frac{di_L(0^+)}{dt} = -2 A / \text{sec} \end{cases}$$

Bzw  $V_L$

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

da KV  $V_L + 6\left(\frac{2}{3}\right) - 2V = 0$

$$V_L = 2V - 4V = -2V$$

$$\frac{di(t)}{dt} = \frac{-2V}{1} = -2 \text{ A/sec}$$

e' una sinusoide

$$i(0^+) = k_1 + 2A = \frac{2}{3} A$$

$$k_1 = \frac{2}{3} - 2A = -\frac{4}{3}$$

$$\frac{di(t)}{dt} = -3k_1 e^{-3t} \cos(t) + k_2 e^{-3t} \sin(t)$$

$$t=0^+ \Rightarrow -3k_1 + k_2 = -2$$

$$-3\left(-\frac{4}{3}\right) + k_2 = -2$$

$$k_2 = -6$$

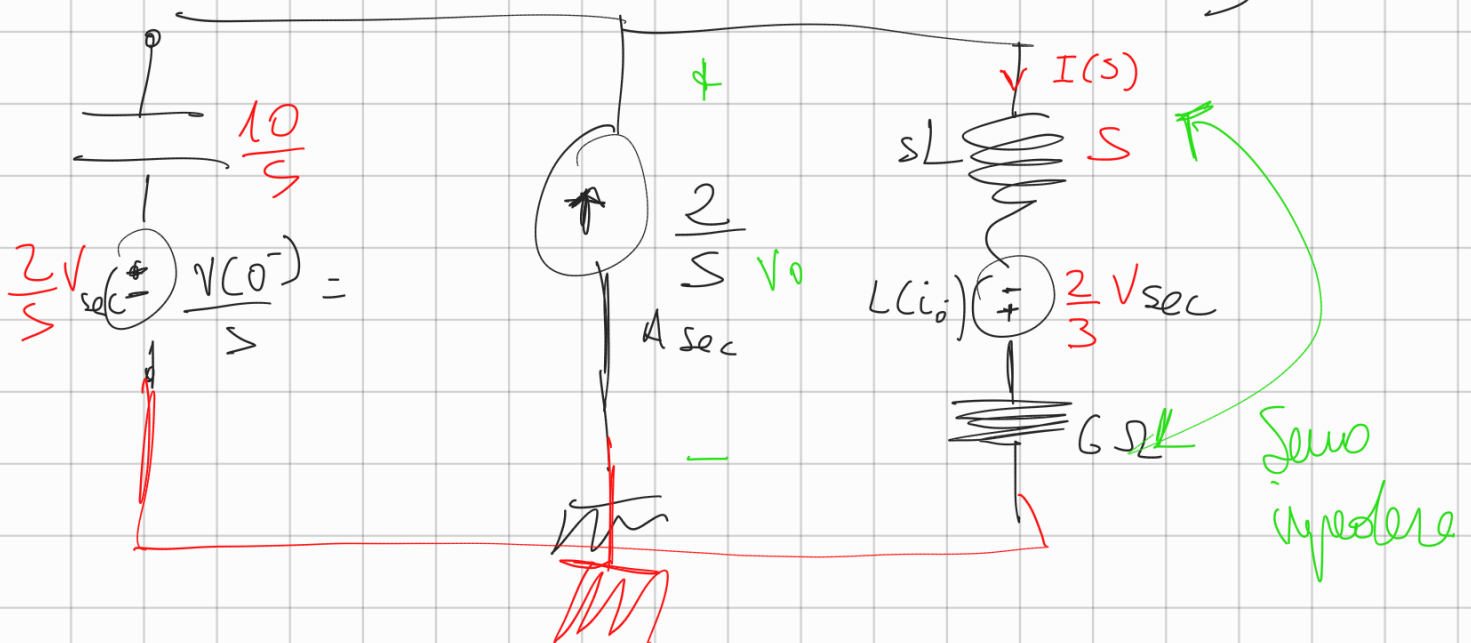
$$i(t) = \frac{4}{3} e^{-3t} \cos(t) - 6 e^{-3t} \sin(t) + 2$$

Circolo Impulso Laplace

Usa modello serie

$$v(0^-) = 2V$$

$$i(0^-) = \frac{2}{3} A$$



$$Z_C = \frac{1}{sC} = \frac{10}{s}$$

See Above  $I(s)$

$$\text{Millman } V_o = \frac{\frac{2}{s} + \frac{2}{s} \cdot \frac{s}{10} - \frac{2}{3} \frac{1}{s+6}}{\frac{s}{10} + \frac{1}{s+6}}$$

$$\frac{\frac{2}{s} + \frac{2}{10} + \frac{2}{3(s+6)}}{\frac{s}{10} + \frac{1}{s+6}} = \frac{\frac{2}{s} + \frac{2}{10} - \frac{2}{3(s+6)}}{\frac{s(s+6) + 10}{10(s+6)}}$$

$$\frac{20(s+6) + 2(s+6) - \frac{20}{3}}{s} =$$

$$\frac{s(s+6) + 10}{s^2 + 6s + 10}$$

$$\frac{20 + \frac{6}{s} + 2s + 12 - \frac{20}{3}}{s^2 + 6s + 10} = V_o$$

$$\bullet V_o = I(s) \cdot (s+6) - \frac{2}{3}$$

$$I(s) = \frac{V_o(s) + \frac{2}{3}}{s+6}$$

$$\frac{\frac{6}{\cancel{s}} + 2s^2 + \frac{76}{3}s}{s^3 + 6s^2 + 10s} + \frac{2}{3}$$

$$s + 6$$

$$2s^2 + \frac{76}{3}s + \frac{2}{3}(s^3 + 6s^2 + 10s)$$

$$s + 6(s^3 + 6s^2 + 10s)$$

$$I(s) \quad \frac{2}{3}s^3 + \frac{2}{3}(8s^2) + \frac{2}{3}\left(\frac{106}{3}s\right)$$

$$(s + 6)(s^3 + 6s^2 + 10s)$$

$$\left(\frac{2}{3}\right) s^3 + 8s^2 + \frac{106}{3}s$$

$$s(s + 6)(s^2 + 6s + 10)$$

$$s^3 + 8s^2$$

$$\frac{2}{3} \leq \left( s^2 + 8s + \frac{106}{3} \right)$$

$$F(s) = \frac{s^2 + 8s + \frac{106}{3}}{(s+6)(s^2 + 6s + 10)}$$

$$\Rightarrow \text{Pole in } s_1 = -6$$

$$s_{2,3} = -3 \pm j$$

$$A e^{-6t} + B e^{-3t} \cos(t) + C e^{-3t} \sin(t)$$

$$\frac{A}{(s+6)} + \frac{Bs+3}{(s+3)^2+1} + \frac{C}{(s+3)^2+1}$$

$$= \frac{A(s^2 + 6s + 10) + B(s+6)(s+3) + C(s+6)}{(s+6)(s^2 + 6s + 10)}$$

$$As^2 + 6As + 10A + Bs^2 + 9Bs + 18B + Cs + 6C$$

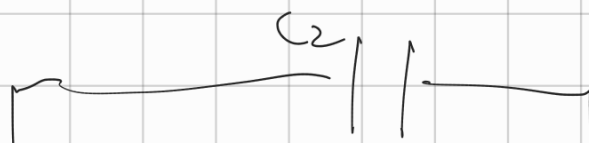
$$\begin{cases} A+B = 1 \\ 6A+9B+C = 8 \\ 10A+18B+6C = \frac{106}{3} \end{cases}$$

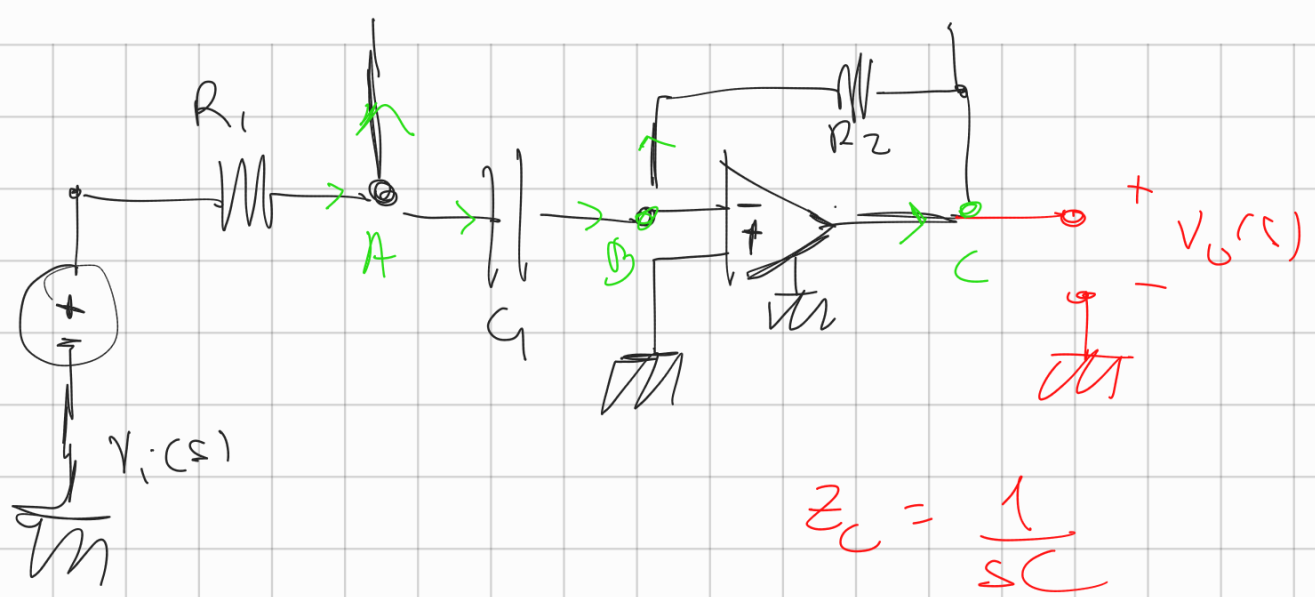
$$A = \frac{7}{3} \quad B = -\frac{4}{3} \quad C = 6$$

$$\frac{7}{3} u(t) - \frac{4}{3} e^{-3t} \cos(t) u(t) + 6 e^{-3t} \sin(t) u(t)$$

Für die Übertragung in Transfer

$$H(s) = \frac{V_o(s)}{V_i(s)}$$





$$Z_C = \frac{1}{sC}$$

K1 al nodo B

$$V_B = 0 \text{ V}$$

$$\frac{(V_A - V_B)}{\frac{1}{sC_1}} = \frac{-V_o}{2R}$$

$$-\frac{V_o}{2R_2} = V_A \cdot sC_1$$

$$V_o = V_A \cdot sC_1 \cdot 2R_2$$

KI al nodo A

$$-\frac{(V_i - V_A)}{R_1} + V_A sC_1 + (V_A - V_o) sC_2 = 0$$

$$\frac{V_A}{R_1} + V_A s C_1 + V_A s C_2 - V_C s C_2 = 0$$

$$- \frac{V_1}{R_1}$$

$$\frac{V_A}{R_1} + V_A s C_1 + V_A = V_C s C_2$$

$$V_A \left( \frac{1}{R_1} + s C_1 + 1 \right) = V_C s C_2 + \frac{V_1}{R_1}$$

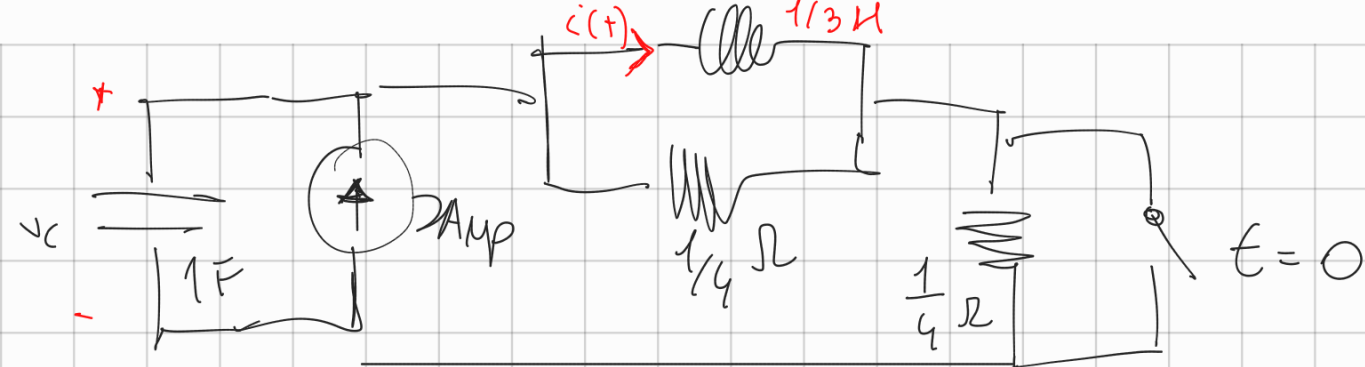
$$V_A = \frac{V_C s C_2}{\frac{1}{R_1} + s C_1 + 1} + \frac{V_1}{R_1 s C_1 + R_1}$$

$$V_C = V_A \cdot s C_1 \cdot 2 R_2$$

$$= \frac{V_C s C_2 \cdot s C_1}{\frac{1}{R_1} + 1}$$

$i(t) \in \mathbb{R}_0$  RISPONDA completa  
nel DT e verifico nel DL

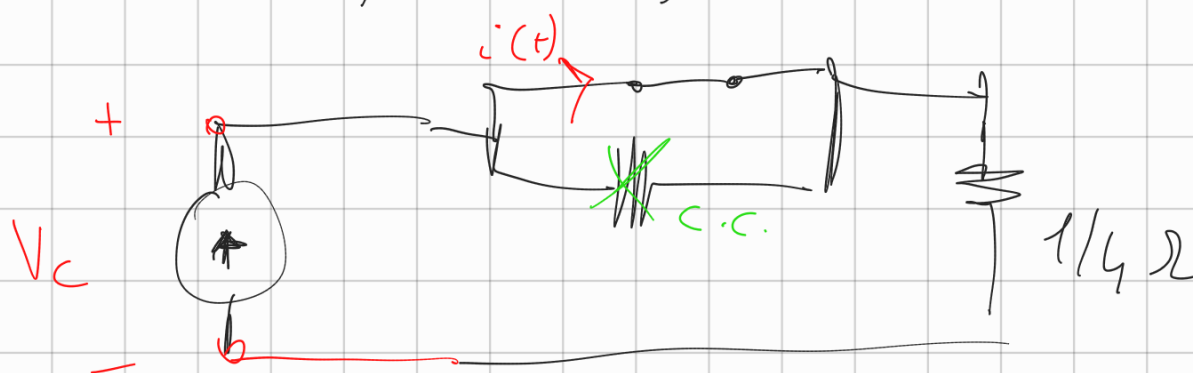




Variabili di stato  
 Reg. Str. 1  $V_C$  e  $i_C$   
 Reg. Str. 2  
 Timeline:  $i(0^-), V(0^-)$  at  $t=0$  and  $i(0^+), V(0^+)$

C. to non separare

Per  $i(0^-)$  e  $V(0^-)$  valiamo circuito a  $t=0^-$



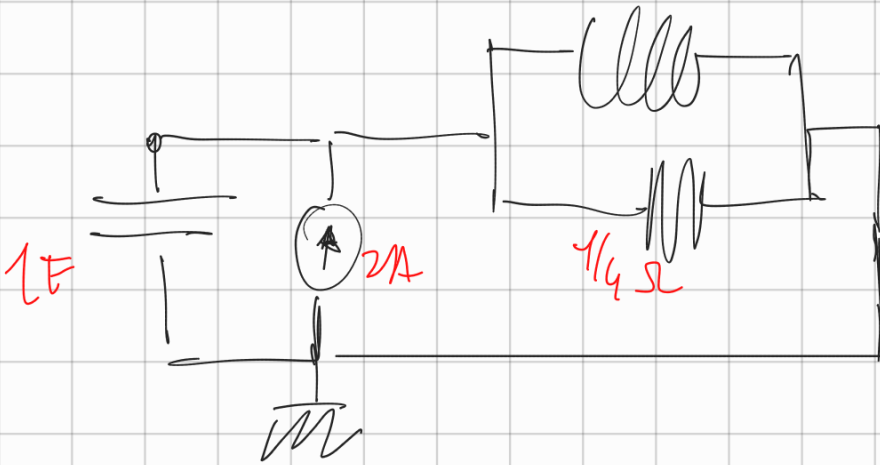
$$i(0^-) = 2\text{ A} \quad V_C(0^-) = \frac{1}{2} V$$

C. to non separare,

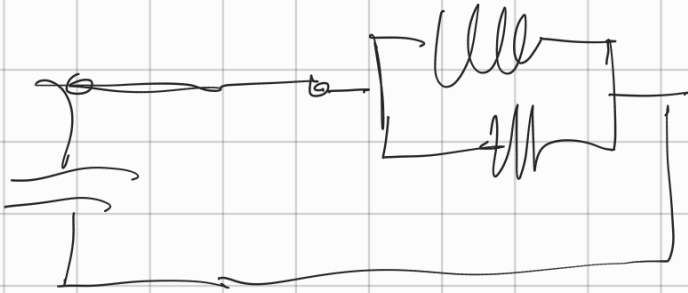
$$i(0^-) = i(0^+) = 2\text{ A} \quad V_C(0^-) = V_C(0^+) = \frac{1}{2} V$$

$$\epsilon > 0$$

$$\frac{1}{3} \text{ H}$$

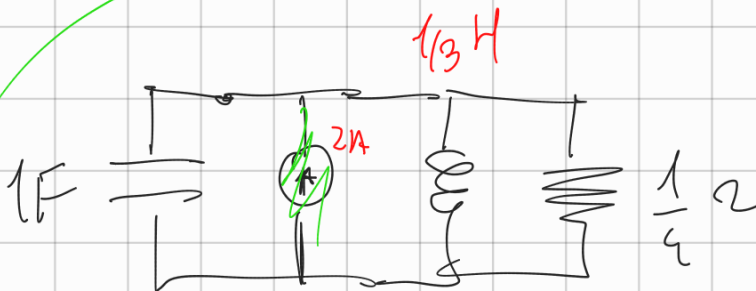


in the case source? Super pos



$\Rightarrow$  RLC parallel

$$R_p = \frac{1}{4} \Omega$$



$$C_p = 4 \Omega$$

can obtain Norton

$$C = TC + \text{Ney. Res. } 2$$

$$i(\infty) = 2A$$

$$C = 1$$

$$\alpha_{\text{parallel}} = \frac{G_p}{2C} = 2$$

$$\omega_0^2 = \frac{1}{LC} = 3 \quad \omega_0 = \sqrt{3}$$

$$G_p > \omega_0, \quad G_p > G_c = 2\sqrt{3}$$

$$\alpha > \omega_0, \quad \text{cas suramortissement}$$

$$s = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2} \Rightarrow$$

$$= -2 \pm \sqrt{1} = -1, -3$$

$$s_1 = -1$$

$$s_2 = -3$$

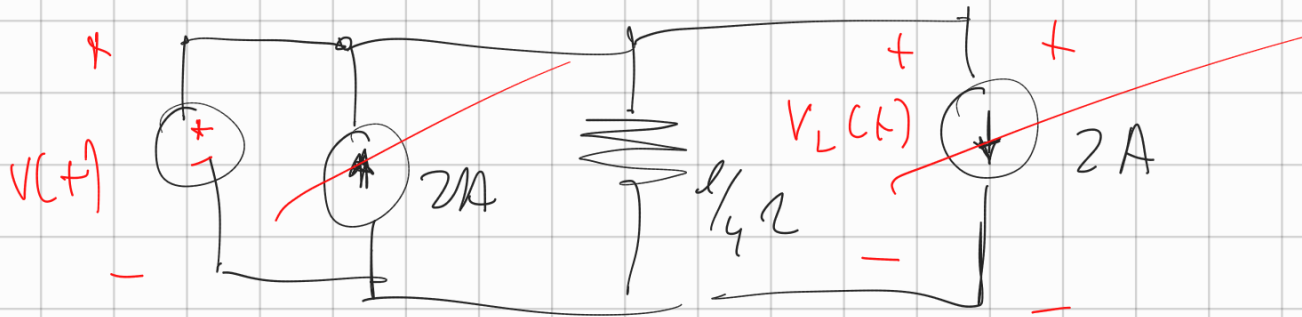
rad/sec

$$i(t) = \underbrace{k_1 e^{-t} + k_2 e^{-3t}}_{TC} + 2 + i(\infty)$$

Per le condizioni, calcoliamo le cost. det.

$$i(0^+) = 2A, \quad V(0^+) = \frac{1}{2} V$$

qualmo circolo a  $0^+$ , per Duvoy  $\frac{di_L}{dt} = \frac{V_L(0)}{L}$



$$V_L(t) = V_0(t)$$

$$\frac{di_L}{dt} = \frac{\frac{1}{2}}{\frac{1}{3}} = \frac{3}{2} \text{ A sec}$$

Problema.

$$\begin{cases} i(t) = k_1 e^{-t} + k_2 e^{-3t} + 2 \\ i(0^+) = 2A \\ \frac{di(0^+)}{dt} = \frac{3}{2} \text{ A sec} \end{cases}$$

$$i'(0^+) = k_1 - 3k_2 + 2 = 2 \quad 0$$

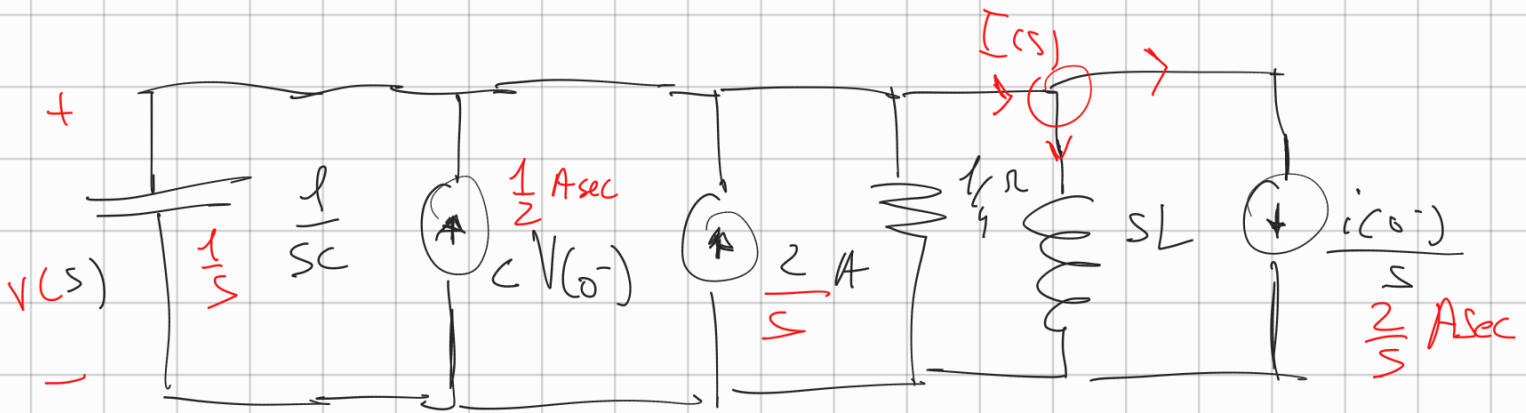
$$-k_1 - 3k_2 = \frac{3}{2}$$

$$k_1 = \frac{3}{4}$$

$$k_2 = -\frac{3}{4}$$

$$c(t) = \frac{3}{4} e^{-t} - \frac{3}{4} e^{-3t} + 2 \quad t \geq 0$$

Circuito Sottoposto Laplace



$$Z_C = \frac{1}{s}$$

$$I(s) = \frac{V(s)}{sL} + \frac{2}{s}$$

$$cV(0^-) = \frac{1}{2} Asec$$

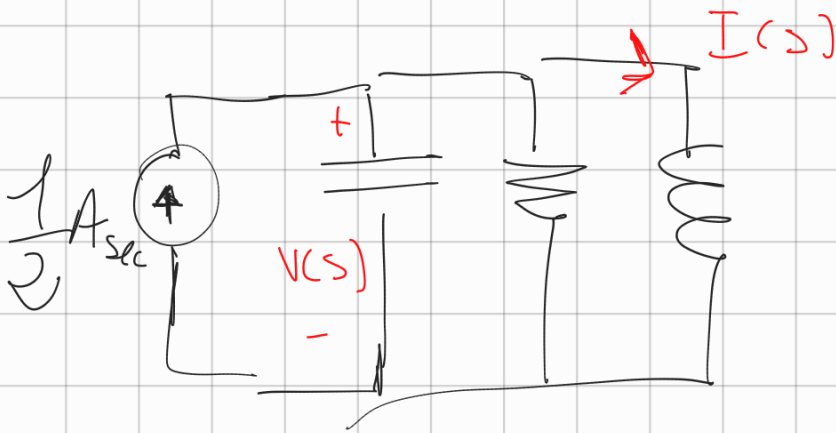
$$sL = \frac{s}{3}$$

$$\frac{c(0^-)}{s} = \frac{2}{s} Asec$$

• Derivazione  $I(s)$

Sono i generati di corrente

$$\frac{1}{2} + \frac{2}{s} - \frac{2}{s} = \frac{1}{2}$$



con Port in. corrente

$$\frac{\frac{1}{2} \cdot \frac{3}{s}}{s + 4 + \frac{3}{s}} = \frac{\frac{3}{2s}}{s^2 + 4s + 3}$$

$$= \frac{3}{2} \cdot \frac{1}{s^2 + 4s + 3} = \frac{1}{(s+1)(s+3)}$$

$$= \frac{3}{2} F(s)$$

poli.  $s_1 = -1$   $s_2 = -3$

$\Rightarrow$  aufheben

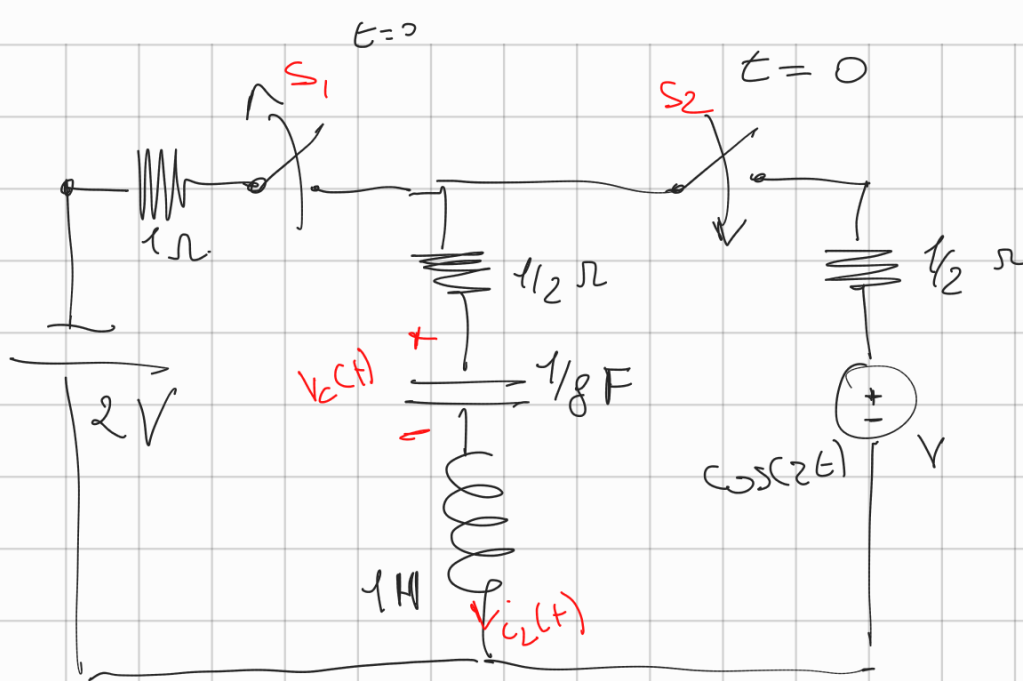
$$\frac{3}{2} \left[ A e^{-t} + B e^{-3t} \right] u(t)$$

$$A = \lim_{s \rightarrow -1} (s+1) F(s) = \frac{1}{2}$$

$$B = \lim_{s \rightarrow -3} (s+3) F(s) = -\frac{1}{2}$$

$$\Rightarrow c(t) = \frac{3}{4} e^{-t} + -\frac{3}{4} e^{-3t} u(t) + 2u(t) \quad \text{glatt}$$

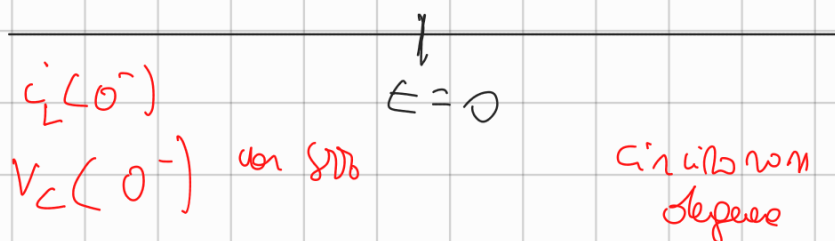
Sp. 1 von 1



Determinare  $v(t)$ ,  $t > 0$ , prima e dopo

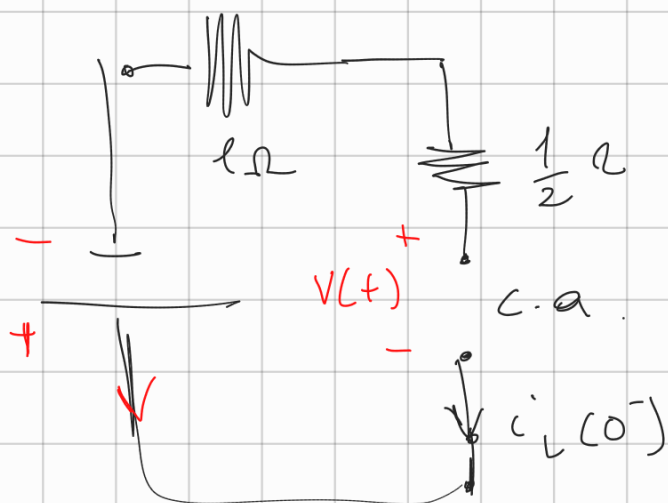
Regime Staz.

Regime Transiz.



analisi a  $t=0^-$  per trovare variabile staz.

$t=0^-$



$$v_C(0^-) = -2V$$

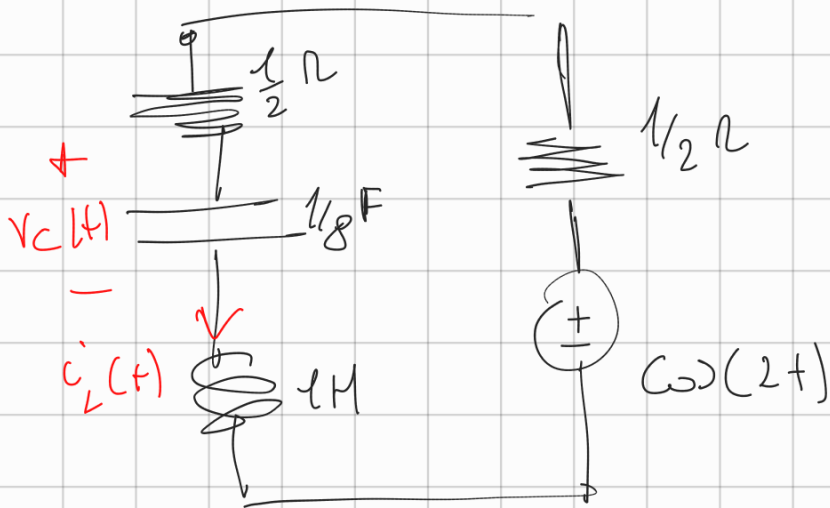
$$i_L(0^-) = 0A$$

C. non spezzare.



• Design complete RLC

$$a \quad t = 0^+$$



the solutions in Nizjor's library, e

um RLC series con

$$R_s = 1 \Omega$$

$$\alpha_s = \frac{R_s}{2L} \text{ rad/sec} = \frac{1}{2} \text{ rad/sec}$$

$$\omega_0^2 = \frac{1}{LC} = 8 \text{ rad/sec}$$

$$\alpha_p < \omega_0, \quad \text{cos subsmorzo}$$

$$s_{1,2} = -\alpha \pm j\beta \quad \beta = \sqrt{\omega_0^2 - \alpha^2} =$$

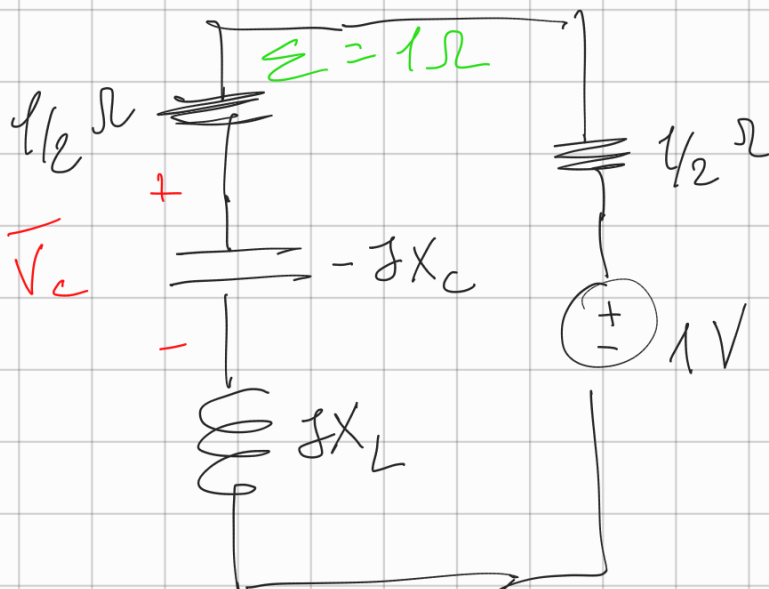
$$s_{1,2} = -\frac{1}{2} \pm j \frac{\sqrt{3}}{2}$$

$$V(t) = k_1 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{3}}{2}t\right) + k_2 e^{-\frac{1}{2}t} \sin\left(\frac{\sqrt{3}}{2}t\right) + i_{reg. sinus.}(t)$$

• Trovo  $i_{reg. sinus.}$  con metodo Forzi

Circuito Simbolico D. Forz.

$$\omega = 2$$



$$X_C = \frac{1}{\omega C} = 4 \Omega$$

$$X_L = \omega L = 2 \Omega$$

$V_C$  ? Partizione tensione

$$\bar{V}_c = \frac{1 \cdot -j4}{1 - j4 + j2} = \frac{-j4}{1 - j2} \cdot \frac{(1+j2)}{(1+j2)}$$

$$\bar{V}_c = \frac{8 - j4}{5} \text{ V} = 1.8 e^{-j26^\circ}$$

$$\Rightarrow v_c(t) = 1.8 \cos(2t - 26^\circ)$$

$$\left\{ \begin{aligned} v_c(t) &= k_1 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{3}}{2}t\right) + k_2 e^{-\frac{1}{2}t} \sin\left(\frac{\sqrt{3}}{2}t\right) \\ &\quad + 1.8 \cos(2t - 26^\circ) \end{aligned} \right.$$

$$v_c(0^+) = -2 \text{ V}$$

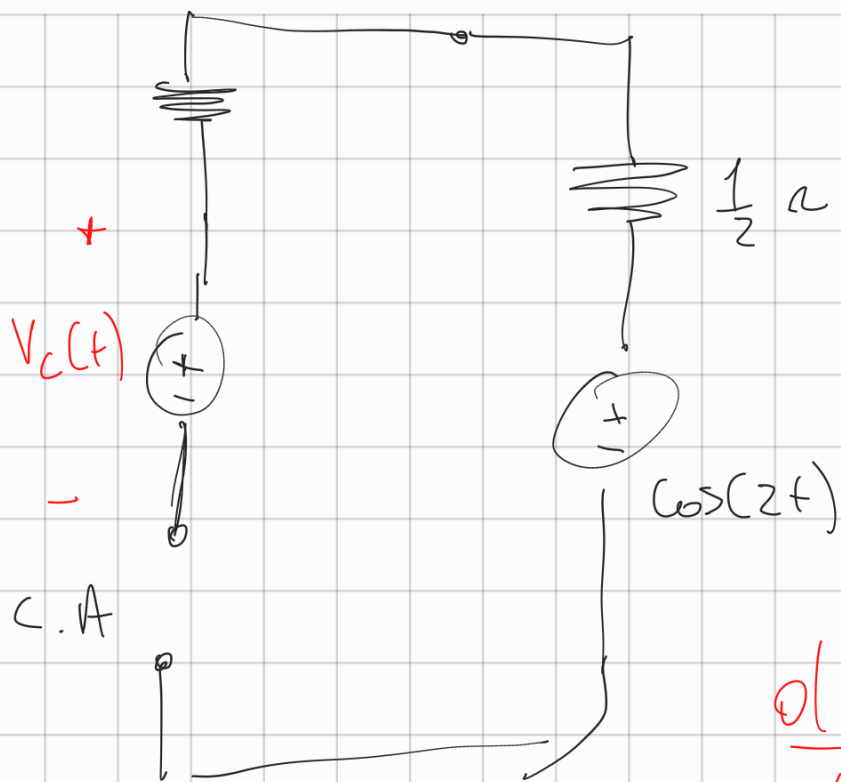
$$i_L(0^+) = 0$$

$$\frac{d v_c(0^+)}{dt} ?$$

$$i_c(t) = C \frac{d v_c(t)}{dt} \quad \text{istartieren a } 0^+$$

$$\text{com } C \text{ con } \omega$$

$$\text{Circuito a } 0^+$$



Stato di carica

$$i_c = 0$$

Voglio  $i_c(0^+)$  e  
s' carica

$$i_c(0^+) = 0$$

$$\frac{dv}{dt} = \frac{i_c}{C} = 0$$

$$\left\{ \begin{aligned} V_c(t) &= k_1 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{3}}{2}t\right) + k_2 e^{-\frac{1}{2}t} \sin\left(\frac{\sqrt{3}}{2}t\right) \\ &\quad + 1.8 \cos(2t - 26^\circ) \end{aligned} \right.$$

$$V_c(0^+) = -2V$$

$$\frac{dv_c}{dt} = 0$$

$$V_c(0^+) = k_1 + 1.8 \cos(-26^\circ) = -2$$

$$k_1 = -3.62$$

da wo

$$-\frac{1}{2} k_1 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{31}}{2}t\right) + k_2 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{31}}{2}t\right) \frac{\sqrt{31}}{2}$$

0

$$-\frac{1}{2} k_1 + \frac{\sqrt{31}}{2} k_2 = 0$$

$$k_2 = -1.81 \cdot \frac{2}{\sqrt{31}} = -0.65$$

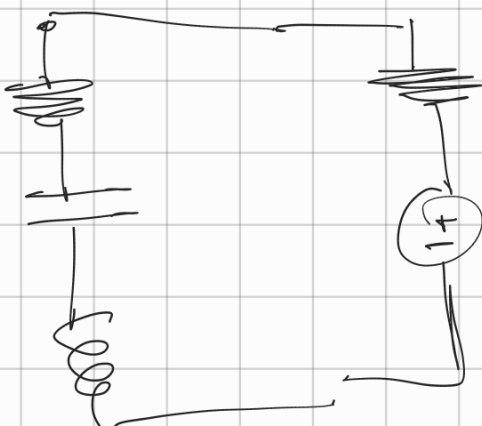
$$\begin{aligned} V_c(0^+) &= -3.62 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{3}}{2}t\right) \\ &\quad - 0.65 \sin\left(\frac{\sqrt{3}}{2}t\right) \\ &\quad + 1.8 \cos(2t - 26^\circ) \end{aligned}$$

airwobnel

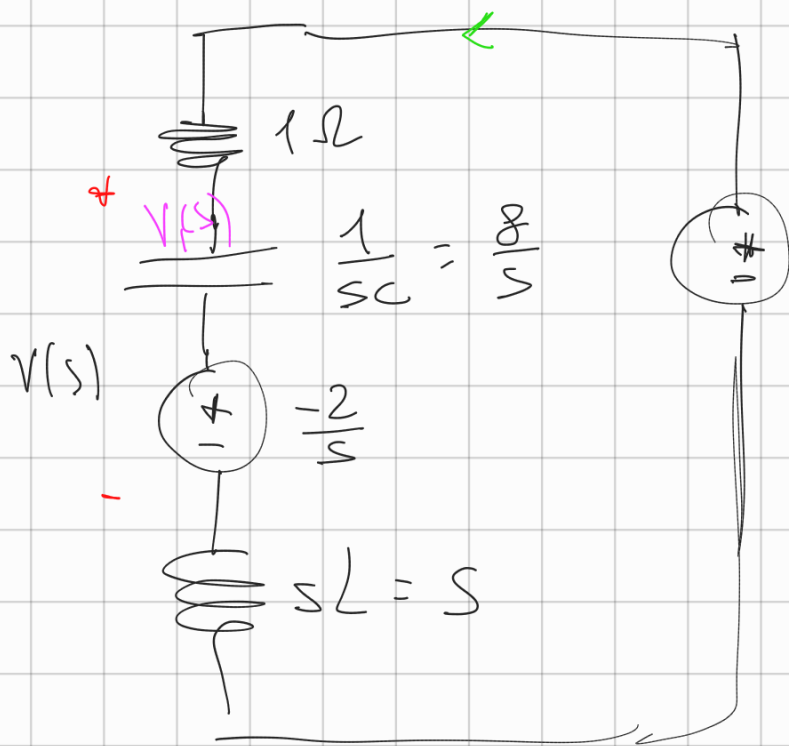
DL

$$V_C = -2V$$

$$i_L = 0 \text{ A}$$



uso modello serie



$V(s) ?$

$\omega = 2$

$$\frac{s}{s^2 + 4}$$

$$\frac{s}{s^2 + 4} = I + \frac{8I}{s} - \frac{2}{s} + sI$$

$$\Rightarrow I(1 + \frac{8}{s} + s) =$$

$$V(s) = V_1(s) - \frac{2}{s}$$

$$\frac{s}{s^2 + 4} + \frac{2}{s}$$

$$= \frac{\frac{s}{s^2 + 4} + \frac{2}{s}}{1 + \frac{8}{s} + s} = \frac{\frac{s^2}{s^2 + 4} + 2}{s^2 + s + 8} + \frac{2}{s} = \frac{s^2 + 2s^2 + 8}{(s^2 + 4)(s)} = \frac{3s^2 + 8}{(s^2 + 4)(s)}$$

$$V_1(s) = \frac{3s^2 + 8}{(s^2 + 4)(s)} \cdot \frac{s}{s} = \frac{3s^2 + 8}{s^2 + s + 4}$$

$$\frac{s^2 + s + 8}{s}$$

$$= \frac{24s^2 + 64}{(s^2+4)(\cancel{s})(s^2+s+8)}$$

$$\frac{\frac{s^2}{s^2+4} + 2}{s^2+s+8} \cdot \frac{8}{s} =$$

$$\frac{\frac{8s}{s^2+4} + \frac{16}{s}}{s^2+s+8}$$

$$= \frac{\frac{8s^2 + 16(s^2+4)}{s^2+4}}{s^2+s+8}$$

$$\bullet \frac{24s^2 + 64}{(s^2+s+8)(s^2+4)}$$

$$\Rightarrow s^4 + 4s^2 + s^3 + 4s + 8s^2 + 32$$

$$s^4 + s^3 + 12s^2 + 4s + 32$$

$\Rightarrow$  aufwerfen, Pol:

$$s_{1,2} = -\frac{1}{2} \pm j\frac{\sqrt{3}}{2}$$

$$s_{3,4} = \pm 2j$$

$$\Rightarrow A e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{3}}{2}t\right) + B e^{-\frac{1}{2}t} \sin\left(\frac{\sqrt{3}}{2}t\right) + C \cos(2t) + D \sin(2t)$$

Antinero

$$\omega_1 = \frac{\sqrt{3}}{2} \quad \omega_2 = 2$$

$$A \frac{s}{s^2 + \omega^2} + \frac{B \omega_1}{s^2 + \omega^2} +$$

$$+ C \frac{s}{s^2 + \omega_2^2} + \frac{D \omega_2}{s^2 + \omega_2^2}$$

$$= \frac{A(s + \frac{1}{2})}{(s + \frac{1}{2})^2 + (\frac{\sqrt{3}}{2})^2} + \frac{B(\frac{\sqrt{3}}{2})}{1} +$$

$$+ \frac{C s}{s^2 + 4} + \frac{2D}{s^2 + 4}$$

$$= \frac{A(s + \frac{1}{2})(s^2 + 4) + B(\frac{\sqrt{3}}{2})(s^2 + 4) + C s(s + \frac{1}{2}) + 2D(s + \frac{1}{2})^2}{1}$$



$$A \left( s^2 + s + \frac{1}{4} \right) (s^2 + 4) + B \frac{\sqrt{3}}{2} s^2 + 2\sqrt{3} B \\ + C s \left( s^2 + s + \frac{1}{4} \right) + D 2 \left( s^2 + s + \frac{1}{4} \right)$$

$$A (s^4 + 4s^2 + s^3 + 1) + B \frac{\sqrt{3}}{2} s^2 + 2\sqrt{3} B \\ + C (s^3 + s^2 + \frac{1}{4} s) + D 2s^2 + 2sD + \frac{1}{2} D$$

$$A s^4 + s^3 (A + C) +$$

$$s^2 \left( 4A + \frac{\sqrt{3}}{2} B + C + 2D \right)$$

$$s \left( \frac{1}{4} C + 2D \right) + A + 2\sqrt{3} B + \frac{1}{2} D$$

$$24s^2 + 64$$

$$A = 0$$

$$A + C = 0$$

$$\frac{\sqrt{3}}{2} B + C + 2D = 24$$

$$\frac{1}{4}C + 2D = 0$$

$$A + 2\sqrt{3}B + \frac{1}{4}D = 0$$

$$f = 50 \text{ Hz}$$

$$V_{\bar{z}_a} = 100 \text{ V}_{eff}$$

$$\cos(\varphi_{\bar{z}_a}) = 0,7 \text{ induttivo}$$

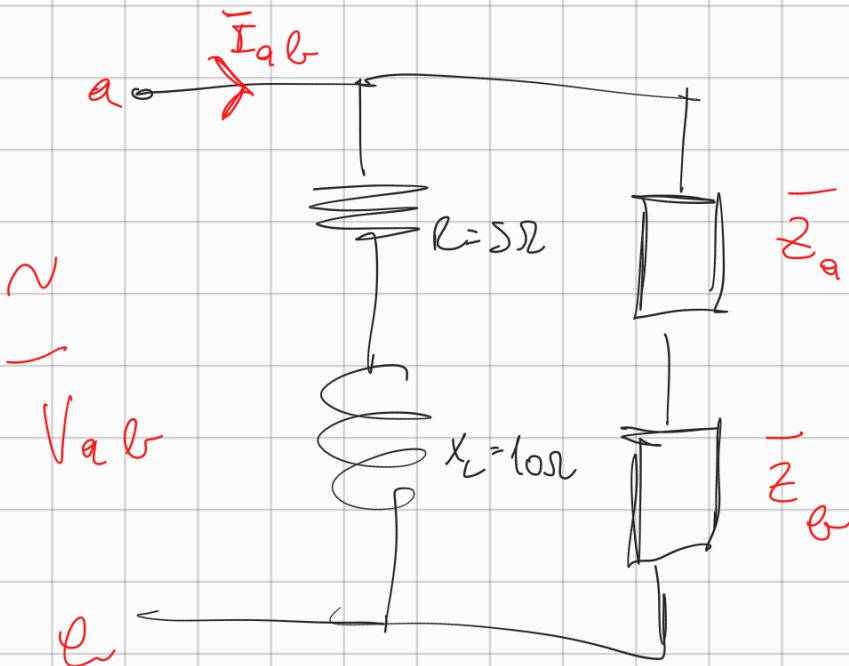
$$P_{a \bar{z}_a} = 1 \text{ kW}$$

$$V_{\bar{z}_b} = 100 \text{ V}_{eff}$$

$$\cos(\varphi_{\bar{z}_b}) = 0,3 \text{ capacitivo}$$

effettiva r. lineare

$$0,55 \text{ induttivo}$$

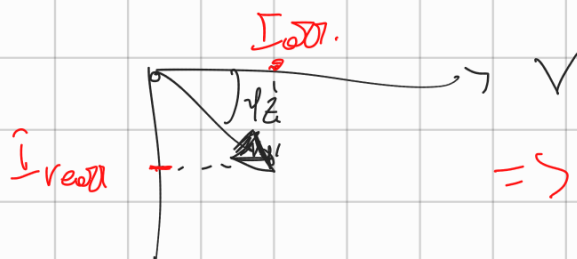


$$I_{\bar{z}_a}?$$

$$P_{a \bar{z}_a} = 1 \text{ kW} \Rightarrow P_a = V_{\bar{z}_a} \cdot I_{a \text{ eff}} =$$

$$\Rightarrow I_{a \text{ eff}} = 10 \text{ A}_{eff}$$

$$\varphi_z = 0,7$$



$$\Rightarrow \varphi_z = 49,57^\circ$$

$\vec{I}$  ass



$$\vec{I} \cdot \cos(\varphi_2) = \vec{I}_R$$

$$P = A \cdot \cos(\varphi_2)$$

$$A = \frac{P}{\cos(\varphi_2)}$$

$$1428 \text{ VA}$$

$$\Rightarrow Q = \tan(\varphi_2) \cdot A = 1020$$

$$Q_{\bar{z}_1} = 1020 \text{ VAR}$$

$$P_{\bar{z}_1} = 1000 \text{ W} \quad A_{\bar{z}_1} = 1428$$

$$I = 14,28 \text{ A}$$

$$\varphi_{z_2} = 72.55$$

$$A_{z_2} = 1428$$

$$P_{\bar{z}_2} = 1428 \cdot 0,3 = 428,5 \text{ W}$$

$$Q_{\bar{z}_2} = -1362 \text{ VAR}$$

$$P_A = 1428 \text{ W}$$

$$Q_B = 1020 - 1362 = -342 \text{ VAR}$$

$$A_B = 1468 \text{ VA}$$

$$V_B = \frac{1428}{14,28} = 100 \text{ V}_{\text{eff}}$$

$$\bar{Z}_A = 5 \Omega + j10 \Omega \Rightarrow Z_A = 11,2$$

$$I_{\text{eff}} = \frac{V_{\text{eff}}}{Z} = 8,95 \text{ A}_{\text{eff}}$$

$$P_R = 8,95 \cdot 5^2 = 223,75 \text{ W}$$

$$Q_R = 895 \text{ VAR}$$

$$Q_B = Q_A + 895 = 553 \text{ VAR}$$

$$P_B = 1428 + 223,75 = 1652 \text{ W}$$

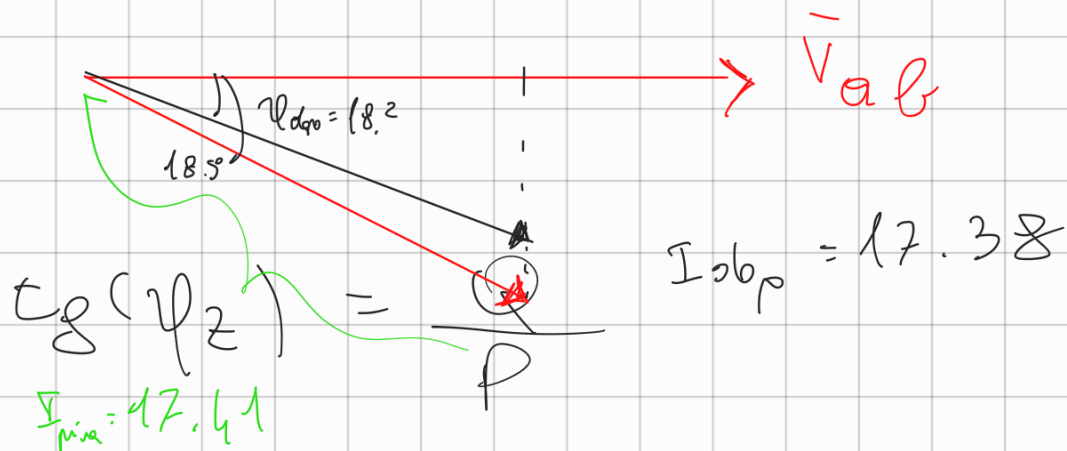
$$A_B = 9741$$

$$I_{AB} = 17,41 \text{ Aeff}$$

 $\psi z$ 

$$C = \frac{553 - 1652 \cdot \epsilon_g(18,2)}{314 \cdot 100^2} = \frac{9,85}{3}$$

$$= 3.13 \cdot 10^{-6} \text{ F}$$



$$\alpha_z = \arctan\left(\frac{Q}{P}\right) = 18.5^\circ$$

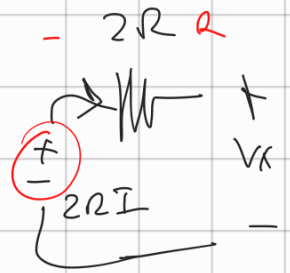
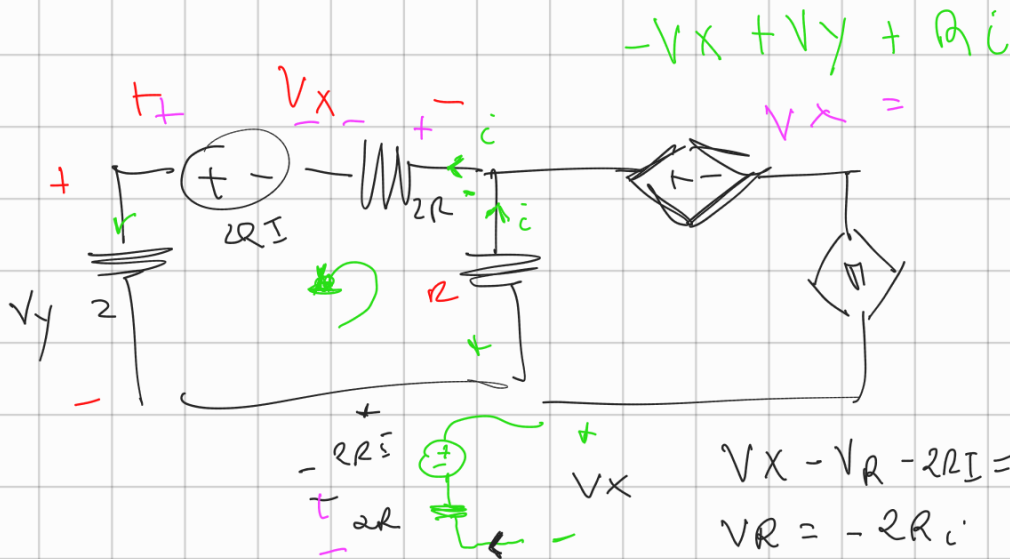
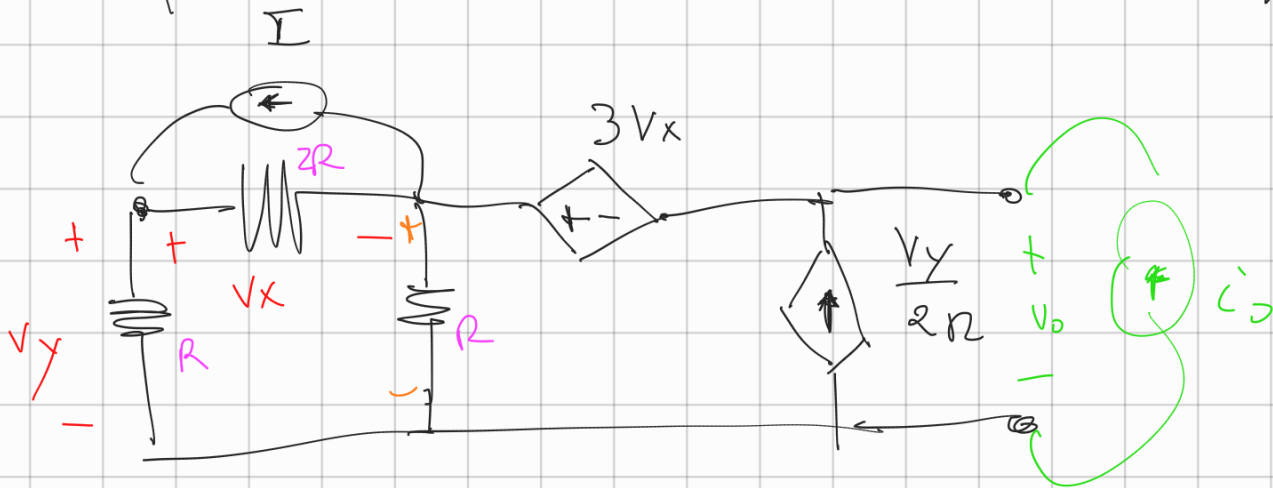
$$Q_{\text{Spino}} = 543,14$$

$$A_{\text{dopo}} = \sqrt{p^2 + Q_{\text{obp}}^2} = 1738 \text{ V}$$

Eq. Thavenu

AB

$$V_o = V_{eq} + R_{eq} i_o$$



$$V_x - V_R - 2RI = 0 \quad V_x = 2RI - 2Ri$$

$$V_R = -2Ri \quad V_x + 2Ri - 2RI = 0$$

$$2Ri - 2RI + Ri + Ri = 0$$

$$-2RI + 2Ri + Ri + Ri = 0$$

$$V_x = 2RI - 2Ri$$

$$4Ri = 2RI$$

$$V_x = 2RI - 2Ri$$

$$-V_x + V_y + Ri = 0$$

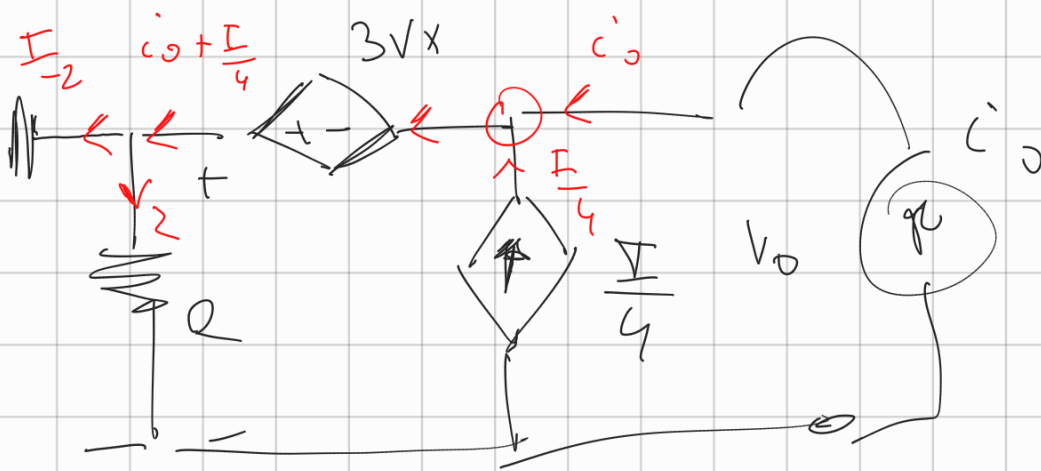
$$V_y = Ri = R \frac{I}{2}$$

$$V_x = 2RI - 2Ri$$

$$V_x = 2RI - RI = RI$$

$$i = \frac{I}{2}$$

$$4Ri = 2RI$$



$$i_2 = i_0 + \frac{I}{4} - \frac{I}{2} = i_0 - \frac{1}{4} I$$

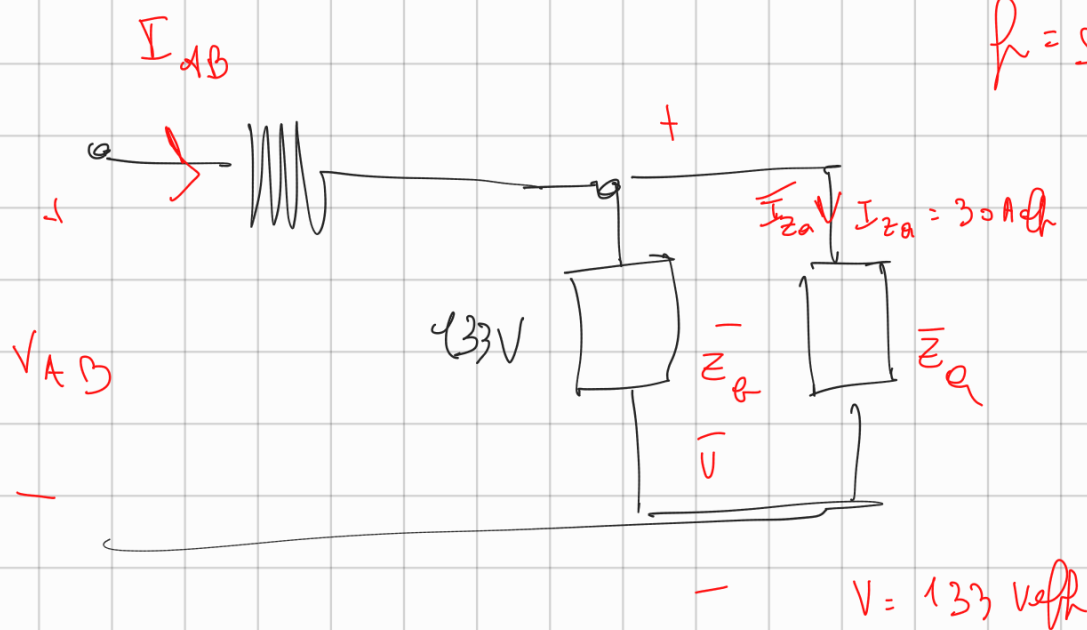
$$V_2 = R \cdot \left( i_0 - \frac{1}{4} I \right)$$

$$\begin{aligned} V_0 &= -3V_x + R \left( i_0 - \frac{1}{4} I \right) \\ &= -3RI + Ri_0 - \frac{R}{4} I \end{aligned}$$

$$= \underbrace{R i_0}_{V_{dep}} - \underbrace{\frac{3R}{4} I}_{V_0}$$

Ex. 2 Capitulo 23 gilgus

$$R = 50 \text{ } \Omega$$



$$I \bar{Z}_a = 30 \text{ A}_{eff}$$

$$A \bar{Z}_a = 4 \text{ kVA}$$

$$\cos(\varphi_{\bar{Z}_a}) = 0.3 \quad \text{resistor (cosine always)}$$

$$I \bar{Z}_b, 15 \text{ A}_{eff}$$

$$R_e \bar{Z}_b = 9 \text{ ohms}$$

$$\text{Rifasamento } AB \quad \cos(\varphi_{Z_{AB}}) = 0.85$$

$$V = 4000 / 30 = 133 \text{ V}_{eff} \quad \varphi_{\bar{Z}_a} = 72.5^\circ$$

$$P_{Za} = A \cdot \cos(\varphi_{\bar{Z}_a}) = 1200 \text{ W}$$

$$Q_{Za} = A \cdot \sin(\varphi_{\bar{Z}_a}) = 3815 \text{ W}$$



$$I_{\bar{z}_0} = 15 \text{ A eff}$$

$$A_{\bar{z}_0} = 2000 \text{ VA}$$

$$I_{\bar{z}_0}^2 \cdot \operatorname{Re}[z] = P = 2025 \text{ W}$$

$$\operatorname{Im}[z] = 5$$

---


$$Q^2 = A^2 - P^2$$

$$P_{z_0} = 1125 \text{ W}$$

$$Q = 1654 \text{ VAR}$$

$$U_{\text{so}} \text{ behind } A \Rightarrow$$

$$P_B = 2325 \text{ W}$$

$$Q_B = 5469 \text{ VAR}$$

$$A_B = 5842 \text{ VA}$$

$$I_B = 44.7 \text{ A eff}$$

$$P_2 = 44.7 \cdot \underbrace{(22)}_{\text{inverted}}$$

$$P_{\text{tot}} = 6320 \text{ W}$$

$$Q_c = 5469$$

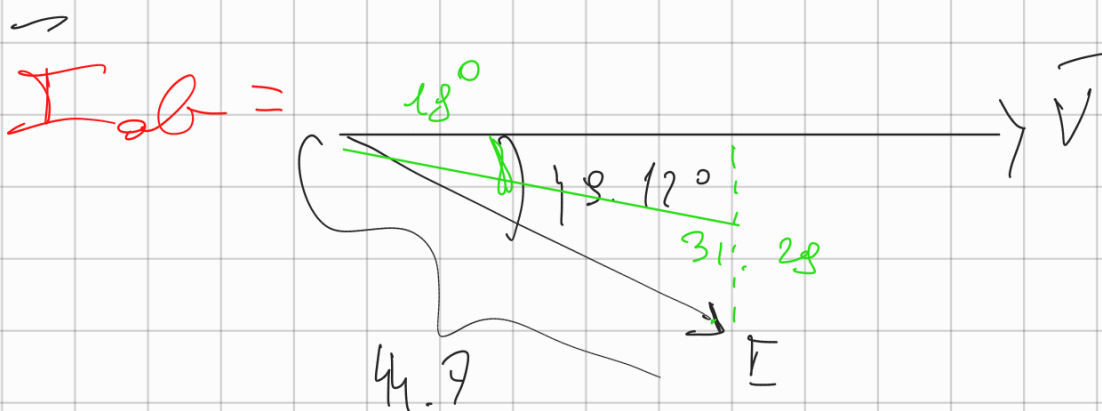
$$A = 8358 \text{ VA}$$

$$V_{\text{eff}} = 187$$

$$C_{\text{corr}} = \frac{5469 - 6320 \cdot \tan(18.19^\circ)}{V_{\text{eff}}^2 \cdot 314}$$

$$= 3,088 \cdot 10^{-4} \text{ F}$$

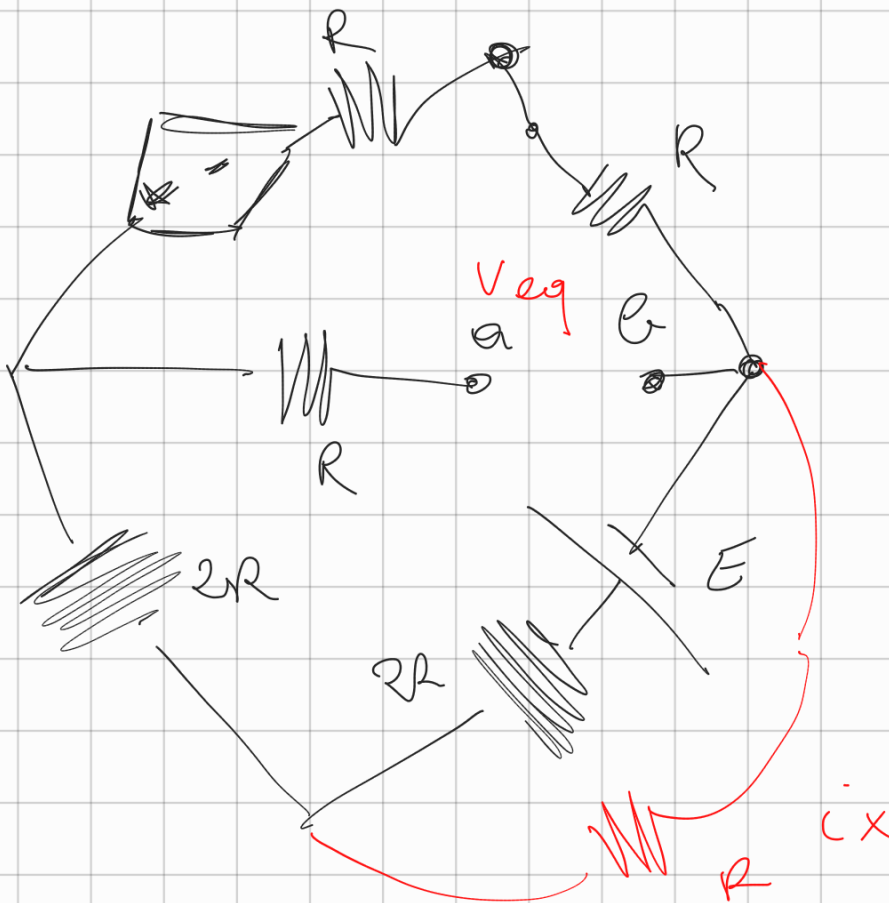
$$= 308 \text{ nF}$$



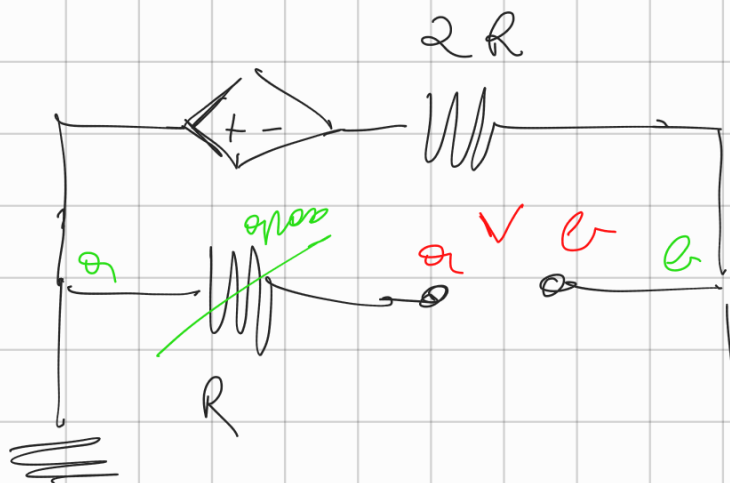
$$Q_{\text{dps}} = 2077$$

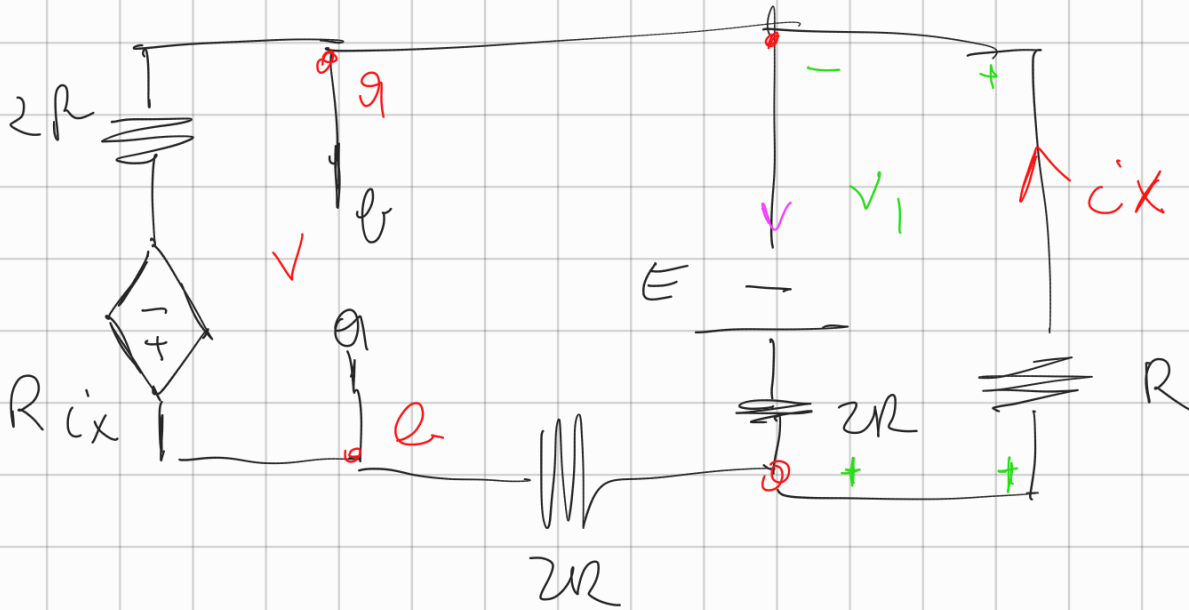
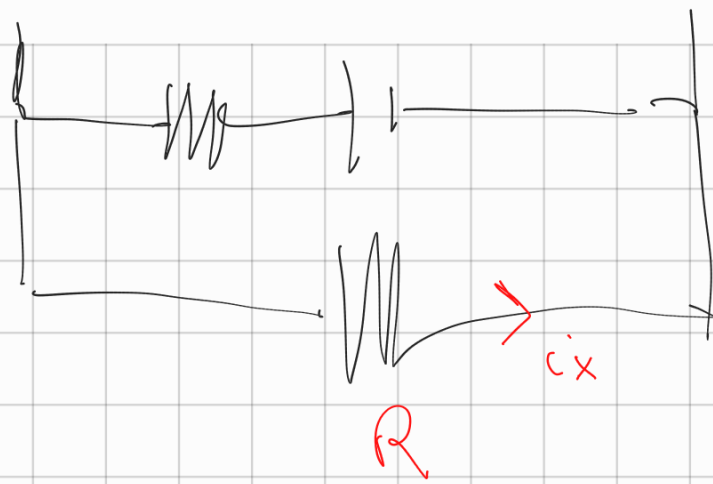
$$I_{\text{dps}} = 31,2 \text{ A}$$

$$A_{\text{dps}} = 5850$$

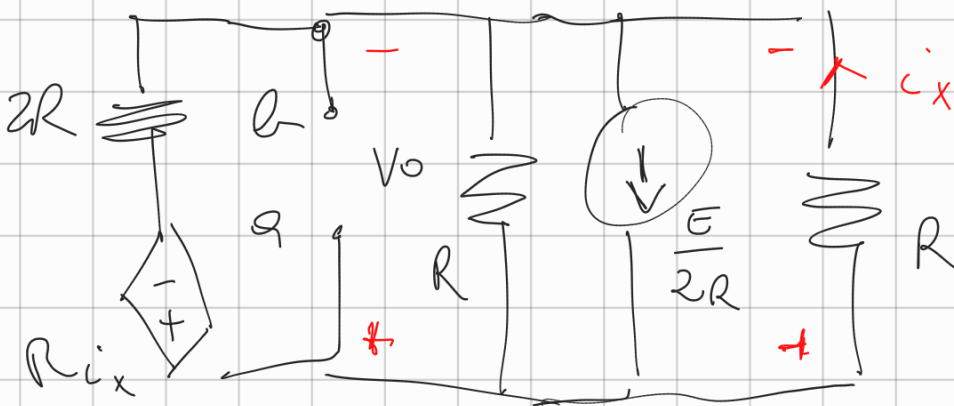


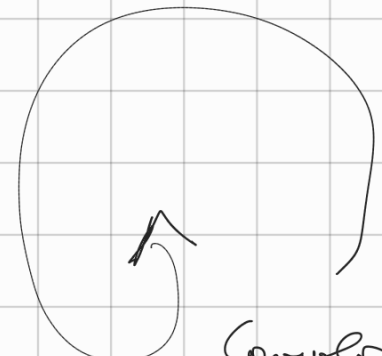
$V_{eg}$

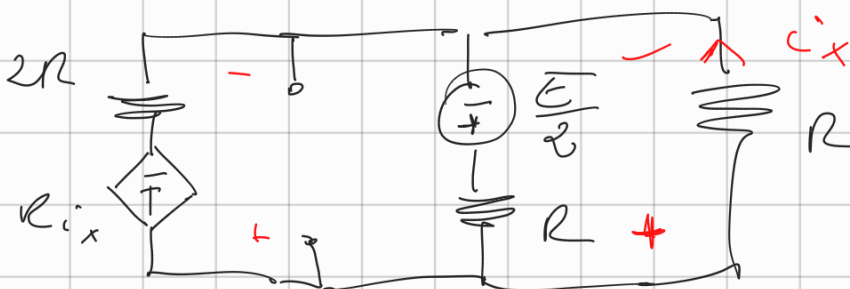




$$V_1 = -E + 2R i$$



  
 Group...  
 Círculo



Willow

$$V_o = \frac{\frac{c'x}{2} + \frac{\bar{E}}{2R}}{\frac{1}{2R} + \frac{1}{R} + \frac{1}{R}} = \frac{1+2+2}{2R}$$

$$V_o = \frac{c'x \cdot R + \bar{E}}{5}$$

$$V_o = \frac{R}{5} c'x + \frac{\bar{E}}{5}$$

$$V_o = R \cdot c'x$$

$$R c'x = \frac{R}{5} c'x + \frac{\bar{E}}{5}$$

$$\rightarrow \left( R - \frac{R}{5} \right) c'x = \frac{\bar{E}}{5}$$

$$= \left( \frac{5R - R}{5} \right) c'x = \frac{\bar{E}}{5} \Rightarrow \left( \frac{4R}{5} \right) c'x = \frac{\bar{E}}{5}$$

$$c'x = \frac{\bar{E}}{4R}$$

$$V_{eq} = \frac{R}{5} \frac{\bar{E}}{4R} + \frac{\bar{E}}{5} =$$

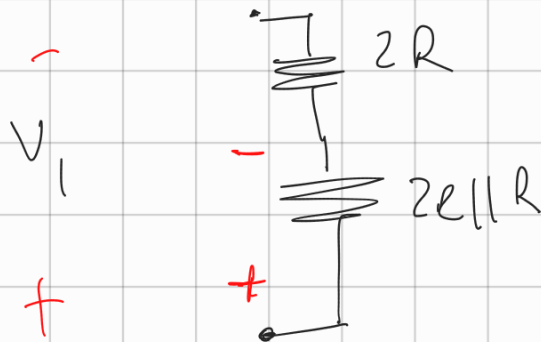


$$= \frac{4R i_x + 8R i_o}{7} = V_1$$

libbrends  $i_x =$

$$V_1 - V_o + R i_o = 0$$

$$V_1 = V_o - R i_o$$

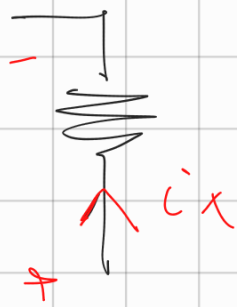


Porto R. ten'ap

$$V_{II} = \frac{\frac{2R}{3} V_1}{\frac{8}{3} R}$$

$$V_{II} = \frac{1}{4} V_1$$

$$V_{II} = \frac{R i_x + 2R i_o}{7}$$



$$V_{11} = R i_x$$

$$i_x = \frac{V_{11}}{R}$$

$$i_x = \frac{i_x}{7} + \frac{2}{7} R i_o$$

$$i_x - \frac{i_x}{7} = \frac{2}{7} R i_o$$

$$\Rightarrow \frac{6}{7} i_x = \frac{2}{7} i_o$$

$$i_x = \frac{1}{3} i_o$$

$$\Rightarrow V_{11} = \frac{R i_x + 2 R i_o}{7}$$

$$V_{11} = \frac{\frac{R}{3} i_o + 2 R i_o}{7}$$

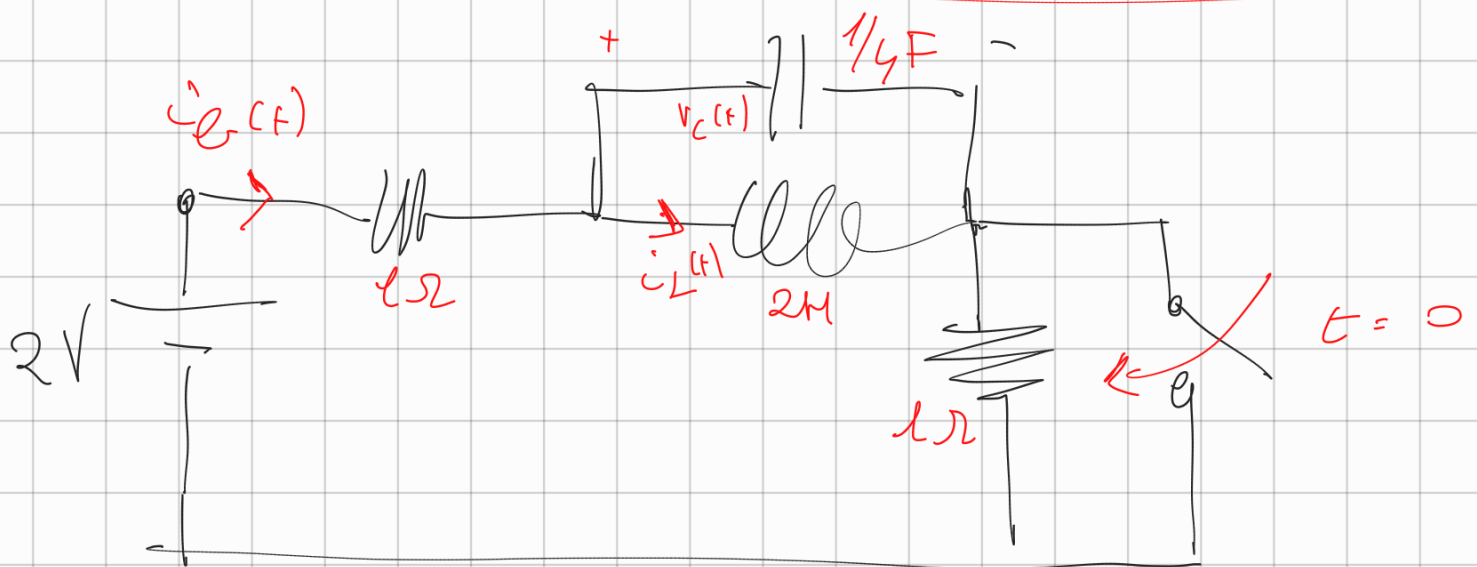
$$= \frac{\frac{7}{3} R i_o}{7} = V_{11} = \frac{1}{3} R i_o$$



$$V_o = V_n + R_{i_o}$$

$$= \frac{1}{3} R_{i_o} + R_{i_o} = \frac{7}{3} R_{i_o}$$

$$V = \frac{E}{4} + \frac{7}{3} R_{i_o}$$



$i_C(t)$   $t > 0$

Bob i'mento Teme

corrente del circuito, riguarda quello...

Varie di stato...

$v_C(t)$ ,  $i_L(t)$

Reg. Sol. 1

complete

Reg. Sol. 2

$$V_L(0^-)$$

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

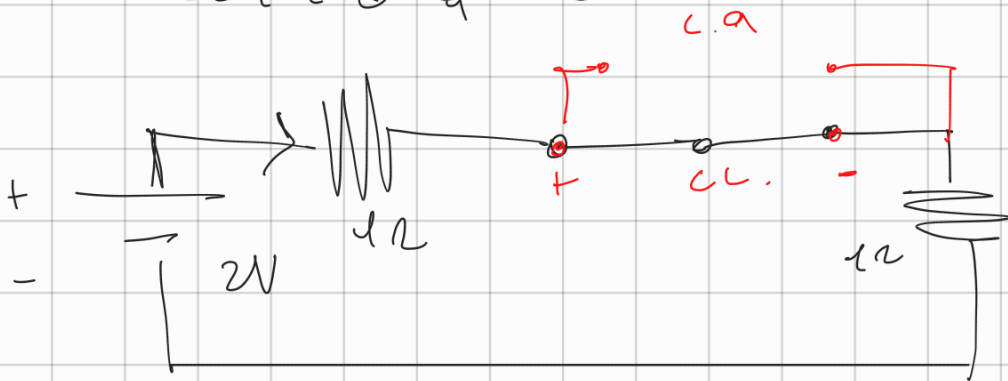
$t = 0$

$$V_L(0^+)$$

$$i_L(0^+)$$

Gr. non  
dep.

Circuit a  $0^-$



$$V_C(0^-) = 0$$

$$i_L(0^-) = 1 \text{ A}$$

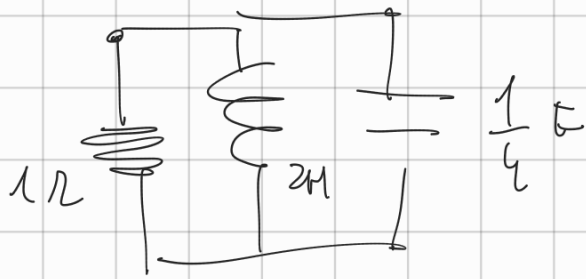
$$V_C(0^-) = 0 \text{ V}$$

$i_b(t)$ , circuit  $t > 0$  solve

$$i(t) = T_C + \text{response}$$

in the  $\cos$  wave? guess for

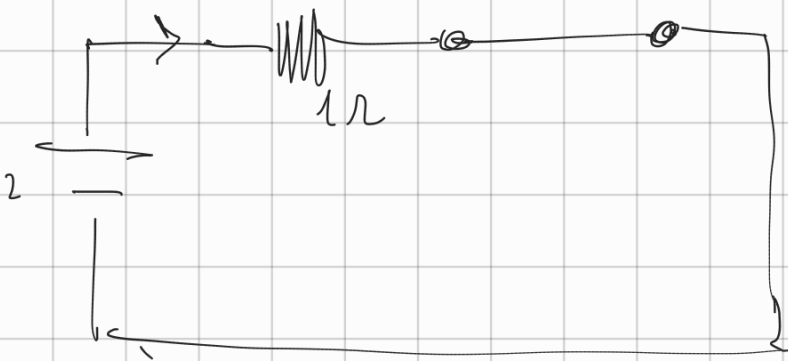
$$t = 0^+, \text{ possible}$$



$$i_c(t) = TC + 2A$$

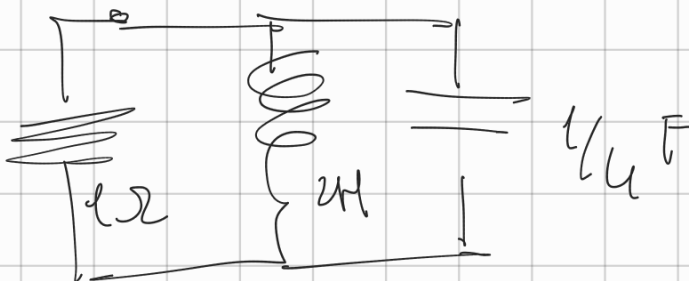
Now  $i_c(\infty)$

$$i_c(\infty) = 2A$$



Circuit at  $t = 0$

for  $i_c(\infty)$ , we have the circuit like



$$\Delta \text{ voltage} = \frac{V_p}{2C} = 2 \text{ volt/sec.}$$

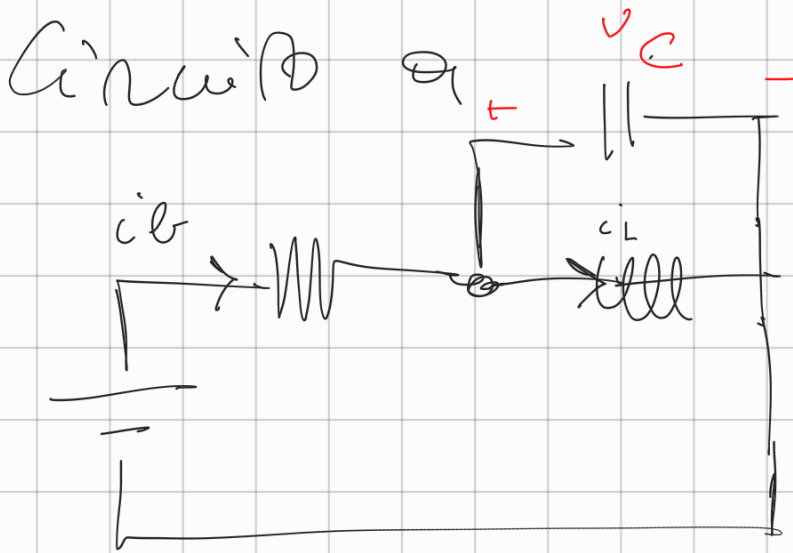
$$\omega_0^2 =$$

$$2 \text{ rad/sec}$$

$\alpha > \omega_0$ ,  $\cos$  overdamped.

$$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

$$i(t) = k_1 e^{-3,41 t} + k_2 e^{-0,58 t} = -2 \pm \sqrt{2}$$



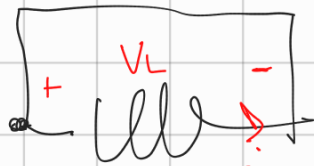
Before  $t_C$ ,  $v = 0$

Circuit at  $t = 0^+$

$$\begin{cases} i_L(0^+) = k_1 e^{-3,41 t} + k_2 e^{-0,58 t} \\ i_L'(0^+) = 1 \text{ A} \\ \frac{di}{dt} = \frac{v_L(0^+)}{L} = 0 \end{cases}$$

C.C.

Circuit a 0



$$i_L = 2A$$

$$V_L = 0$$

$$\begin{cases} k_1 + k_2 = 1 \\ -3,41 k_1 - 0,58 k_2 = 0 \end{cases}$$

$$k_1 = -0,20$$

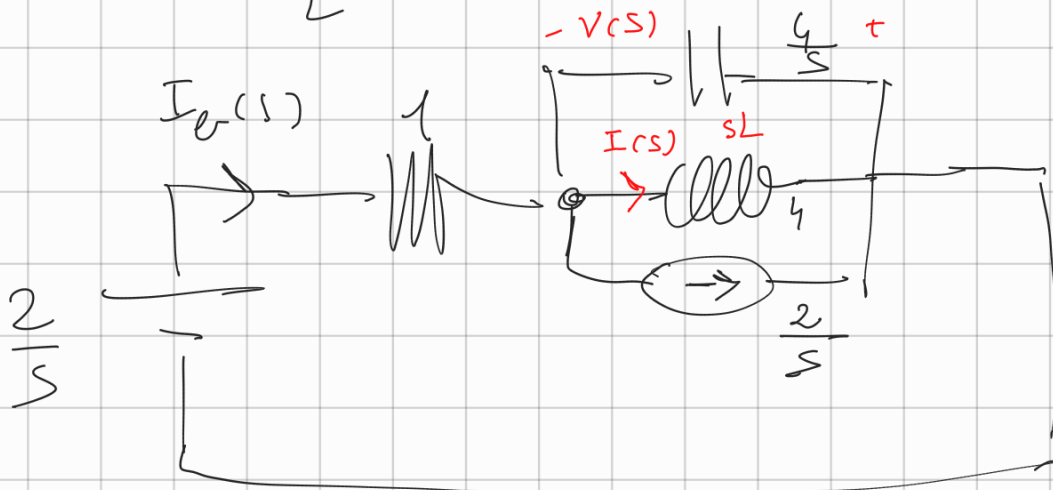
$$k_2 = 1,20 \quad k_1 = -0,20$$

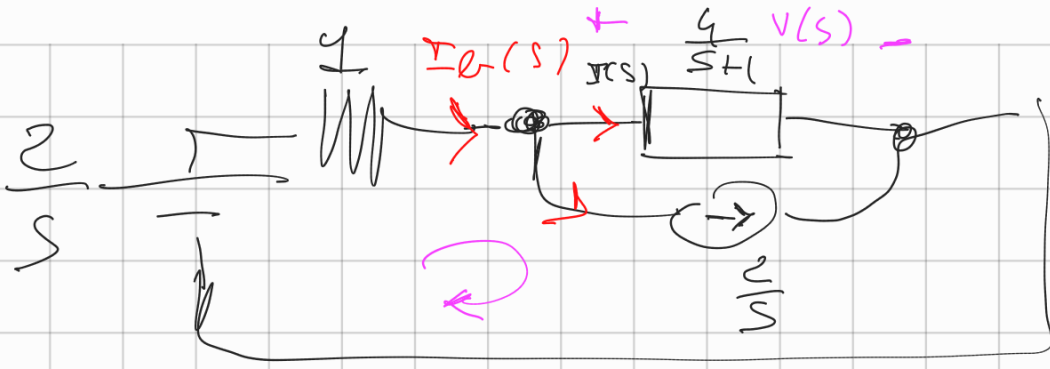
$$-0,20 e^{-3,41 t} + 1,2 e^{-0,58 t}$$

Nel DL

$$i_L(0^+) = 2A$$

$$V_C(0^+) = 0V$$





$$\frac{\frac{4}{s} \cdot 4}{\frac{4}{s} + 4} = \frac{16}{4s + 4} = \frac{4}{s+1}$$

$$\bullet \quad I_e(s) = I(s) + \frac{2}{s}$$

$$I(s) = \frac{V(s)}{\frac{4}{s+1}}$$

da KVL

$$\bullet \quad \frac{2}{s} = 1 I_e(s) + V(s)$$

$$= I(s) + \frac{2}{s} + V(s)$$

$$I(s) = -V(s)$$

$$\bullet \quad V(s) = I(s) \cdot \frac{4}{s+1}$$

$$I(s) = \frac{s+1 - I(s)}{4}$$

$$I(s) = I_e(s) - \frac{2}{s}$$

$$I(s) = \frac{s+1}{2}$$

$$V(s) = \left( I_e(s) - \frac{2}{s} \right) \frac{4}{s+1}$$

$$= \frac{4 I_e}{s+1} - \frac{8}{s(s+1)}$$

$$\text{Da } \frac{k}{v} \quad \frac{2}{s} = I_e + \frac{4 I_e}{s+1} - \frac{8}{s(s+1)}$$

$$I_e \left( 1 + \frac{4}{s+1} \right) = \frac{2}{s} + \frac{8}{s(s+1)} =$$

$$I_e = \frac{2s+10}{s(s+1)} \frac{(s+1)}{(s+9)}$$

$$\checkmark s+9$$

$$s+1$$

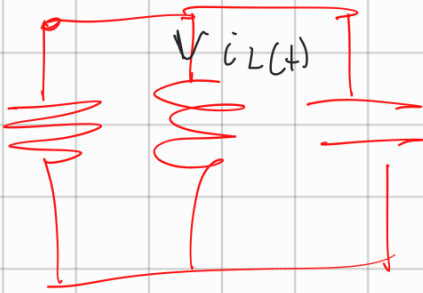
$$I_e = \frac{2s+10}{s(s+9)}$$

$$\Rightarrow \frac{A}{s} + \frac{B}{s+9}$$

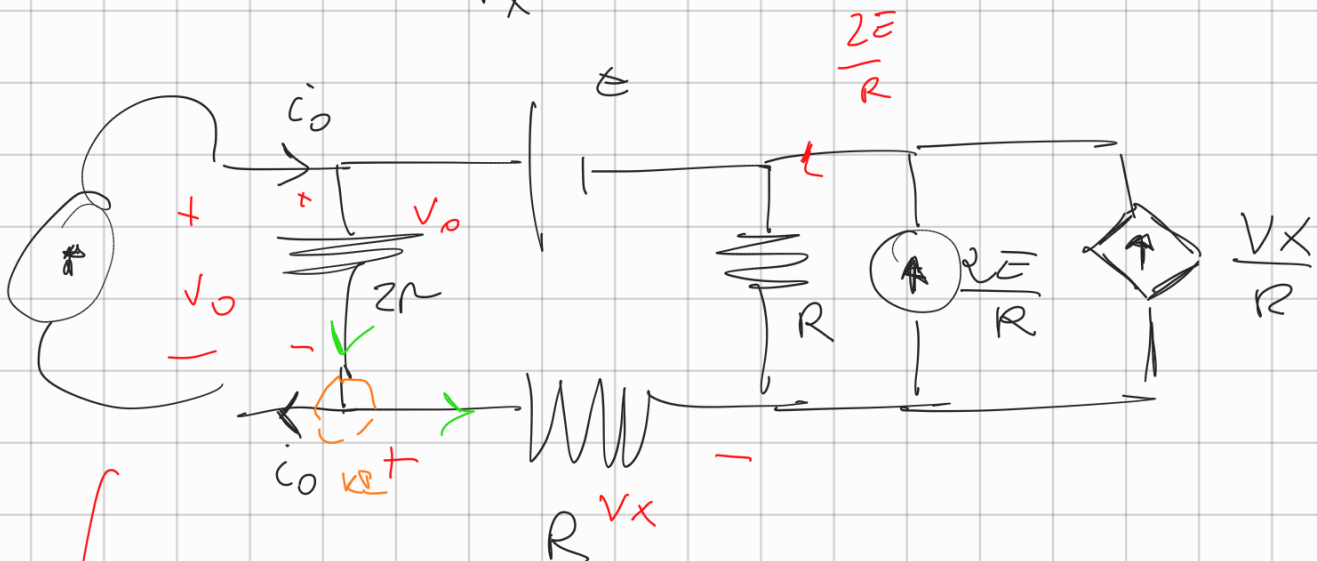
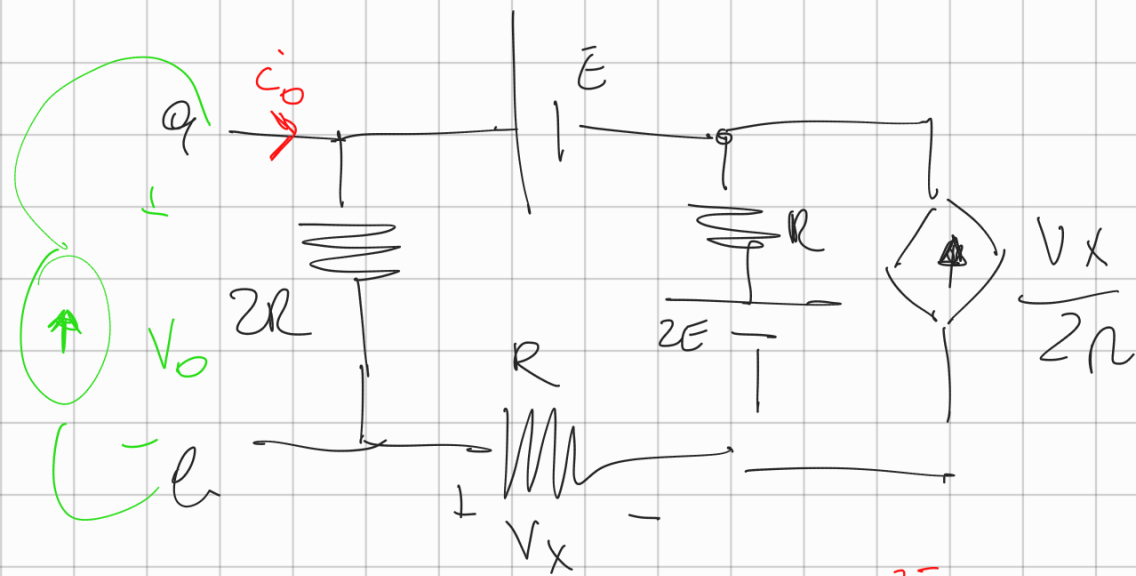
$$A = \lim_{s \rightarrow 0} I_e \cdot s = 2$$

$$B = \lim_{s \rightarrow -9} (s+9) I_e = \frac{-10+10}{-9} = 0$$

$$I_G = 20(+)$$



Determine Thevenin ab circuit  
Netzwerk Diagramm



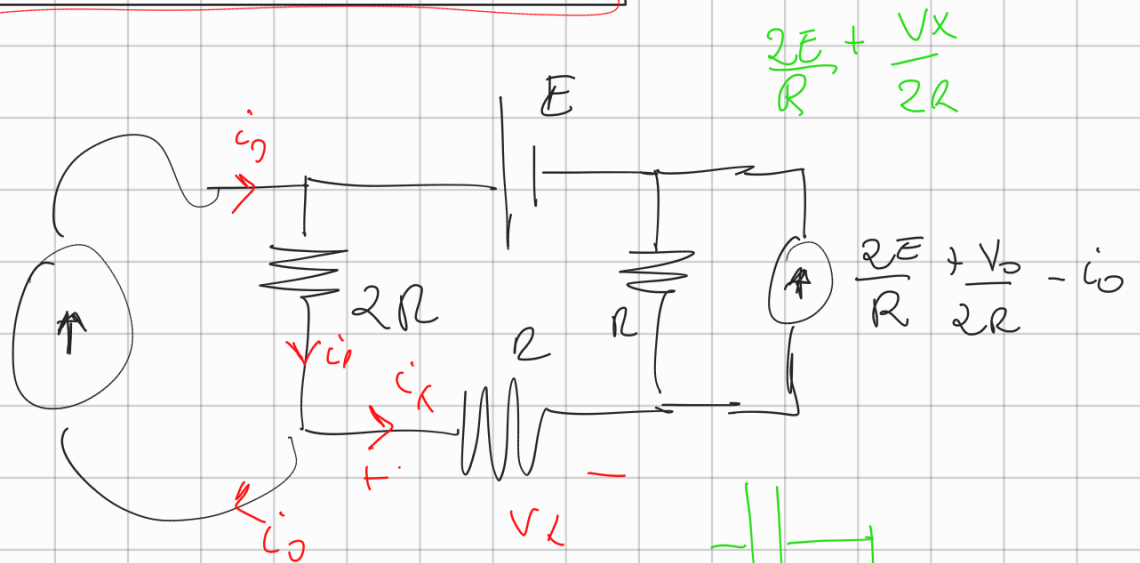


$$C_1 = \frac{V_0}{2R}$$

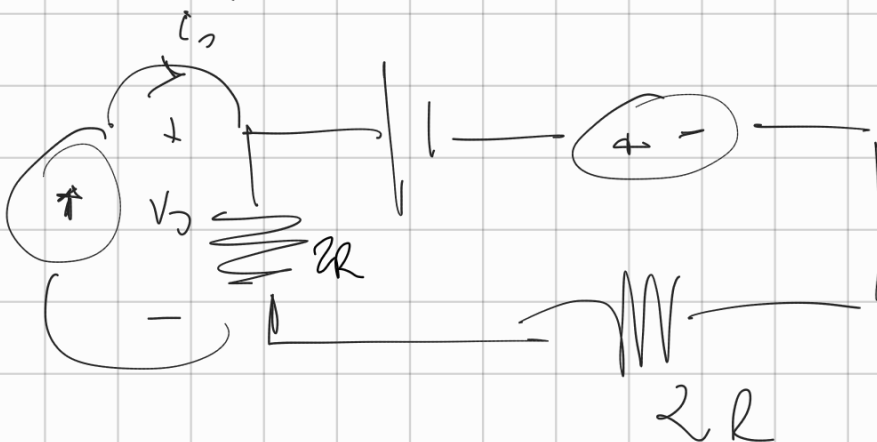
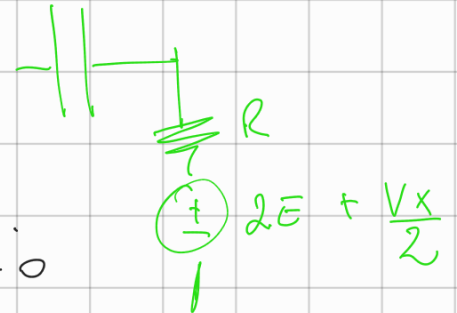
$$i_X = i_f - i_0 = \frac{V_0}{2R} - i_0$$

$$V_X = \left( \frac{V_o}{2R} - C_o \right) R$$

$$V_x = \frac{V_o}{2} - i\omega R$$

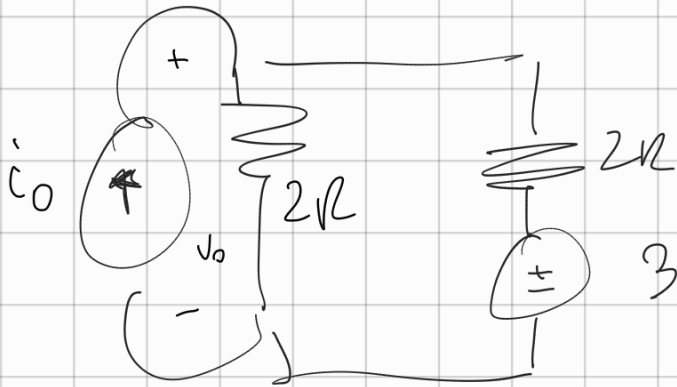


$$b \quad \frac{2E}{R} + \frac{\left(\frac{V_0}{2} - i_0 R\right)}{R} = \frac{2E}{R} + \frac{V_0}{2R} - i_0$$



$$\bullet \quad E + 2E + 2V_0 - i_0 R$$

$$= 3E + 2V_0 - i_0 R \quad \frac{3E + \frac{V_0}{2} - i_0 R}{2R}$$



$$3E + 2V_0 - i_0 R$$

$$V_0 = \frac{3E}{2R} + \frac{\left(\frac{V_0}{2} - i_0 R\right)}{2R} + i_0$$

$$\frac{1}{\frac{1}{2R} + \frac{1}{2R}} = \frac{\frac{3E}{2R} + \frac{V_0}{4R} + \frac{i_0}{2}}{\frac{1}{R}} = V_0$$

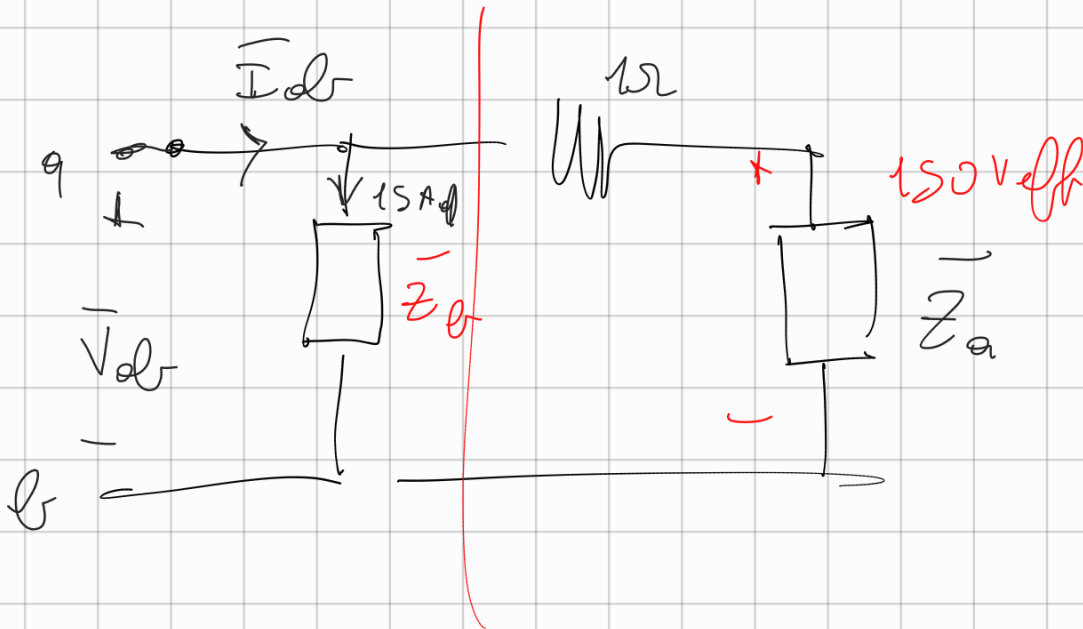
$$V_0 = \frac{3}{2} E + \frac{V_0}{4} + \frac{R}{2} i_0$$

$$\frac{3}{4} V_0 = \frac{3}{2} E + \frac{R}{2} i_0$$

$$V_0 = \cancel{\frac{4}{3}} \frac{3}{2} 2E + \cancel{\frac{4}{3}} \frac{R}{2} \frac{2}{3} R$$

ab, 50 Hz,  $\bar{E}_a$ , 150 V eff

80 Hz



$$I_a = \frac{2000}{150} = 13.3 A$$

$$V_{\bar{Z}_a} = 150 V \text{ eff}$$

$$A_{\bar{Z}_a} = 2000 VA$$

$$\cos(\varphi_{\bar{Z}_a}) = 0.3 \text{ in ritardo}$$

$$\bar{E}_e = > \bar{I}_{\bar{Z}_e} 15 A \text{ eff.}$$

$$\cos(\varphi_z) = 0.8$$

\* Riformando il polo ab,  $\cos(\varphi_{AB}) = 0.35$

$$I_{\bar{Z}_a} = 13.3 A$$

$$P_a = 600 W$$

$$Q = 1807 VAR$$

$$P_a = 600 + (13.3)^2 \cdot 1 = 777 W$$

$$A_a = 2060 \text{ VA}$$

$$V_a = 154 \text{ V}$$

$$I_{ZB} \text{ con } \cos \phi = 0.8 = 15 \text{ A} \quad \phi_{ZB} = \arccos(0.8) = 36^\circ$$

$$I_{Zr} = \frac{I_{ZB}}{\cos(\phi)} = 25 \text{ A} \quad A_{AB} = 3850 \text{ VA}$$

$$\text{Compl } I_{ZB} = 25 \cdot 0.8 = 20 \text{ A} \quad Q_{ZB} = 2312 \text{ VAR}$$

$$\text{Berndt} \quad P_{ZB}^2 = A^2 - Q_{ZB}^2 \Rightarrow 3080 \text{ W} \quad P_{ZB}$$

$$P_{AB} = 3080 + 777 = 3857 \text{ W}$$

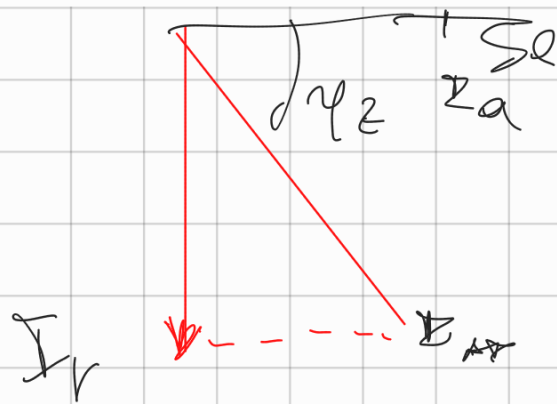
$$Q_{AB} = 2312 + 1897 = 4209$$

$$A_{AB} = 5716 \text{ VA}$$

$$I_{AB} = 37.11 \text{ A eff}$$

$$C_{\text{com}} = 400 \mu\text{F}$$

$$\cos(\phi_{ZB}) = 0.8 \Rightarrow \phi_{ZB} = 36.86$$



$$I_{08} \cdot \sin(\psi_2) = 15$$

$$\Rightarrow \frac{15}{\sin(\psi_2)} = I_{08} = 25 \text{ A eff}$$

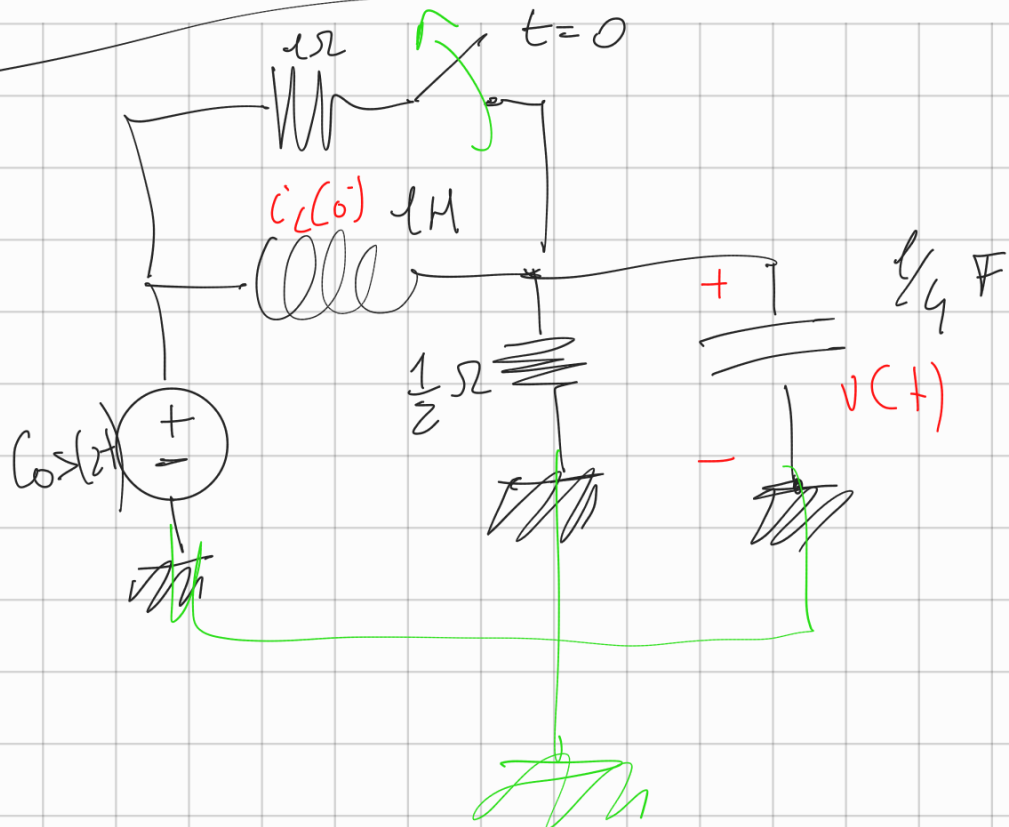
$$I_{\text{Bosma}} = 25 - 0.8 = 20 \text{ A eff}$$

$$Q_{\text{dep}} = 126 \text{ J}$$

$$A_{\text{dep}} = \sqrt{\quad} = 4060$$

$$I_{\text{dep}} = 26.35 \text{ A eff}$$

$$\psi_{\text{ris}}$$



debrisare  $V(t)$

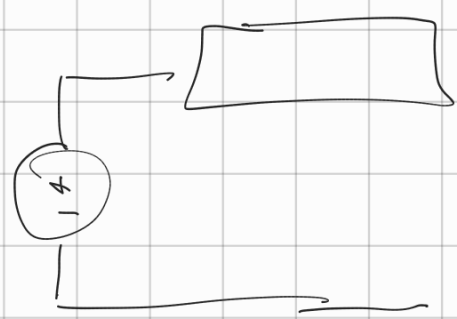
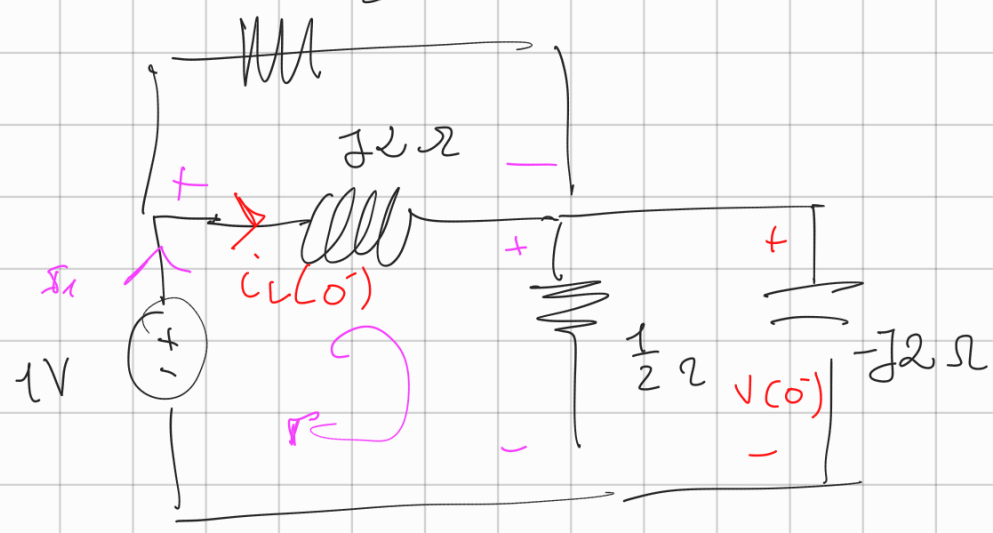
Reg. sinus. 1      Caplata      Reg. sinus 2

$V_c(0^-)$   
 $i_L(0^-)$

Brow cos'it. d.h.

$$\omega = 2$$

$$t = 0^-$$



$$Z_{||1} = \frac{j2}{1 + j2} \Omega$$

$$= \frac{4}{5} + j\frac{2}{5}$$

$$1V = V_L + V_O$$

$$Z_{112} = \frac{-j2 \cdot \frac{1}{2}}{\frac{1}{2} - j2}$$

$$= \frac{8 - j2}{12}$$

$$V(O^-) = 1V \cdot \frac{Z_{112}}{Z_{111} + Z_{112}} = \frac{8 - j2}{12} \cdot \frac{1}{\frac{4}{5} + \frac{18}{12} + j\left(\frac{2}{5} - 2\right)}$$

$$= \frac{\frac{8 - j2}{12}}{\frac{158}{85} - j\frac{8}{5}} = \frac{1}{3} - \frac{1}{6}j$$

$$V(O^-) = \frac{1}{3} - \frac{1}{6}j$$

$$V_L = 1 - V_O = \frac{2}{3} + j\frac{1}{6}$$

$$\Rightarrow \dot{I}_L = \frac{\frac{2}{3} + j\frac{1}{6}}{2j} = \frac{1}{12} - \frac{1}{3}j$$

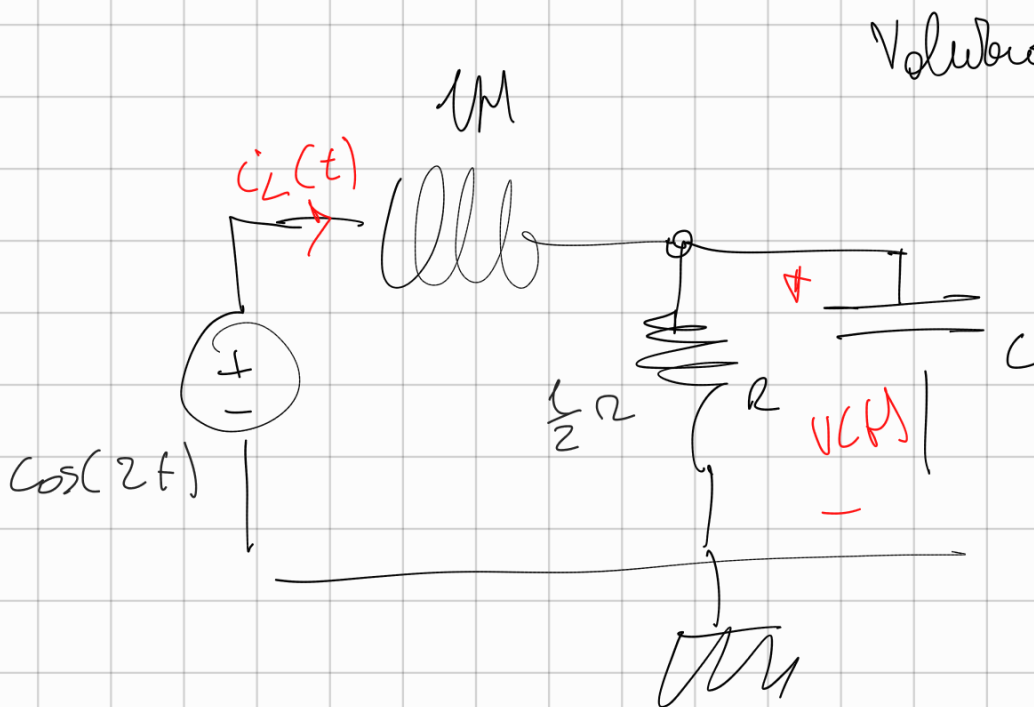
$$\left( \frac{1}{3} + j\frac{1}{12} \right) - \vec{v}$$

$$V_0(0^-) = \operatorname{Re} \left[ \bar{V} e^{j\omega t} \right]_{t=0} = \operatorname{Re}[\bar{V}]$$

$$= \frac{2}{3} V = V(0^+)$$

$$i(0^-) = i(0^+) = \frac{1}{12} \text{ A}$$

Circuito a  $t > 0$



Volubiamo il circuito in  
risposta libera,  
visto che è un RLC  
parallelo

Cost parallelo

$$\alpha_P = \frac{2}{2C} = 4 \text{ rad/sec.} \quad \omega_0^2 = \frac{1}{LC} = 4$$



$$\omega_0 = 2$$

$\alpha > \omega_0 \Rightarrow$  caso sovrasmorzato

$$\begin{aligned} s_{1,2} &= -\alpha \pm \sqrt{\alpha^2 - \omega_0^2} \\ &= -4 \pm \sqrt{16 - 4} = -4 \pm 2\sqrt{3} \end{aligned}$$

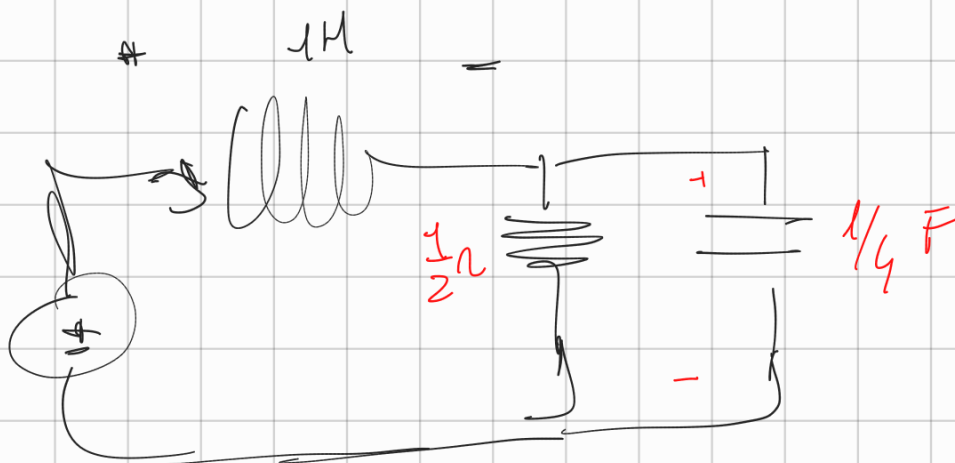
$$\begin{cases} V(t) = k_1 e^{(-4+2\sqrt{3})t} + k_2 e^{(-4-2\sqrt{3})t} \\ V(0) = \frac{2}{3} \end{cases}$$

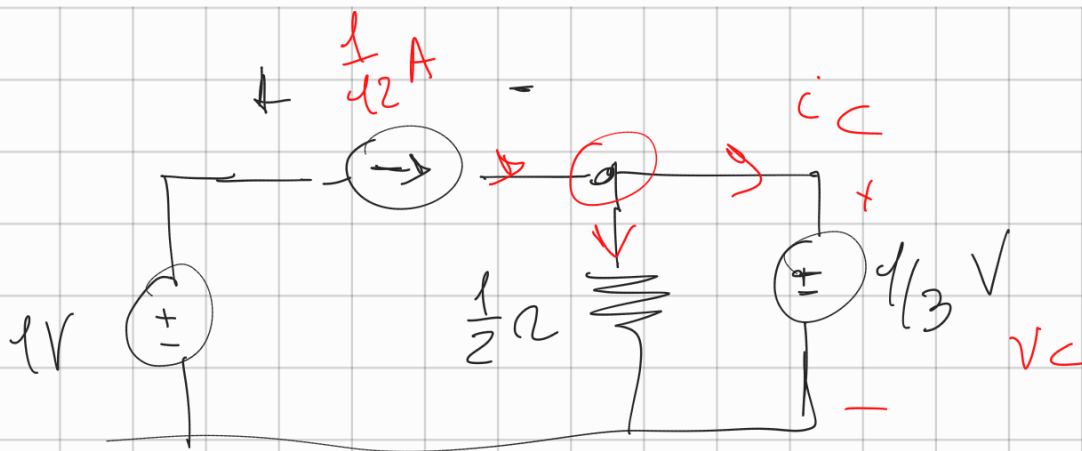
$$i_c = C \frac{dV_c}{dt}$$

ispirazione di  
Circuiti

Sei trovare a  $0^+$   $i_c(0^+)$

Domio Frazz





$$i_R = \frac{\frac{1}{3}}{\frac{1}{2}} = \frac{2}{3} \text{ A}$$

$$i_C = \frac{1}{12} \text{ A} - \frac{2}{3} \text{ A} = -\frac{7}{12}$$

$$\frac{dv}{ds} = \frac{-7}{12} = \frac{-7}{3} \text{ V/sec}$$

$$\left\{ \begin{array}{l} k_1 + k_2 = \frac{1}{3} \\ (-4 + 2\sqrt{3})k_1 + (4 + 2\sqrt{3})k_2 = -\frac{7}{3} \end{array} \right.$$

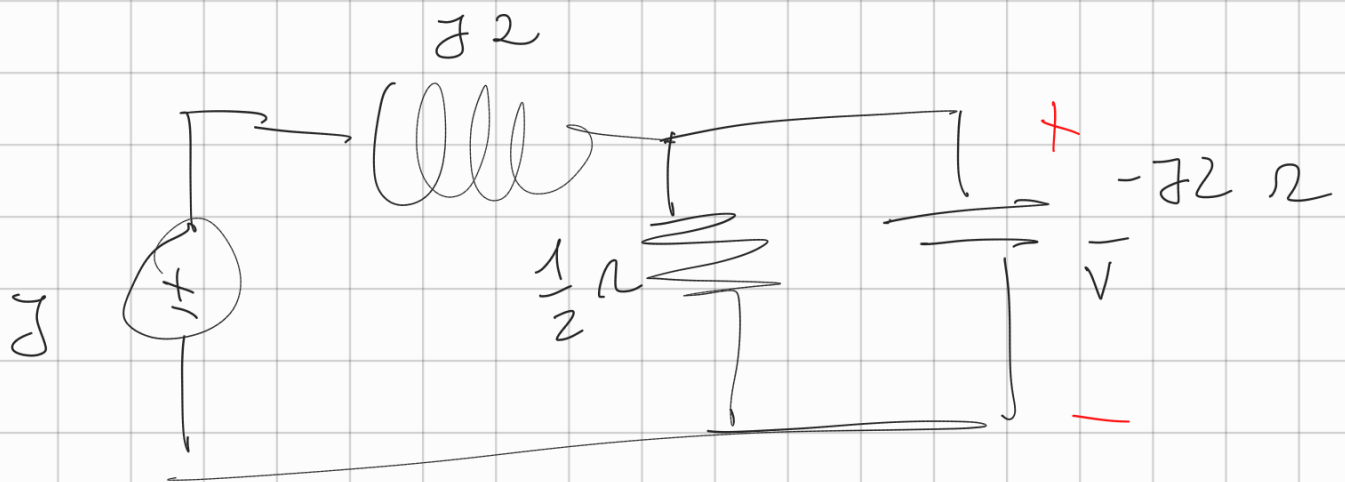
$$k_1 = 0,91$$

$$k_2 = -0,25$$

+ Copela

$$\omega = 2$$

V copela



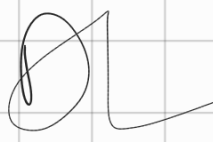
$$\bar{V}_c = \frac{2 \cdot Z_{11}}{2j}$$

$$Z_{11} = \frac{-j}{\frac{1}{2} - 2j} = \frac{8}{17} - \frac{2}{17}j$$

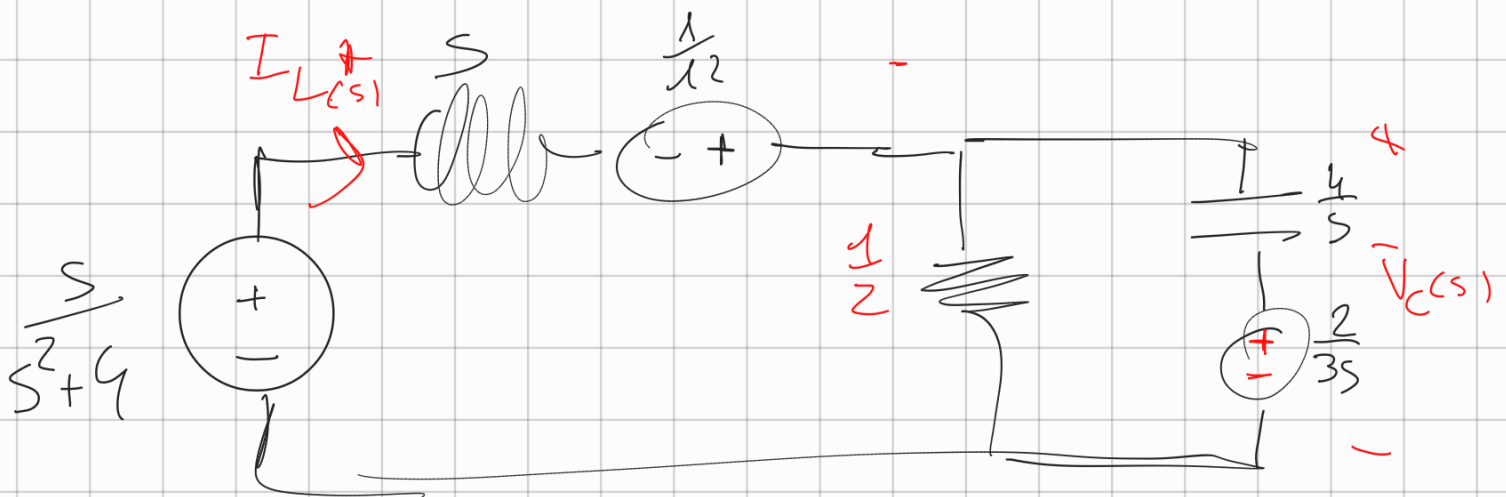
$$\bar{V}_c = \frac{4}{17} - j\frac{1}{17}$$

$$V_C(t) = 0,91 e^{(-4+2\sqrt{3})t} - 0,25 e^{(-4-2\sqrt{3})t} + \frac{\sqrt{12}}{17} \cos(2t - 14^\circ) - 14t$$

$$V_C = \frac{\sqrt{17}}{17} e$$

Verifica 

$$\omega = 2$$



$$V_O = V_C(s)$$

Nullman

$$\frac{\cancel{8} + \frac{5}{12}}{s^2+4} + \frac{\frac{2}{3\cancel{8}}}{\frac{4}{\cancel{8}}^2} = \sqrt{\phantom{x}} (s)$$

$$\frac{1}{s} + \frac{1}{2} + \frac{s}{4}$$

$$\frac{1}{s^2+4} + \frac{s}{12} + \frac{3}{2}$$

$$\frac{4 + 2s + s^2}{4s}$$

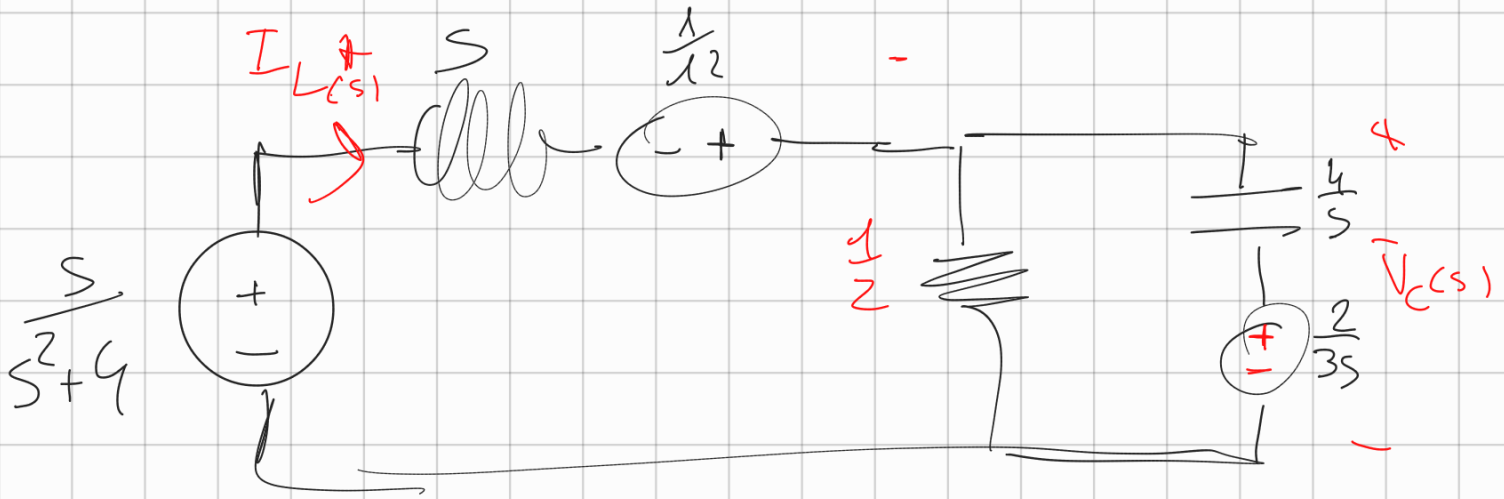
$$= \frac{\frac{4s}{s^2+4} + \frac{s^2}{3} + 6s}{s^2+2s+4}$$

$$\frac{12s + s^2(s^2+4) + 6s(s^2+4)}{3(s^2+4)}$$

$$\frac{12s + s^4 + 4s^2 + 6s^3 + 24}{3(s^2+4)(s^2+2s+4)}$$

$$= 3(s^2+4)(s^2+2s+4)$$

$$= \frac{s^4 + 6s^3 + 4s^2 + 12s + 24}{s^4 + 6s^3 + 4s^2 + 12s + 24}$$



$$V_o = V_C(s)$$

$$\frac{\frac{s}{s^2+4} + \frac{1}{12}}{s} + \frac{\frac{2}{3s}}{\frac{4}{s}}$$

$$\frac{1}{s} + 2 + \frac{s}{4}$$

$$\frac{1}{s^2+4} + \frac{1}{12s} + \frac{1}{6}$$

=

$$\frac{4 + 8s + s^2}{4s}$$

$$\frac{4}{s^2+4} + \frac{1}{3} + \frac{2s}{3}$$

$$\frac{\boxed{s^2 + 8s + 4}}{3(s^2 + 4)}$$

✓ *Minimales*

$$\frac{42 + (s^2 + 4) + 2s(s^2 + 4)}{3(s^2 + 4)}$$

$$s^2 + 8s + 4$$

→

$$\frac{2s^3 + s^2 + 8s + 16}{3(s^2 + 4)(s^2 + 8s + 4)}$$

Partialbruch

$$\frac{1}{3} F(s)$$

$$h(t) = \left( A \cos(2t) + B \sin(2t) \right) + C e^{(-4+2\sqrt{3})t} + D e^{(-4-2\sqrt{3})t} / (s+1)$$

$$F(s)$$

$$A \cdot \frac{S}{S^2+4} + \frac{Bz}{S^2+4} + C \frac{1}{S} + \frac{D}{S}$$

$S - (-4+2\sqrt{3})$

$$A \frac{S}{S^2+4} + \frac{Bz}{S^2+4} + \frac{C}{S+4-2\sqrt{3}} + \frac{D}{S-4-2\sqrt{3}}$$

$$\frac{AS(S^2+8S+4) + 2B(S^2+8S+4) +}{(S^2+4)(S^2+8S+4)}$$

$$+ C(S^2+4)(S-4-2\sqrt{3}) +$$

$$+ D(S^2+4)(S+4-2\sqrt{3})$$

$$AS^3 + 8AS^2 + 4AS + 2BS^2 + 16BS$$

$$+ 8B + C(S^3 - 4S^2 - 2\sqrt{3}S^2 + 4S - 16 - 8\sqrt{3})$$

$$+ D(S^3 + 4S^2 - 2\sqrt{3}S^2 + 4S + 16 - 8\sqrt{3})$$



$$\begin{aligned}
 &As^3 + 8As^2 + 4As + 2Bs^2 + 16Bs + 8B \\
 &+ Cs^3 + C(-4-2\sqrt{3})s^2 + 4s(-16-8\sqrt{3})C \\
 &+ Ds^3 + Ds^2(4-2\sqrt{3}) + 4s^D + (16-8\sqrt{3})
 \end{aligned}$$

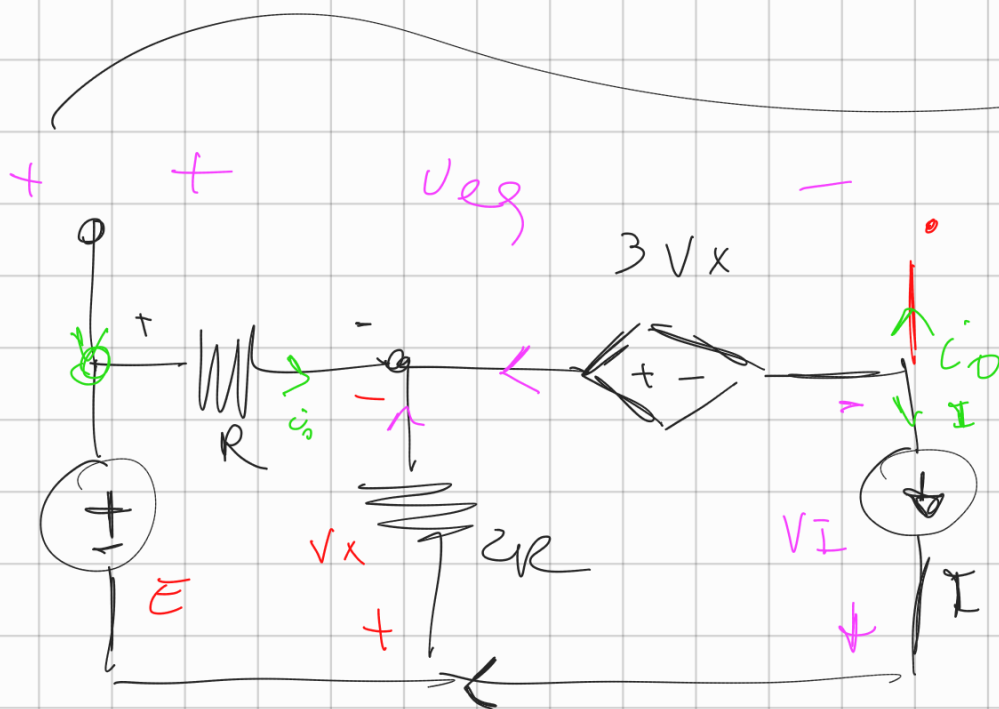
$$\begin{cases}
 A + C + D = 2 \\
 8A + 2B - 7,46C + 0,53D = 1 \\
 4A + 16B + 4C + 4D = 8 \\
 8B - 29,85C + 2,14D = 16
 \end{cases}$$

$$A = -0,37$$

$$B = 0$$

$$C = -0,34$$

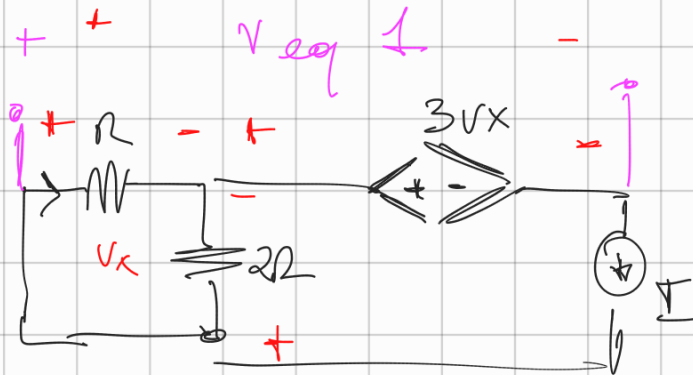
$$D = 2,71$$



$$V_{eq} =$$

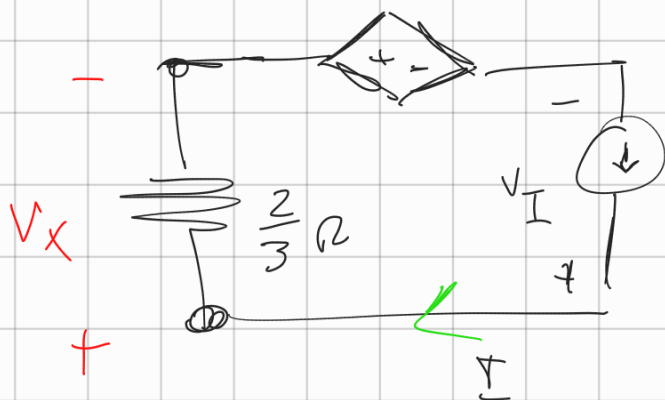
use PSE

$$V_{eq,1}$$



From  $V_x$  is

$$V_x = \frac{1}{3} I$$



$$V_x + 3V_x = V_I$$

$$V_x = \frac{1}{3} R I$$

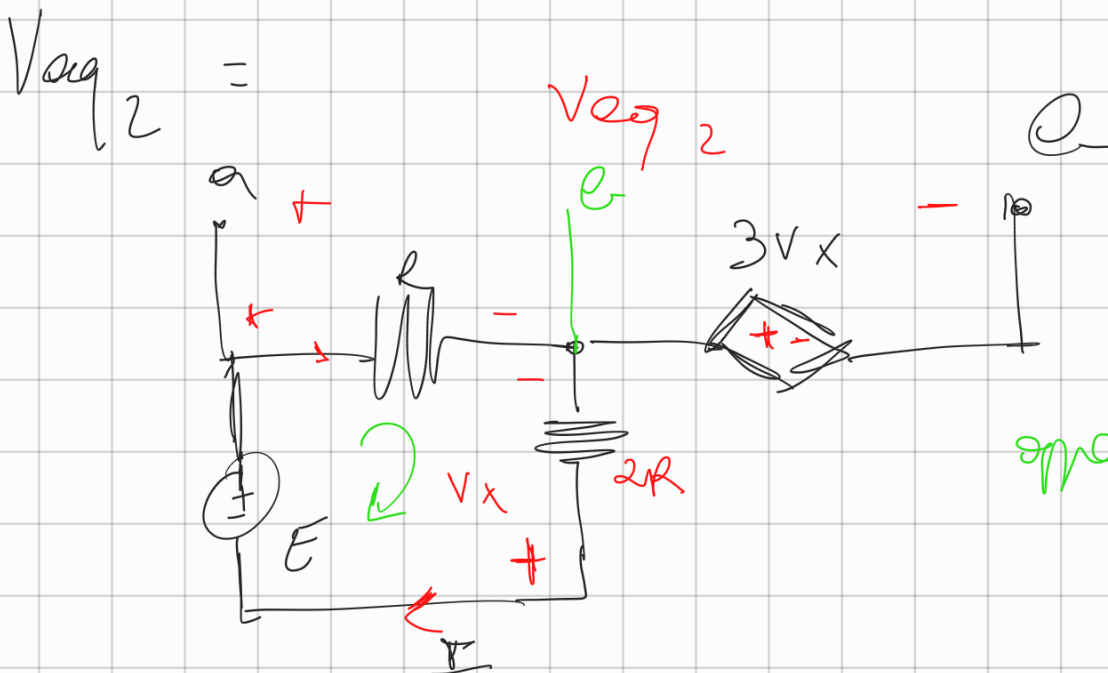
$$\frac{2}{3} R I + 2 R I = V_L$$

$$\frac{I \cdot \frac{1}{2R}}{\frac{1}{R} + \frac{1}{2R}} = \frac{2+1}{2R} = \frac{1}{3} I$$

So  $R$  in parallel  $C$  is zero

$$\frac{I \cdot \frac{1}{R}}{\frac{3}{2R}} = \frac{2}{3} I$$

$$V_{eq1} = \frac{2}{3} R I + R I = \frac{5}{3} R I$$



oppor, lo zero  
stop

$$K V =$$

$$V_X = E + R I$$

$$V_X = (-2R I)$$

$$-2R I = E + R I$$

$$-3R I = E$$

$$I = -\frac{E}{3R} \Rightarrow V_X = \frac{2}{3} E \cdot I$$

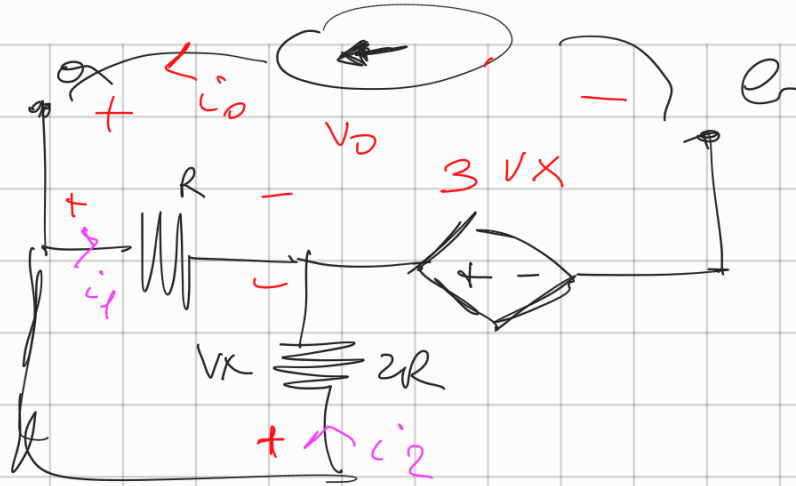
$$I = -\frac{E}{3R}$$

$$V_X = -2R \left( \frac{-E}{3R} \right)$$

$$V_X = \frac{2}{3} E$$

$$V_{eq2} = \frac{2}{3} E + 2E = \frac{8}{3} E$$

$$V_{eq2} = \frac{9}{3} R i + \frac{8}{3} E$$



$$i_1 = \frac{i_0 \cdot \frac{1}{R}}{\frac{1}{R} + \frac{1}{2R}} = \frac{\frac{i_0}{R}}{\frac{3}{2R}} = \frac{2}{3} i_0$$

$$V_1 = R i_1 = \frac{2}{3} R i_0$$

$$V_x = i_2 \cdot 2R = \frac{2}{3} R i_0$$

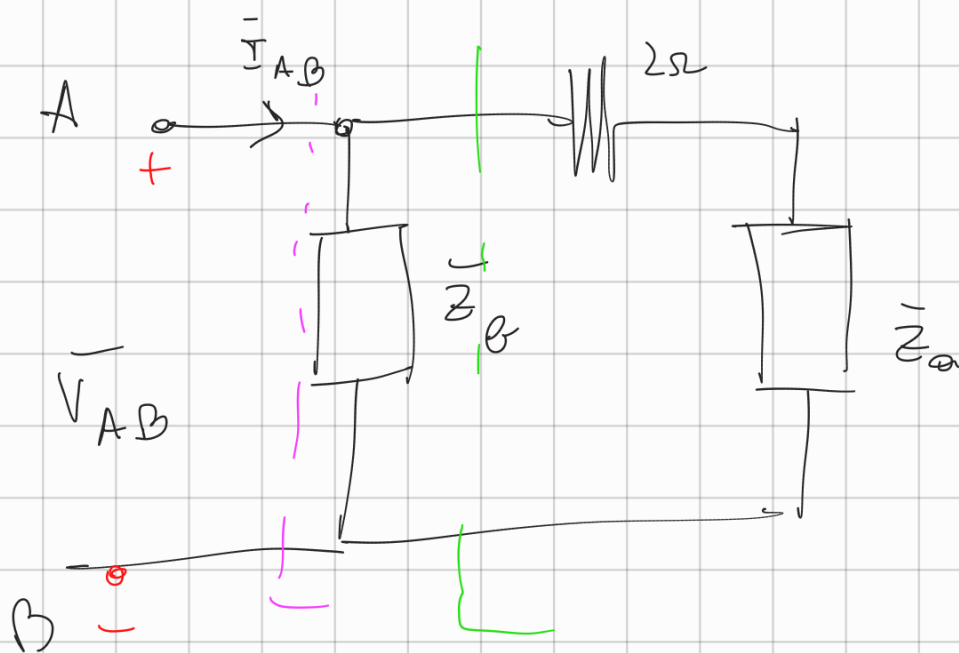
$$V_0 = \frac{2}{3} R i_0 + 2 R i_0 = \frac{8}{3} R i_0$$

$$R_{eq} = \frac{V_0}{i_0} = \frac{8}{3} R$$

Therefore

$$V_{eq} = \frac{8}{3} R i_c + \frac{8}{3} E$$

$$R_{eq} = \frac{8}{3} R$$



$$f = 50 \text{ Hz}$$

$$V_{Za} = 100 \text{ V eff}$$

$$Z_a = 10 \Omega$$

$$\cos(\varphi_{Za}) = 0,3 \text{ in r.d.}$$

$$Z_b = 20 \Omega$$

$$\cos(\varphi_{Zb}) = 0,8$$

mi servono e diagramma Fasoriale



$$I_{Za} = \frac{V_{eff}}{Z} = 10 \text{ A eff}$$

$$\varphi_{Za} = 72,5^\circ$$

$$I_{Za} \cdot 0,3 = I_{Za \text{ attiva}} = 3 \text{ A eff}$$

$$I_{Za} \cdot \sin(72,5) = I_{reatt} = 9,53 \text{ A eff}$$

$$A_{Za} = 1000 \text{ VA}$$

$$P_{Za} = 300 \text{ W}$$

$$V \cdot I_{eff}$$

$$Q_{ZA} = 953,71 \text{ VAR}$$

$$V \cdot I_{reatt}$$

$$P_A = P_{Z_a} + 2 \cdot 10^2 = 500$$

$$A_A = \sqrt{500^2 + 853,71^2} = 1077 \text{ VA}$$

$$V_A = 107,7 \text{ V}_{eff}$$

$$I_{Z_a} = 5,385 \text{ A}_{eff}$$

$$A_{Z_B} = 580 \text{ VA}$$

$$P_{Z_B} = 464 \text{ W}$$

$$Q_{Z_B} = 348$$

$$P_{\text{total}} = P_{AB} = 464 + 500 = 964 \text{ W}$$

$$Q_{\text{tot}} = 348 + 853,71 \text{ VAR} \\ = 1201,71 \text{ VAR}$$

$$A_{AB} = 1620 \text{ VA}$$

$$I_{AB} = 15 \text{ A}_{eff}$$

$$V_{AB} = 107,7 \text{ V}_{eff}$$

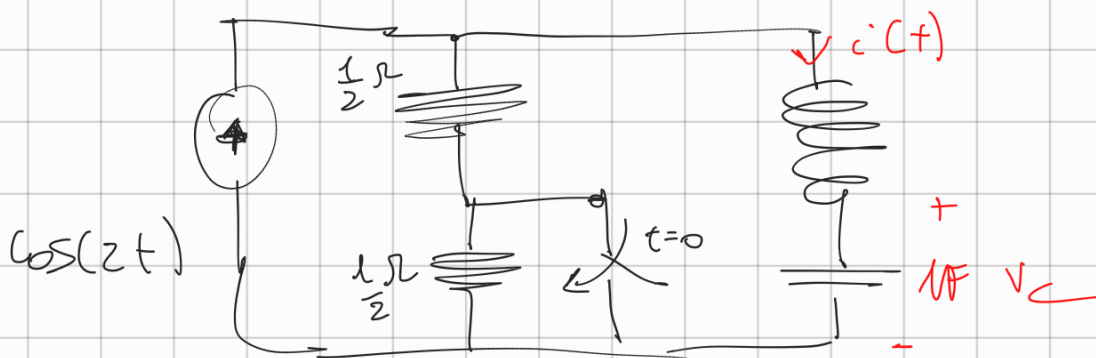
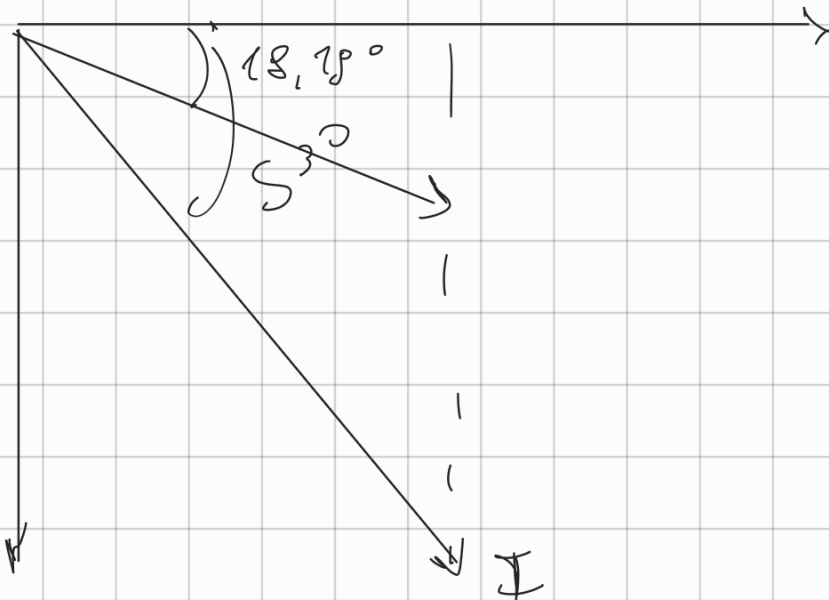
$$C = \frac{1032 - 964 \tan(18,1^\circ)}{314 \cdot 10^2}$$

$$= 182 \mu F$$

$$A_{\text{eff}} = 1014$$

$$\varphi_z = 53,5^\circ$$

$$I_{\text{eff}} = 2,42$$



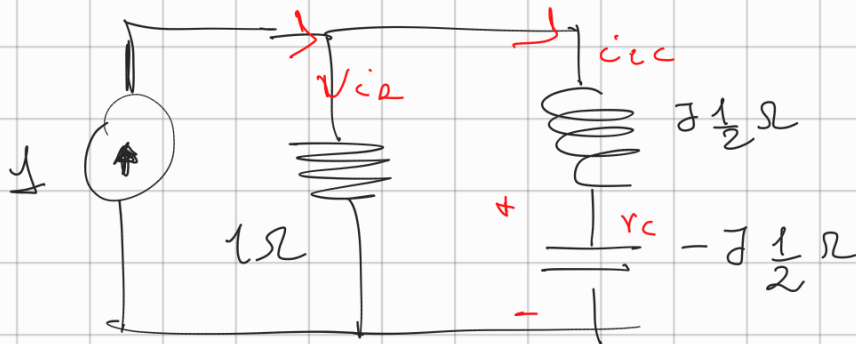
interiore open, si chiud a  $t=0$



$i(t) \quad t \geq 0 \quad ?$  risposta capolare  
nel DL

Dovrei variabili di stato

Simboli



$$X_L = 2 \cdot \frac{1}{4} = \frac{1}{2} \Omega$$

$$X_C = \frac{1}{\omega_C} = \frac{1}{2} \Omega$$

Sono a  $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1}}$   
risposta

$L$  e  $C$  sono in CC,  $I_L = 1 \text{ A}$

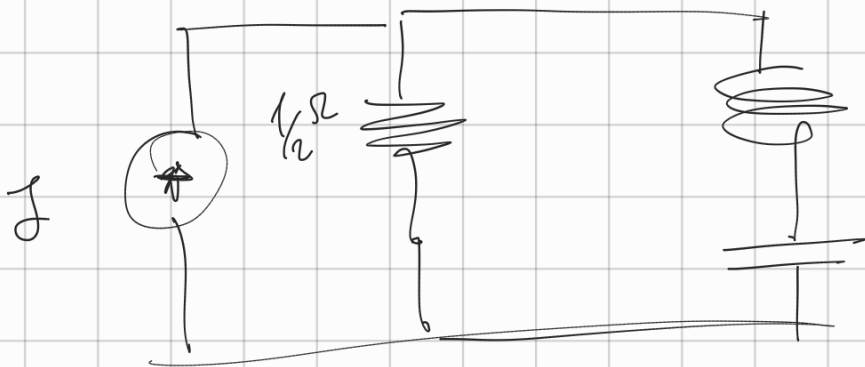
$$V_C = 0 \text{ V}$$

$\Rightarrow$  equazione  $\text{Re} [I_L e^{j\omega t, t=0^-}]$

$$i_L(0^-) = 1 \text{ A} = i_C(0^+)$$

$$V_C(0^-) = 0 \text{ V} = V_C(0^+)$$

$i$  regime dopo l'attacco



Solo un caso  
in risonanza...

il circuito è un RLC serie  
chiuso in risonanza l'impedenza  
con  $R_S = \frac{1}{2} \Omega$

$$\alpha_S = \frac{R_S}{2L} = \frac{\frac{1}{2}}{2 \cdot \frac{1}{4}} = 1$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = 2$$

Solo caso sottosmorzato  
 $\beta = \sqrt{4 - 1}$

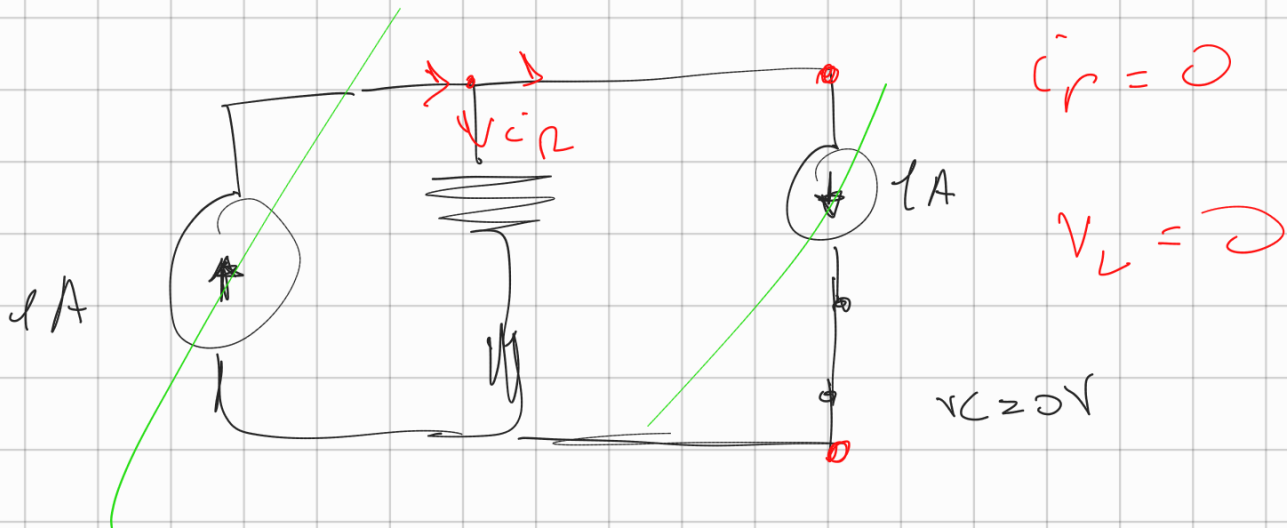
$$s_{1,2} = -1 \pm j\sqrt{3}$$

$$i_L(t) = k_1 e^{-t} \cos(\sqrt{3}t) + k_2 e^{-t} \sin(\sqrt{3}t)$$

$$i_L(0^+) = 1$$

$$\frac{di_L}{dt}(0) = \frac{V_L(0^+)}{L} = 0$$

and no circuit at  $0^+$



no current

$$k_1 = 1$$

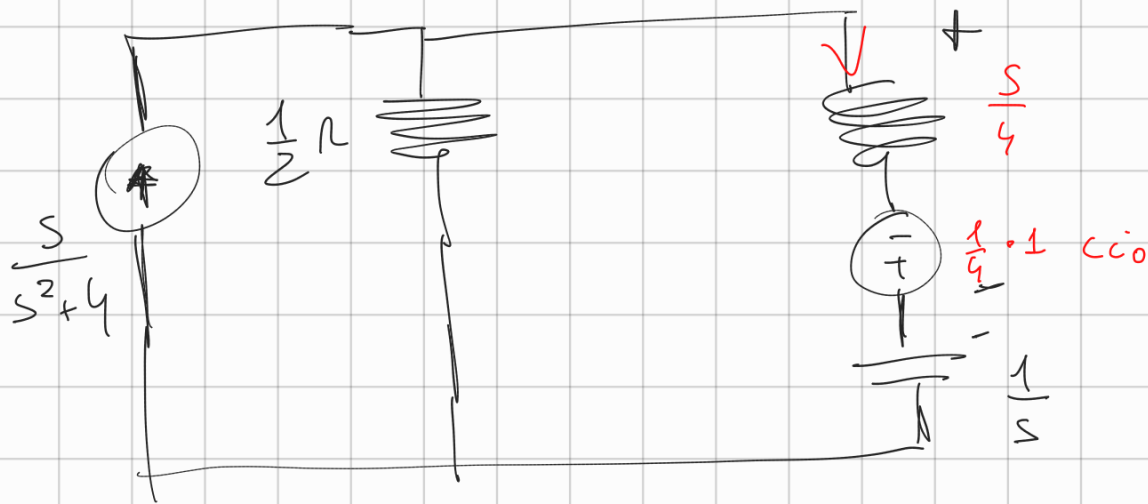
$$-k_1 e^{-t} \cos(\sqrt{3}t) + \sqrt{3}k_2 e^{-t} \cos(\sqrt{3}t)$$

$$t = 0 \quad -1 + \sqrt{3}k_2 = 0$$

$$k_2 = \frac{1}{\sqrt{3}}$$

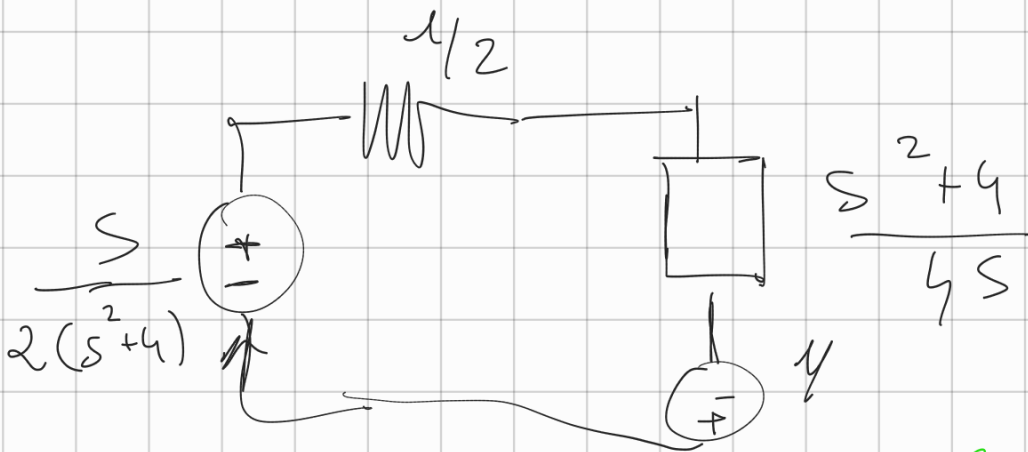
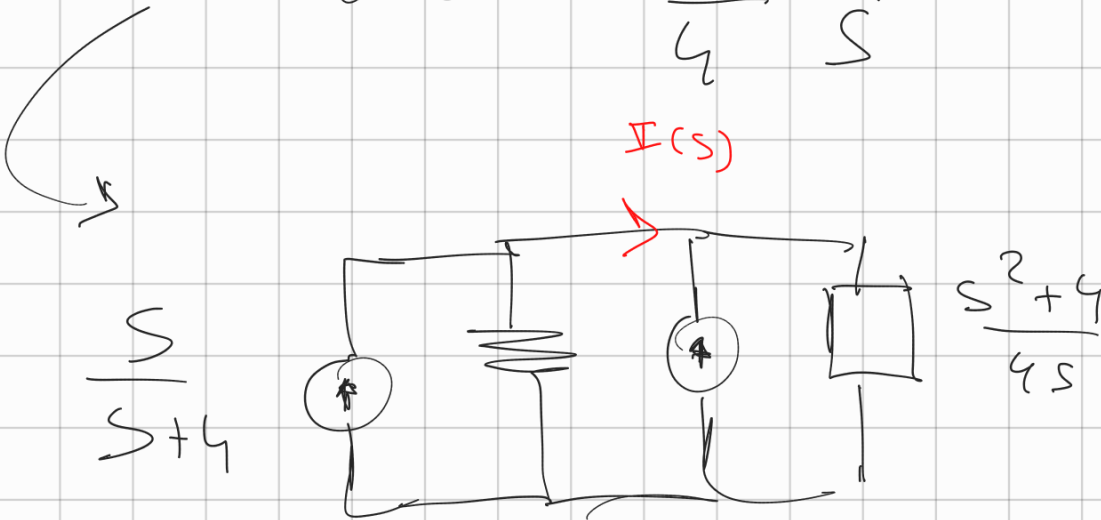
ans'n:  $RL$

$I(s)$



Millman

$$\frac{S}{4} + \frac{1}{S} = \frac{S^2 + 4}{4S}$$



$$\frac{S^2 + 4}{4S} + \frac{1}{2} = \frac{2(S^2 + 4) + 4S}{8S}$$

$$\frac{S}{2(s^2+4)} + \frac{1}{4} = \frac{4S + 2(s^2+4)}{8(s^2+4)}$$

$$i(t) = \frac{\cancel{4S} + \cancel{2}(s^2+4)}{\cancel{8}(s^2+4)} \quad \circ \quad \frac{\cancel{8S}}{\cancel{2}(s^2+4) + \cancel{4S}}$$

$$= \frac{S}{s^2+4}$$

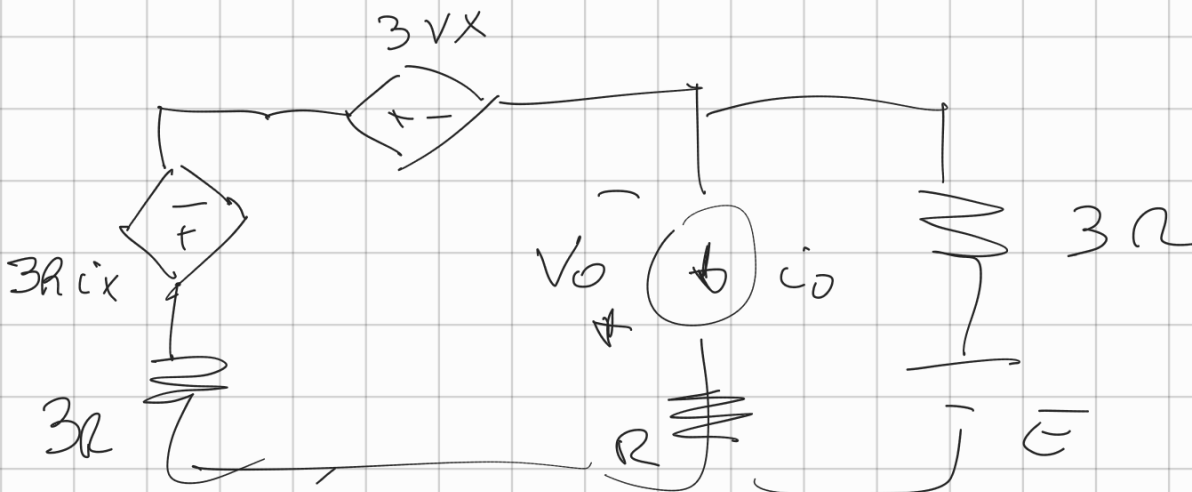
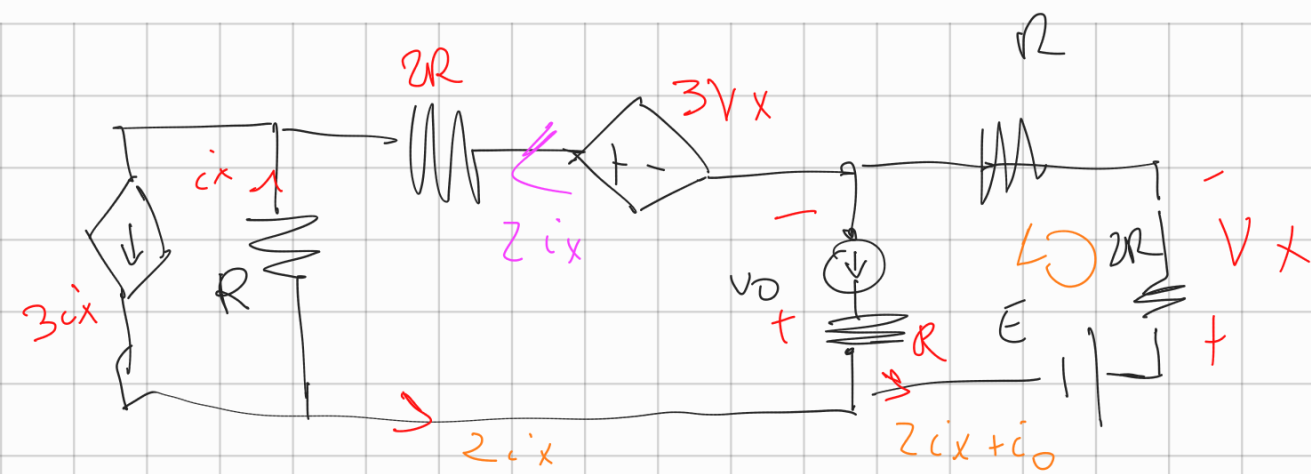
$$\frac{S}{s^2+4} \circ \frac{4S}{s^2+4} =$$

$$= \frac{\frac{4S}{s^2+4} + 2}{\frac{4S^2}{(s^2+4)} \cancel{2}}$$

$$= \frac{4S + 2(s^2+4)}{(s^2+4)}$$

$$= \frac{4S^2}{(s^2+4)(2S^2+4S+8)} \quad \frac{2S^2}{s^2+2S+4}$$

So pol dp



$$V_0 = \frac{3V_x + 3Ri_x}{3R} + i_0 - \frac{E}{3R}$$

---


$$\frac{1}{3R} + \frac{1}{3R}$$

$$= \frac{\frac{V_x}{R} + i_x + i_0 - \frac{E}{3R}}{2}$$

---


$$\frac{2}{3R}$$

$$V_0 = \frac{3}{2} V_x + \frac{3}{2} i_x R + 3 i_o R - E$$

da KVL MP

$$-E + V_x + R(2i_x + i_o)$$

$$-V_0 + R i_o = 0$$

$$-E + V_x + 2R i_x + R i_o$$

$$-V_0 + R i_o = 0$$

$$V_x = E + V_0 - 2R i_x - 2R i_o$$

da KVL M2

$$0 = -R i_o + V_0 - 3V_x + 4R i_x$$

$$4R i_x = R i_o - V_0 + 3V_x$$

$$i_x = \frac{1}{4} i_o - \frac{V_0}{4R} + \frac{3}{4} \frac{V_x}{R}$$

$$V_x = E + V_0 - 2R \left( \frac{1}{4} i_0 - \frac{V_0}{4R} + \frac{3}{4} \frac{V_x}{R} \right) - 2R i_0$$

$$V_x = E + V_0 - \frac{1}{2} R i_0 + \frac{1}{2} V_0 - \frac{3}{2} V_x$$

$$\frac{5}{2} V_x = E + \frac{3}{2} V_0 - \frac{1}{2} R i_0$$

$$V_x = \frac{2E}{5} + \frac{3}{5} V_0 - \frac{R i_0}{5}$$

$$i_y = \frac{1}{4} i_0 - \frac{V_0}{4R} + \frac{2}{4R} \left( \frac{2E}{5} + \frac{3}{5} V_0 - \frac{R i_0}{5} \right)$$

$$= \frac{1}{4} i_0 - \frac{V_0}{4R} + \frac{1E}{2R} + \frac{3}{20} \frac{V_0}{R} - \frac{i_0}{20}$$

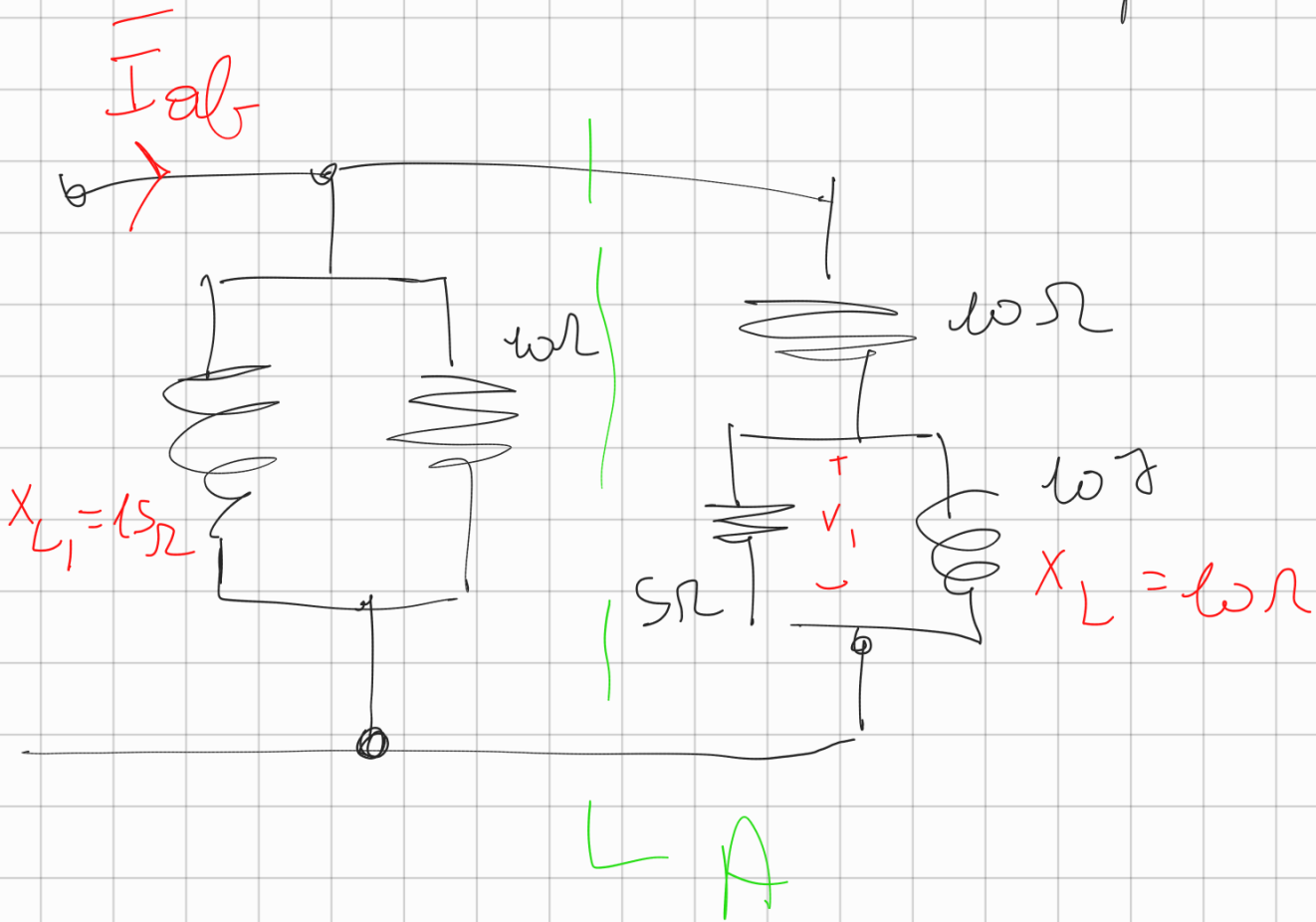
$$V_0 = \frac{3}{2} V_x + \frac{3}{2} i_x R + 3 i_0 R - E$$



$$\bar{z} = \frac{2}{9} + j\frac{3}{5}$$

REFASARZUOTO

$$f = 50 \text{ Hz}$$



$$I_{XL} = 10 \text{ A eff}$$

$$V_1 = 100 \text{ V eff}$$

$$I_{92} = \frac{1000}{9} = 20 \text{ A eff}$$

$$P_{92} = 2000 \text{ W}$$

$$\bar{Z} = \frac{500 (s - 10j) (4 + 2j)}{s + 10j (s - 10j)}$$

$$= \frac{500 + 250j}{125}$$

$$Z = 2\sqrt{5}$$

$$I = \frac{V}{Z} = 22,36 \text{ A eff}$$

$$P_{10\Omega} = 10 \cdot 22,36^2 = 5 \text{ kW}$$

$$P_A = 7 \text{ kW}$$

$$Q_A = 1000 \text{ VA}$$

$$A = 7071 \text{ VA}$$

$$V = 316 \text{ V eff} = V_{AB}$$

$$Q_{X_{L1}} = \frac{316^2}{15} = 6657 \text{ VAR}$$

$$P_{\text{loss}} = 9985.6 \text{ W}$$

$$P_{AB} = 2 \times 9985.6 = 16985.6$$

$$Q_{AB} = 7657$$

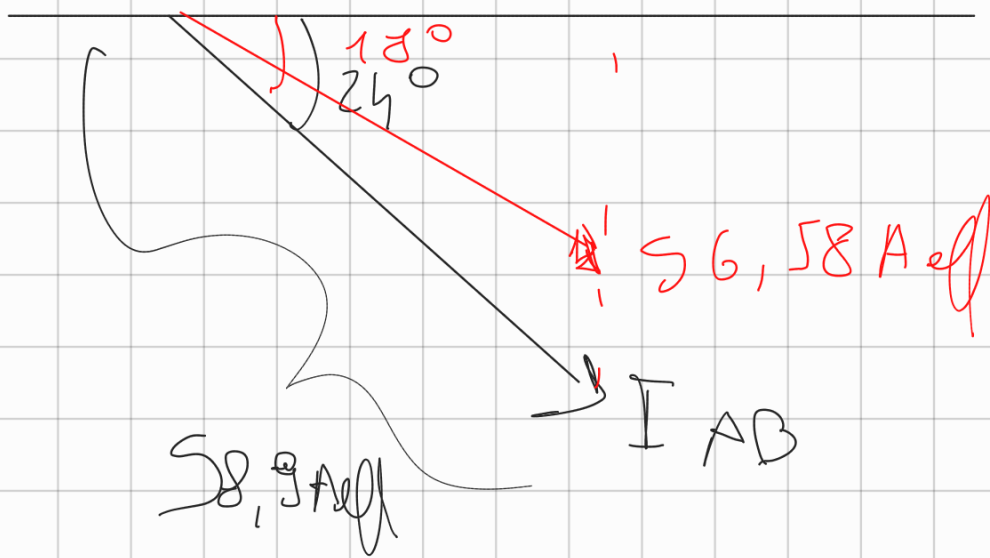
$$A = 18631 \text{ VA}$$

$$I_{A1} = 58.9 \text{ A}$$

$$C_{\text{cor}} = \frac{7657 - 16889 \cdot \tan(18.2)}{316^2 - 314}$$

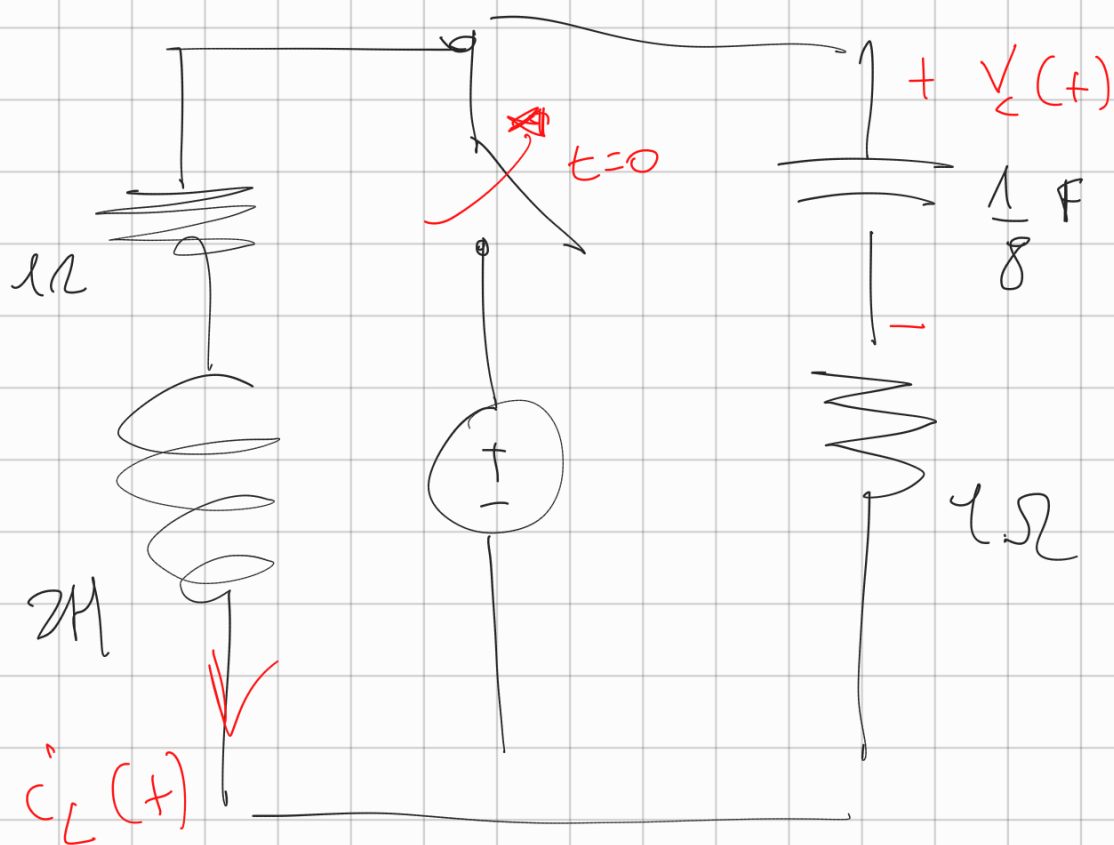
$$316^2 - 314$$

$$= 66,1 \text{ } \mu\text{F}$$



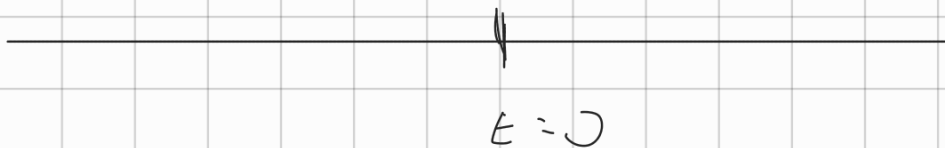
$$A_{\text{sp}} = 17879$$

$$I_{AB, \text{sp}} = 56,58 \text{ Aeff}$$



Var. Simul

TC, Scia quind.



Var. 80%  $i_L(t)$ ,  $V_C(t)$

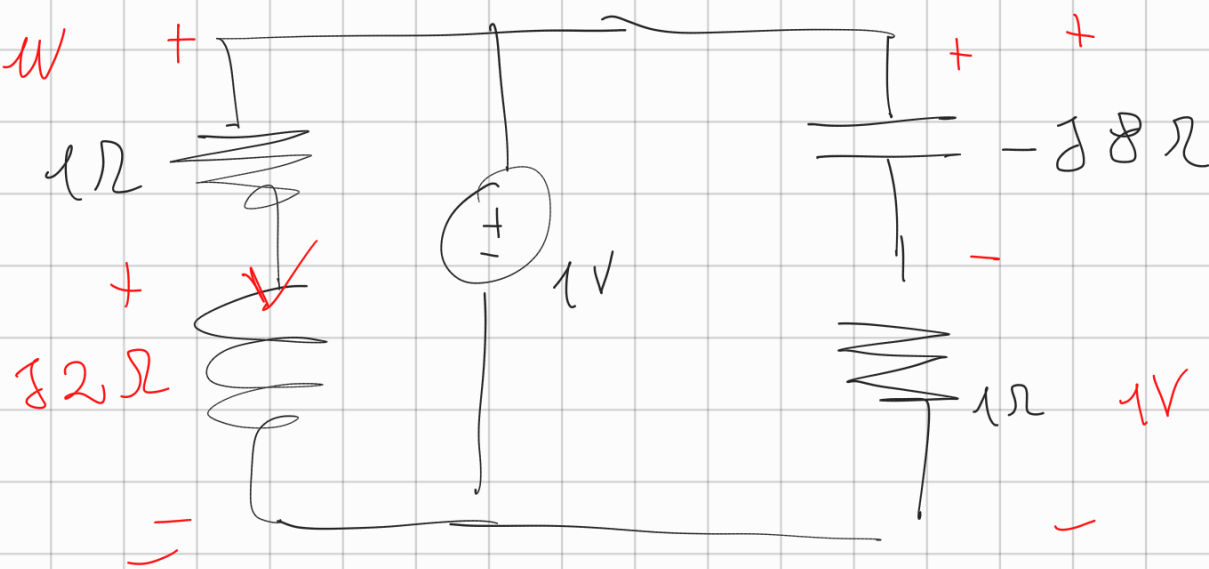
Bravo VAR STATO, circuito chiuso

$$\omega = 1$$

$$X_L = \omega L = 2 \Omega$$

$$X_C = \frac{1}{\omega C} = 8 \Omega$$

a 0-



$$\bar{V}_C = \frac{-88}{1-88} = \frac{64-88}{65} = \frac{-24}{65}$$

$$\bar{V}_L = \frac{82}{1+82} = \frac{82}{83} \text{ V}$$

$$\bar{I}_L = \frac{\bar{V}_L}{\bar{Z}} = \frac{1-82}{83} \text{ A}$$

$$\Rightarrow V(0) = \frac{64}{65} \text{ V} \approx 1 \text{ V} = V_{be} \int e^{st} dt$$

$$i(0^-) = i(0^+) = \frac{1}{83} \text{ A}$$

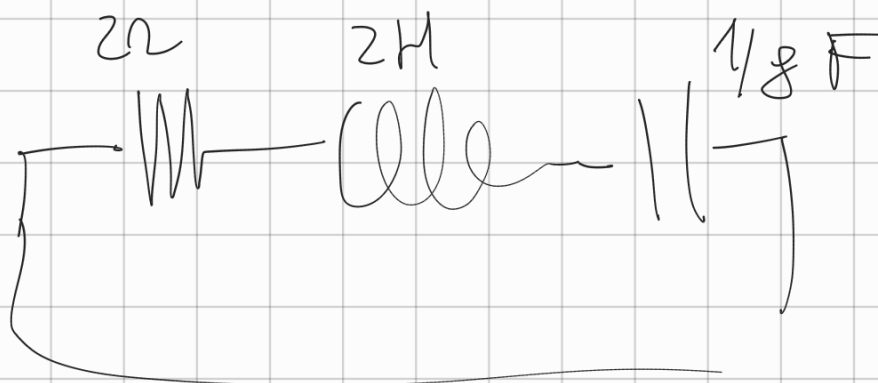
at  $t=0$ , circuit gets

$i(\text{regime}) = 0$ , no steady  
state. & so on

For  $t < 0$ , whole circuit is closed

Initially, into the inductor of

On RLC  $\Sigma$ , as  $R_s = 2R$



$$\alpha = \frac{R_s}{2L} = \frac{2}{4} = \frac{1}{2} \text{ sec}$$

$$\omega_0^2 = \frac{1}{LC} = 4, \quad \omega_0 = 2$$

Case overdamped

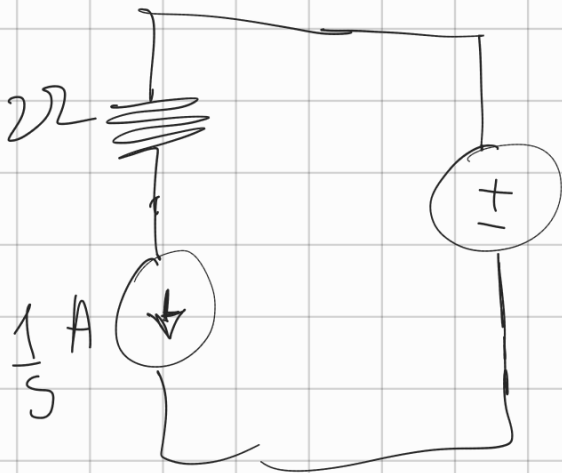
$$s_{1,2} = -\alpha \pm j\beta \quad \beta = \sqrt{\omega_0^2 - \alpha^2}$$

$$= -\frac{1}{2} \pm j \frac{\sqrt{45}}{2}$$

$$\begin{cases} v(t) = k_1 e^{-\frac{1}{2}t} \cos\left(\frac{\sqrt{45}t}{2}\right) + k_2 e^{-\frac{1}{2}t} \sin\left(\frac{\sqrt{45}t}{2}\right) \\ v_0 = 1 \text{ V} \\ i_0 = \frac{1}{5} \text{ A} \end{cases}$$

Wegen  $i_{0^+}$  mit der  $\frac{dV_C}{dt} = \frac{i_C}{C}$

ist der Wert von  $i_C$  zu  $t=0^+$



da der Widerstand vernachlässigt werden kann,  $i_C = i_L = \frac{1}{5}$

$$\Rightarrow \frac{dV_C}{dt}(0^+) = \frac{8}{5}$$

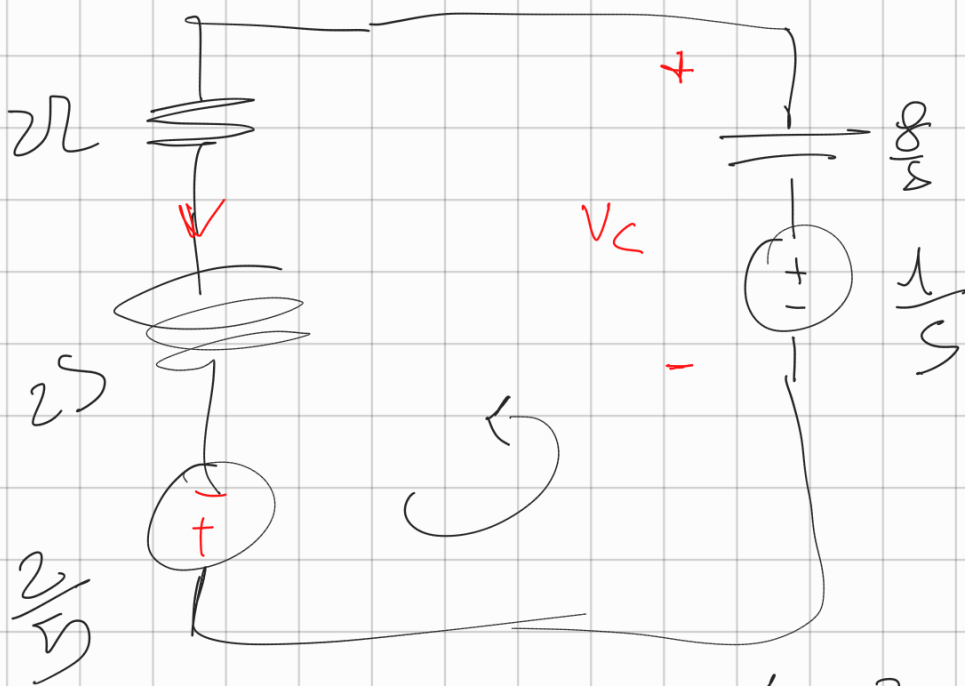
$$v(0) = k_1 = 1$$

$$k_2 \Rightarrow -\frac{1}{2} k_1 + \frac{\sqrt{45}}{2} k_2 = \frac{8}{5}$$



$$k_2 = 1.08$$

Verifica DL a  $0^+$   
 $\frac{1}{s_c}$



$$\frac{1}{s} + \frac{2}{s} = \frac{5 + 2s}{5s}$$

$$0 = 2I(s) + 2sI(s) - \frac{2}{s} - \frac{1}{s} + \frac{8}{s}I(s)$$

$$\left[ \frac{18}{s} + 2s \right] I(s) = \frac{3}{s}$$

$$I(s) = \frac{3}{s} \cdot \frac{1}{\frac{18}{s} + 2s}$$

$$= \frac{18 + 2s^2}{s}$$

$$I(s) = \frac{3s}{25(\cancel{18} + \cancel{2}s^2)} =$$

$$= \frac{3}{10} \frac{s}{s^2 + 9} = I(s)$$

$$V(c) = \left( \frac{\cancel{3}}{\cancel{10} \cancel{s}} \cdot \frac{\cancel{s}}{s^2 + 9} \right) + \frac{1}{(s)} = \frac{12}{s} \cdot \frac{1}{s^2 + 9}$$

A

$$\cos(3i) + \sec(3i)$$

$$\frac{12}{s}$$



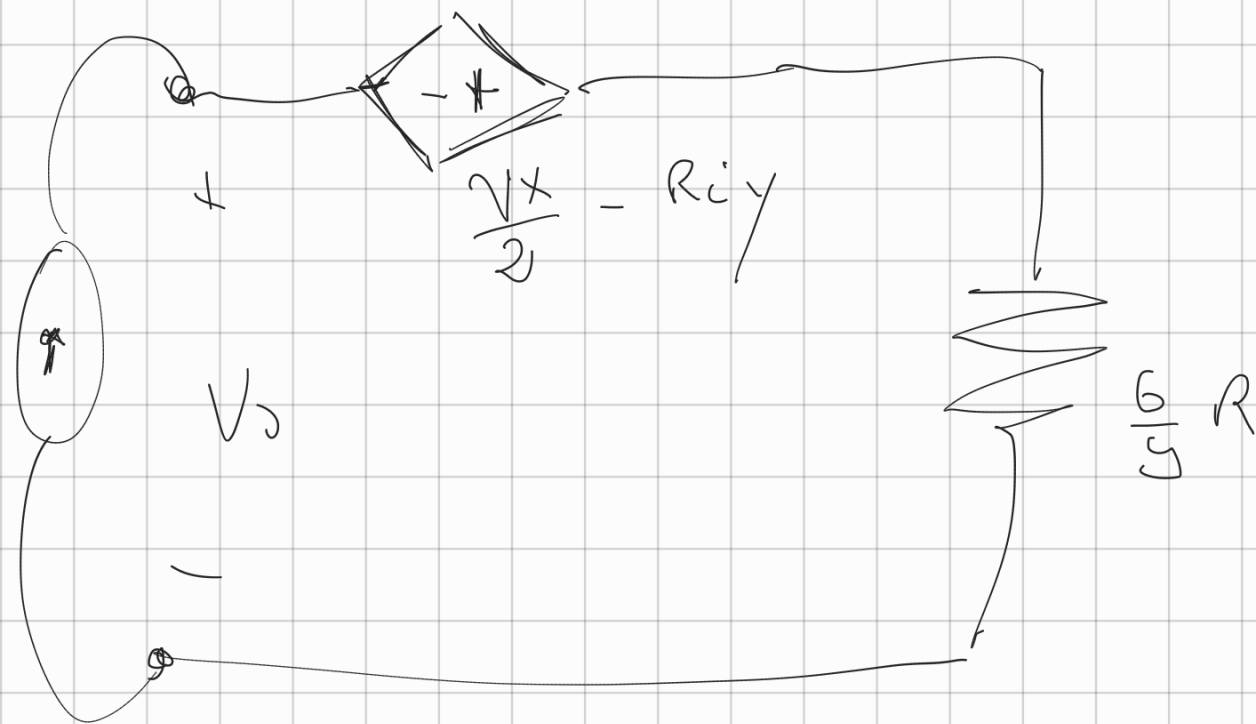
$$\frac{\frac{1}{s} \left[ \frac{s+2}{s} \right] \cdot \frac{8}{s}}{2 + s + \frac{8}{s}} = \frac{2s + s^2 + 8}{s}$$

$$= \frac{8}{s} \cdot \frac{s+2s}{s(s^2+2s+8)}$$

$$\frac{8}{s} \cdot \frac{s+2s}{s(s^2+2s+8)} + \frac{1}{s}$$

$$= \frac{s+2s + s^2+2s+8}{s(s^2+2s+8)} \cdot \frac{8}{s}$$

$$\frac{s^2 + 4s + 13}{s(s^2+2s+8)} \cdot \frac{8}{s}$$

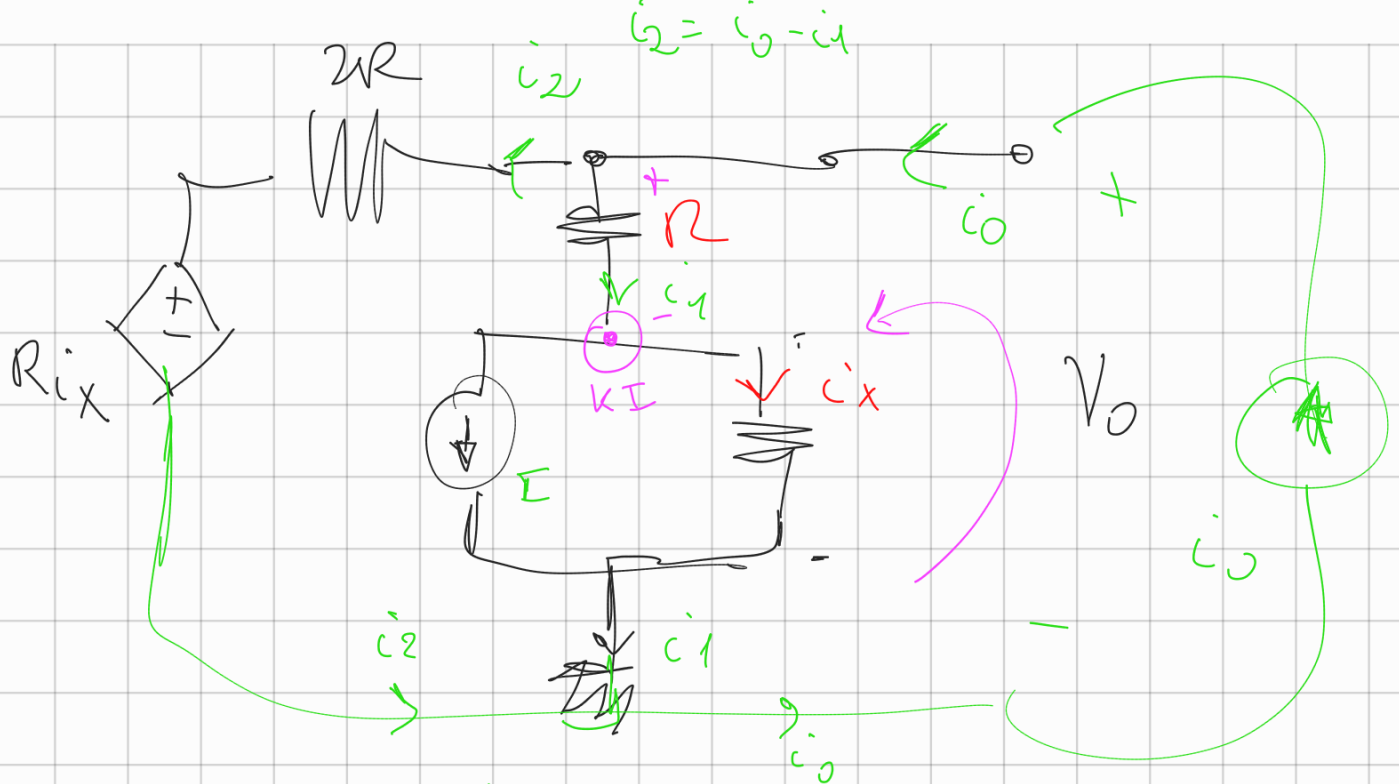


$$V_0 = - \frac{V_x}{2} + R i_y + \frac{6}{5} R i_0$$

$$= - \frac{1}{3} R i_0 + \frac{V_0}{2} - \frac{1}{3} R i_0 + \frac{6}{5} R i_0$$

$$\frac{V_0}{2} = \frac{-5 - 5 + 18}{15} R i_0 = \frac{8}{15} R i_0$$

$$V_0 = \frac{16}{15} R i_0$$



$$V_o = R i_1 + i_x \cdot R = R (i_1 + i_x)$$

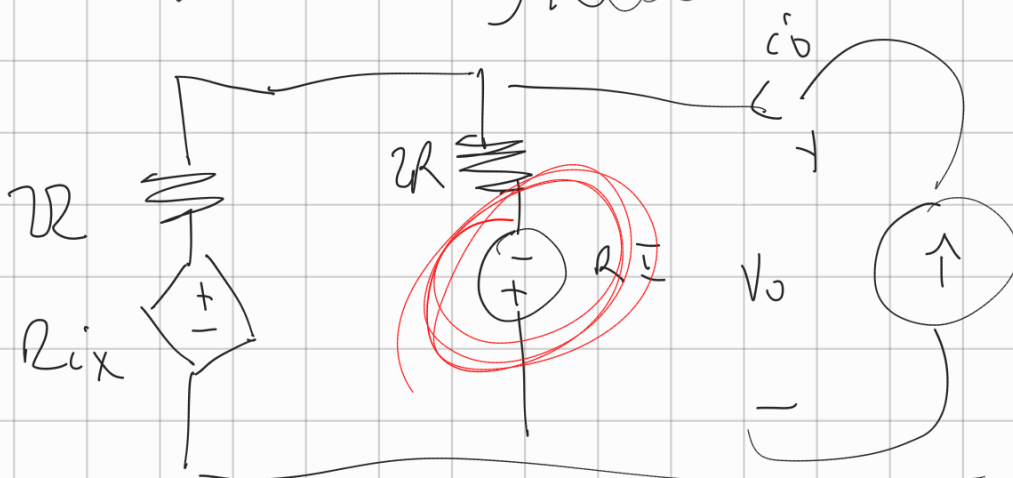
$$\text{dabei so da } i_1 = I + i_x$$

$$V_o = R (I + 2i_x)$$

$$V_o = R I + 2R i_x$$

Einsetzen & Auflösen

$$i_x = \frac{V_o - \frac{I}{2}}{2R}$$



$$V_o = \frac{V_o - \frac{RI}{2R} + \frac{Ri_x}{2R}}{\frac{1}{2R} + \frac{1}{2R} =}$$

$$V_o = Ri_o - \frac{R}{2} I + \frac{Ri_x}{2}$$

$$27 \quad RI + 2Ri_x = Ri_o - \frac{R}{2} I + \frac{R}{2} i_x$$

$$2Ri_x = -\frac{3}{2} RI + Ri_o$$

$$\frac{3}{2} Ri_x = -\frac{3}{2} RI + Ri_o$$

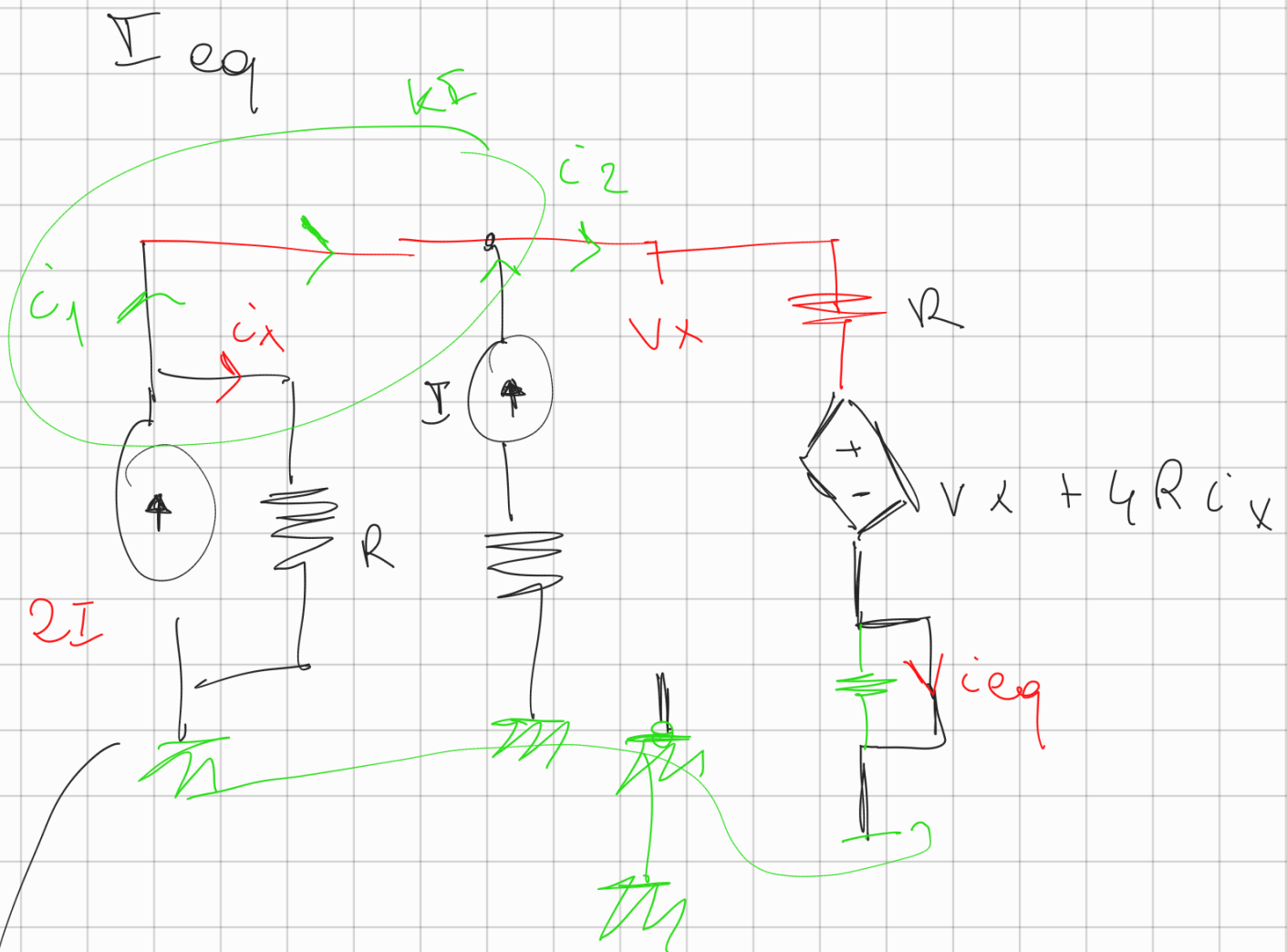
$$i_x = -R I + \frac{2}{3} i_o$$

$$V_o = Ri_o - \frac{R}{2} I - \frac{RI}{2} + \frac{2}{6} Ri_o$$

$$= \frac{4}{3} Ri_o - RI$$

eq. NORTON cell definition

$I_{eq}$  e' la corrente di CC.

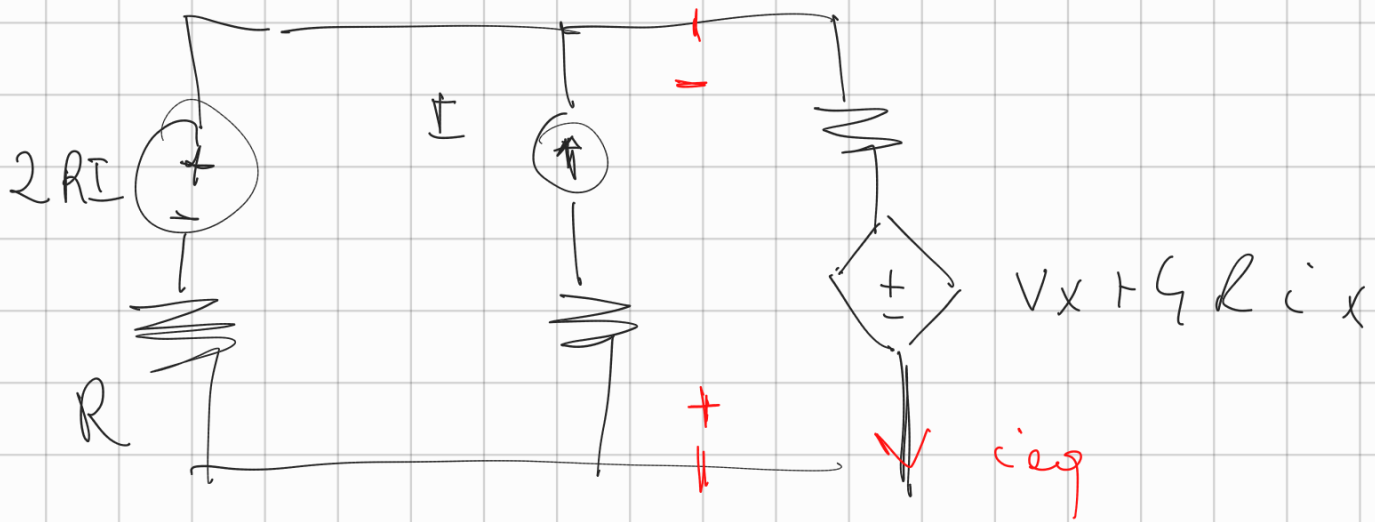


$$i_1 + i_x - 2I = 0$$

$$i_1 = 2I - i_x$$

$$i_2 = I + i_1 = 3I - i_x$$

$$V_0 = -V_x$$



$$V_0 = \frac{2RI + I + \frac{V_x + 4Ri_x}{R}}{\frac{2}{R}}$$

$$V_0 = \frac{3RI}{2} + \frac{V_x}{2} + 2i_x R$$

$\downarrow$   
 $-V_x$

$$\frac{3}{2} V_x = -\frac{3}{2} R I - 2i_x R$$

$$V_x = -R I - \frac{4}{3} R i_x$$



opwe

$$V_X + R i_2 + V_X + 4R i_X = 0$$

$$2V_X = -R(3I - i_X) - 4R i_X$$

$$V_X = -\frac{3}{2}RI + 3R i_X$$

$$i_2 = I + i_1 = 3I - i_X$$

$$-V_X = i_X \cdot R$$

$$i_X = \frac{-V_X}{R}$$

$$V_X = -RI + \frac{4}{3}V_X$$

$$RI = \frac{1}{3}V_X$$

$$V_X = 3RI$$

opwe

$$-\frac{3}{2}RI + 3R\left(-\frac{V_X}{R}\right)$$

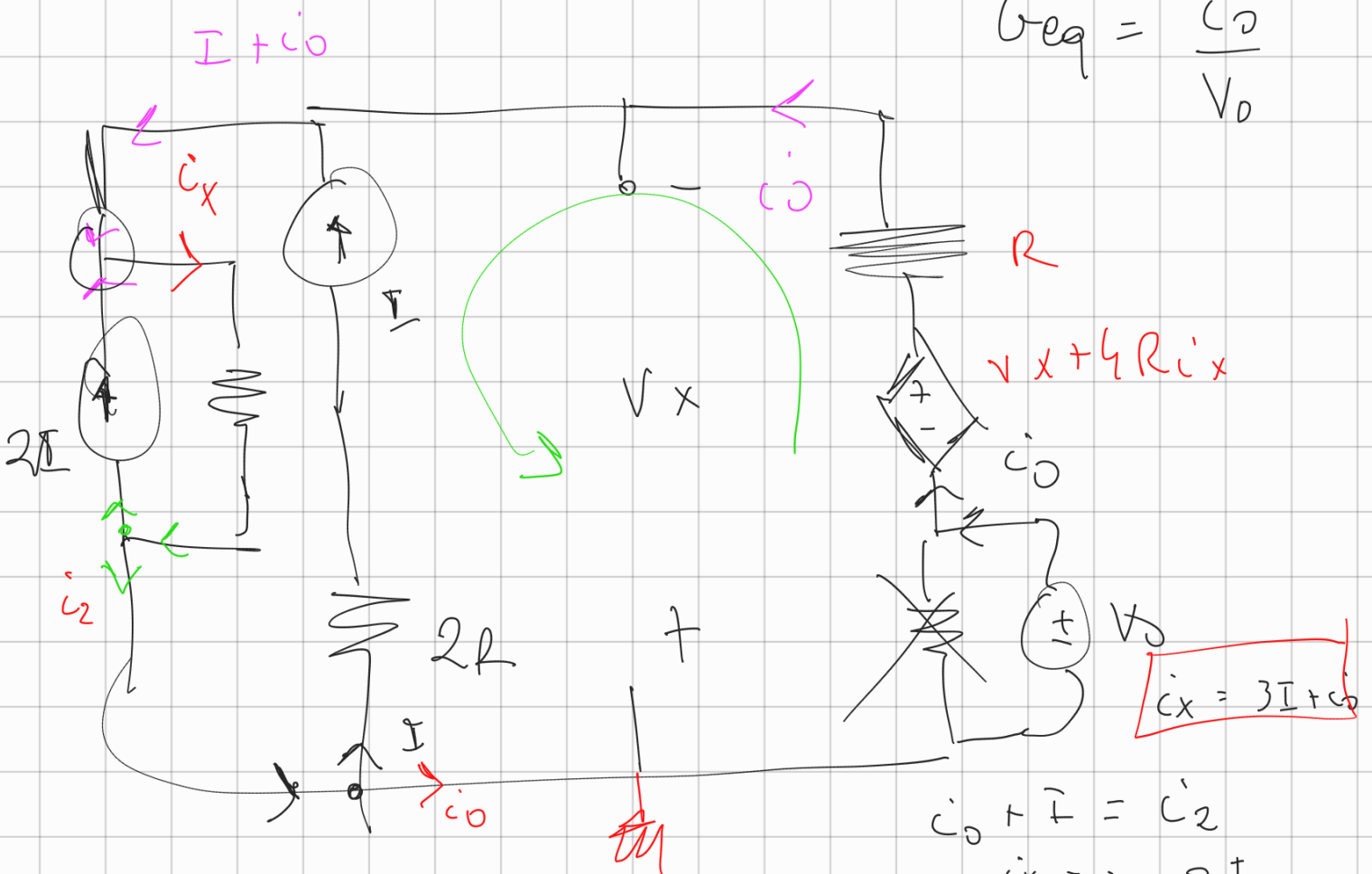
$$V_X = -\frac{3}{2}RI - 3V_X$$

$$i_x = -3I$$

$$i_2 = 3I + 3I = 6I \dots$$

$G_{eq}$  alternative con  $V_0$ , then  $i_0$

$$G_{eq} = \frac{i_0}{V_0}$$



$$i_x = 3I + i_0$$

$$V_x = 2R I$$

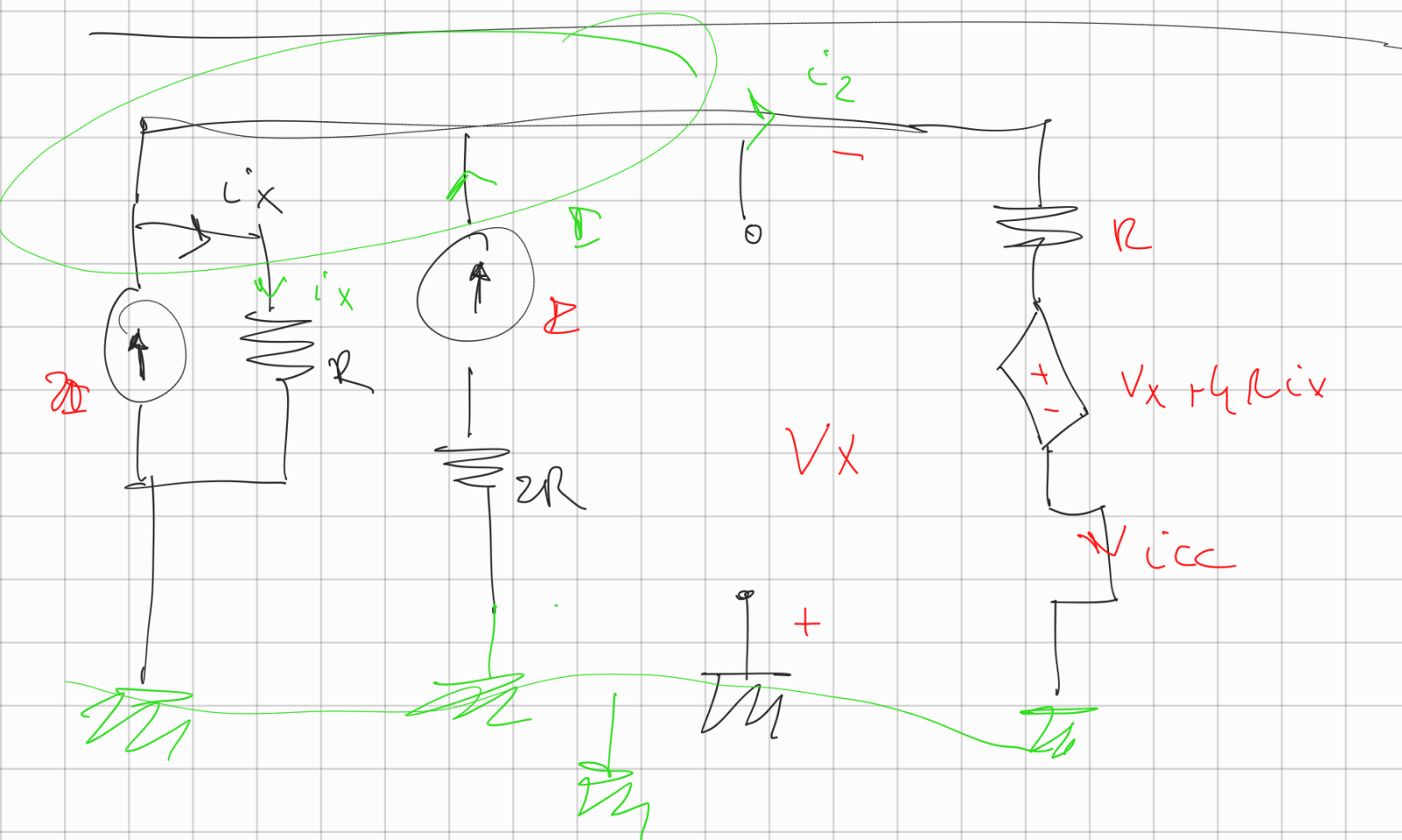
$$-V_x - V_0 - (2R I + 4R(3I + i_0)) + R i_0$$

$$-2R_I - 2R_I - 4R_{3I} - 4R_{i0} + R_{i0}$$

$$V_j = -\frac{1}{2} R T - 3 R u_0$$

$$3R \dot{I}_3 = -V_0 + 12R \dot{I}_1$$

$$U = \frac{-V_0}{3R} + 4I$$



$$V_X = 2R I$$

$$i_X = -\frac{V_X}{R} = -2I$$

$$-2I + i_X - I + i_2 = 0$$

$$i_2 = 3I - i_X = 3I + 2I = 5I$$

$$i_X = 3I + i_0$$

$$V_X = -i_X \cdot R = -3IR - i_0 R$$

da KV

$$-(V_X - 4R i_X) + R i_0 - V_X - V_0 = 0$$

$$V_0 = -V_X + 4R i_X + R i_0 - V_X$$

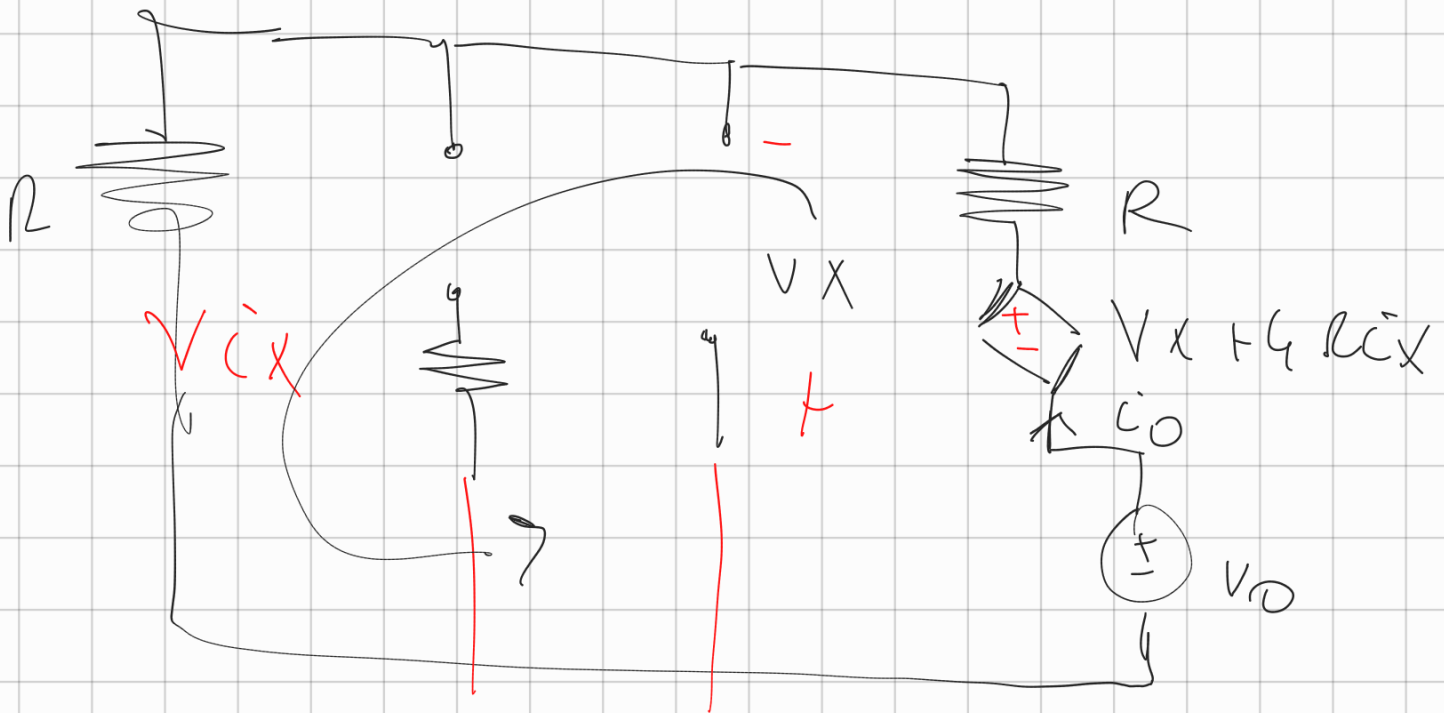
$$-2V_X + 4R i_X + R i_0$$

$$= 6IR + i_0 R + i_0 R$$

$$+ 4R (3I + i_0)$$

$$+ 12R i + 4R i_o$$

G eq. superposition.

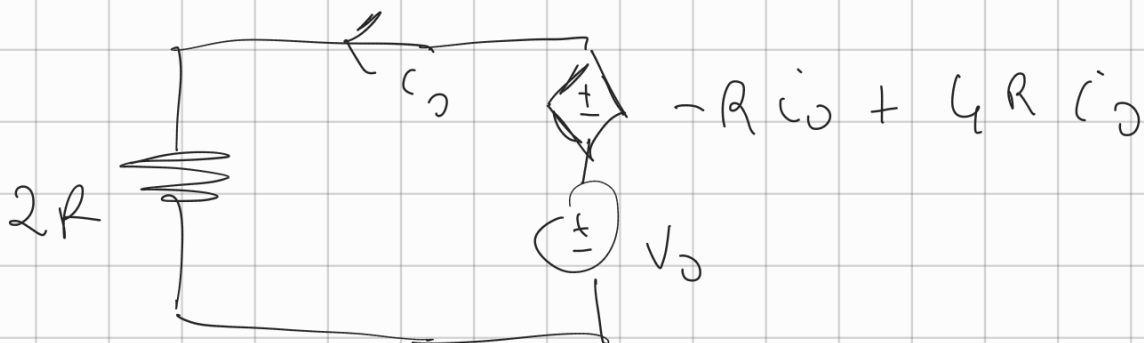


$$V_x = -R i_x$$

using neglect,

$$V_x = -R i_o$$

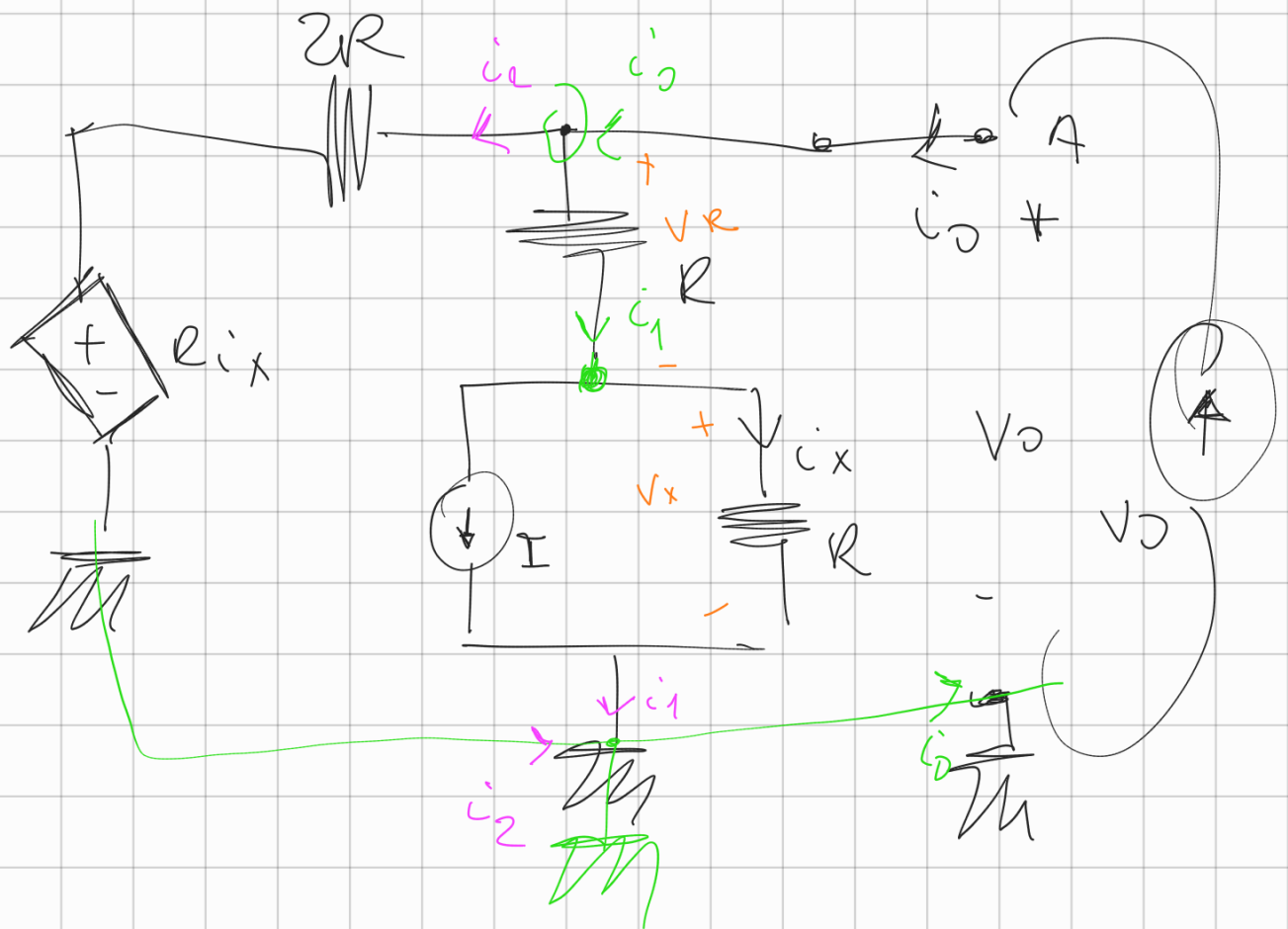
$$i_x = i_o$$



$$-V_0 + R i_0 - 4 R i_0 + 2 R i_0 = 0$$

$$i_0 = \frac{V_0}{R} \quad V_0 = 0,$$

$$V_0 = \frac{i_0 R}{i_0} = R$$



$$i_1 = i_x + I \quad i_2 = i_0 - i_1$$

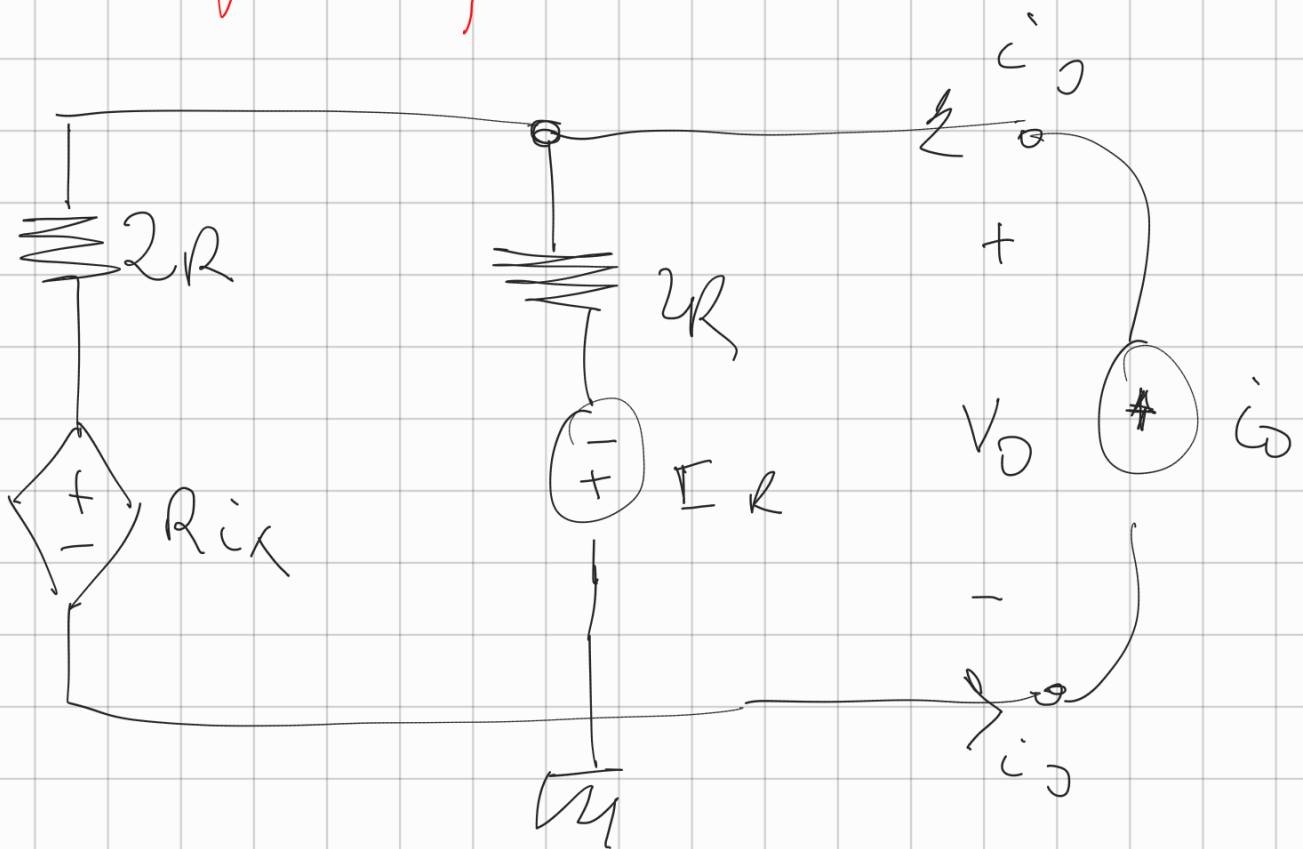
$$V_0 = V_R + V_x = i_1 R + i_2 R$$

$$= Ri_x + RI + Ri_x$$

$$V_o = 2Ri_x + RI$$

$$i_x = \frac{V_o - RI}{2R}$$

Therfore, Millman



$$V_o = \frac{\frac{i_x}{2} - \frac{I}{2} + i_o}{\frac{1}{2R} + \frac{1}{2R} = \frac{1}{R}}$$

$$V_0 = \frac{I \times R}{2} - \frac{RI}{2} + RI_0$$

$$I \times R = \frac{V_0 - RI}{2R}$$

$$V_0 = \frac{V_0 - RI}{4} - \frac{RI}{2} + RI_0$$

$$V_0 - \frac{V_0}{4} = -\frac{RI}{4} - \frac{RI}{2} + RI_0$$

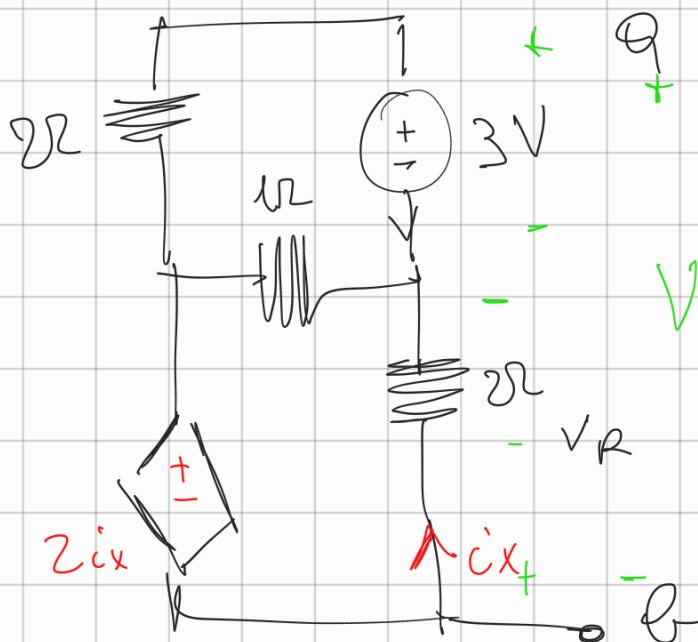
$$\frac{3}{4} V_0 =$$

$$V_0 = -\frac{RI}{3} - \frac{2}{3} RI + \frac{4}{3} RI_0$$



$$V_o = \underbrace{-RI}_{V_{eq}} + \underbrace{\frac{4}{3} R c' o}_{R_{eq}}$$

also def.  $V_{eq}$

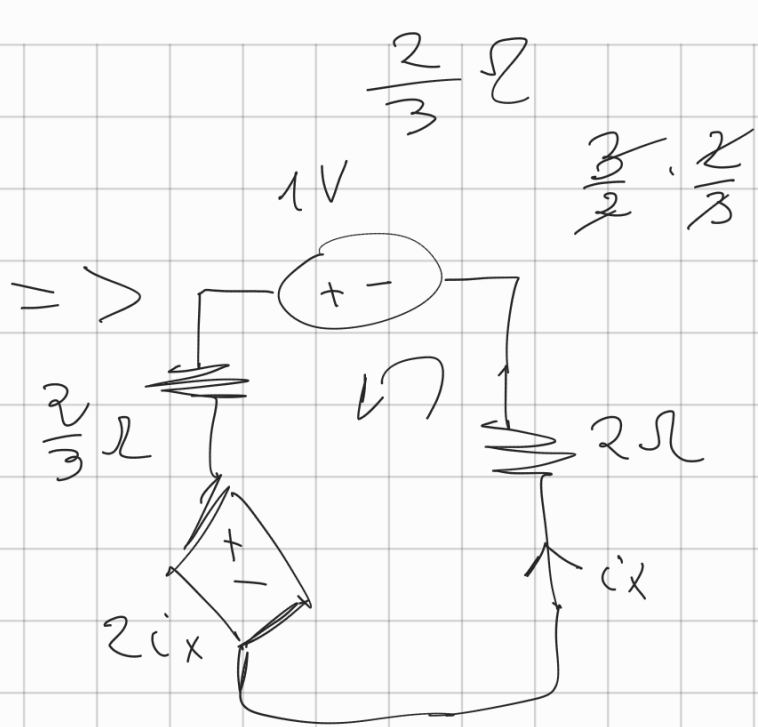
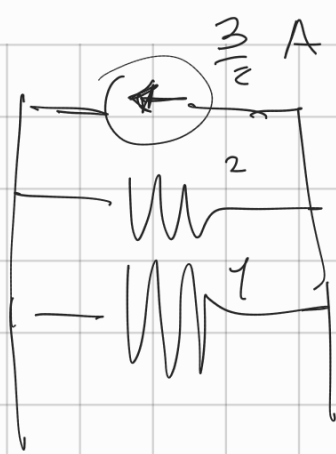


find the  $V_{eq}$  and  $R_{eq}$  of c. b

$$V_R = i_x \cdot 2$$

$$V_{eq} = 3V - V_R = 3V - 2i_x$$

$$i_x = \frac{-V_{eq}}{2} - \frac{3V}{2}$$



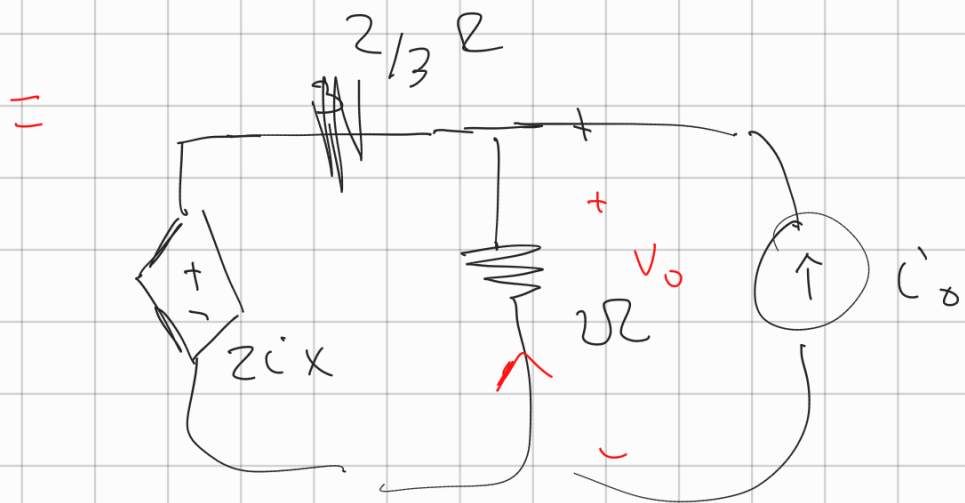
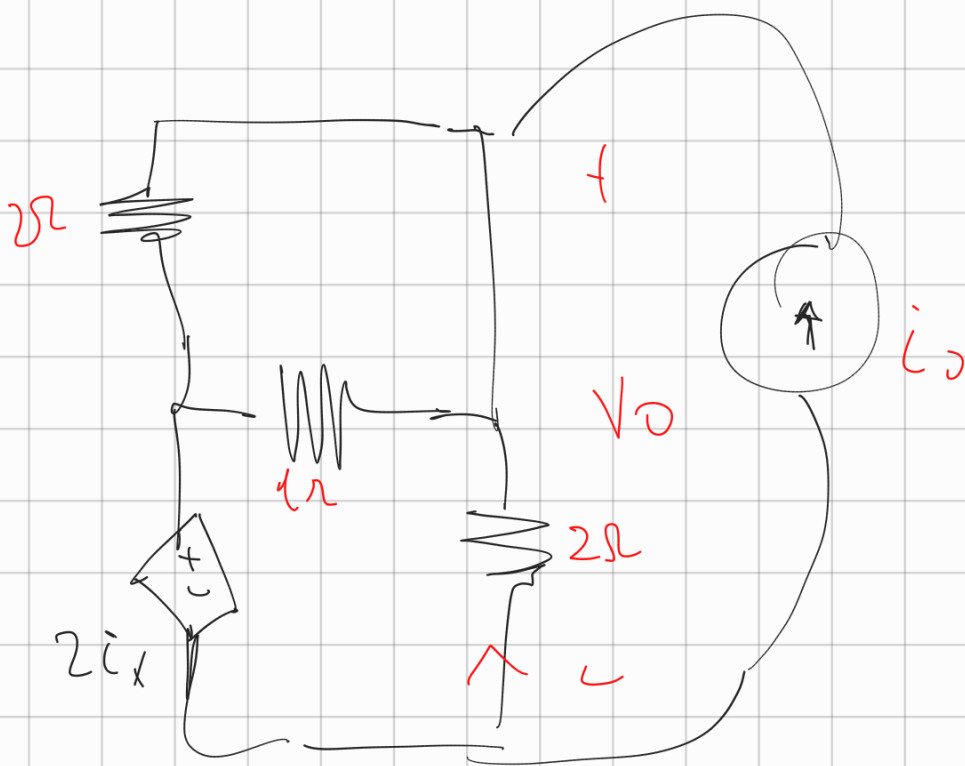
$$-1 + \frac{2}{3} i_x + 2 i_x + 2 i_x = 0$$

$$\frac{14}{3} i_x = 1 \quad i_x = \frac{3}{14} \text{ A}$$

$$V_{eq} = 3 \text{ V} - \frac{6}{14} = \frac{18}{7} \text{ V}$$

$$\frac{8}{3} i_x = 1 + 2 i_x$$

$R_{eq}$  can be def, spec please draw



Nullen

$i$

$$V_o = -2i_x$$

$$V_o = \frac{i_o + 3i_x}{\frac{3}{2} + \frac{1}{2}} = \frac{i_o + 3i_x}{2}$$

$$V_0 = \frac{\dot{c}_0}{2} + \frac{3}{2} \dot{c}_x$$

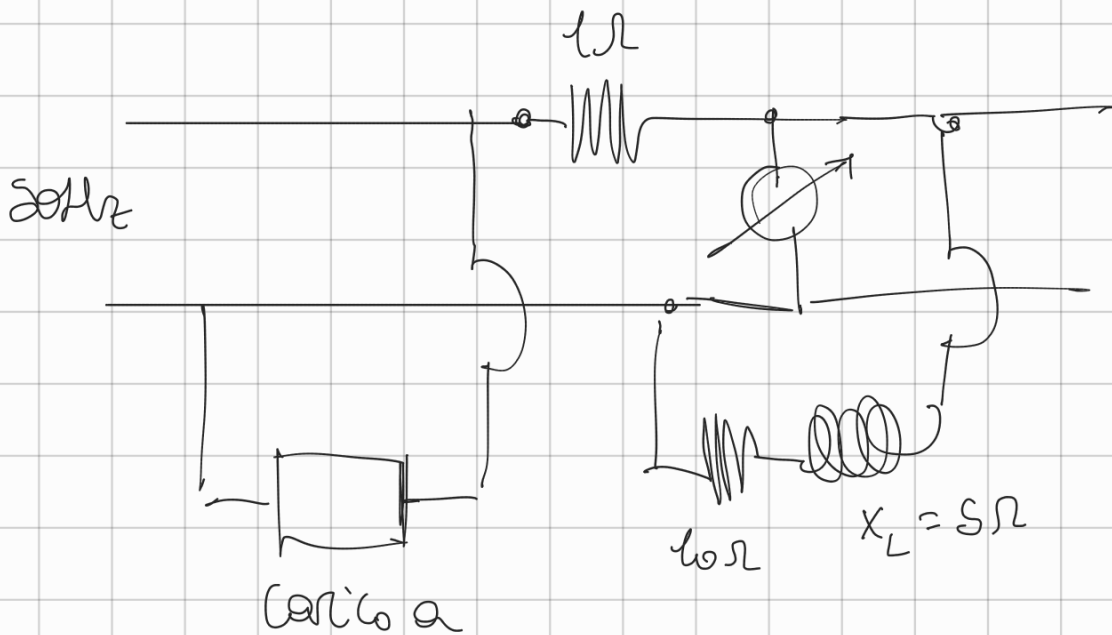
$$\dot{c}_x = -\frac{V_0}{2}$$

$$V_0 + \frac{3}{4} V_0 = \frac{\dot{c}_0}{2}$$

$$\frac{7}{4} V_0 = \frac{\dot{c}_0}{2}$$

$$V_0 = \frac{4}{7} \frac{\dot{c}_0}{2} = \frac{2}{7} \dot{c}_0$$

$$R_{eq} = \frac{2}{7}$$



$$P(t)_{max} = 2500W$$

$$P(t)_{min} = -500W$$

$$V = 100V$$

risultato

$$P_{\max} = P + A = 2500$$

$$P_{\min} = P - A = -500$$

$$A = 2500 - P$$

$$P - (2500 - P) = -500$$

$$2P = 2000$$

$$P = 1000 \text{ W}$$

$$A = 1500 \text{ VA}$$

$$\rightarrow Q^2 = A^2 - P^2 \Rightarrow Q = 1118 \text{ VAR}$$

$$I_A = \frac{V}{Z}, \quad \bar{Z} = 10 + j5 \Omega \Rightarrow Z = 5\sqrt{5}$$

$$I_A = 8.9$$

$$P = 800 \text{ W}$$

$$Q = 400 \text{ VAR}$$

$$P_A = 800 \text{ W} \quad Q = 400 \text{ W}$$

$$A = \sqrt{P^2 + Q^2} = 366 \text{ VA}$$

$$V = \frac{A}{I} = 107 \text{ Veff}$$

Corr  $\omega$  A e' on

$$P_{TOT} = 880 + 1000 = 1880$$

$$Q_{TOT} = 400 + 1118 = 1518$$

$$A_{AB} = 2416 \text{ VA} \quad I = 22,58 \text{ A}$$

Diff. Operando ..

$$C_{cor} = \frac{1518 + 1880 + 8(18.18)}{\omega^2 \cdot 314}$$

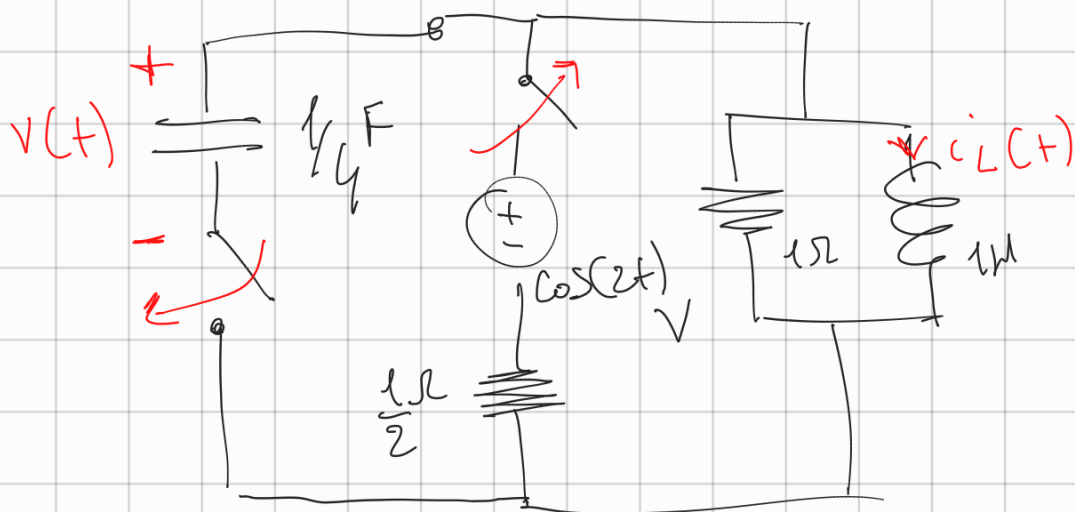
$$= 584 \mu\text{F}$$

$$Q_{dep} = 617$$

$$A_{dep} = 1638 \text{ VA}$$

$V(+)$  comp. lab

$$V(0^-) = 2 \text{ V}$$



$$v(0^-) = 2V, \text{ Datum}$$

low Thore

$$i_L(0^-)$$

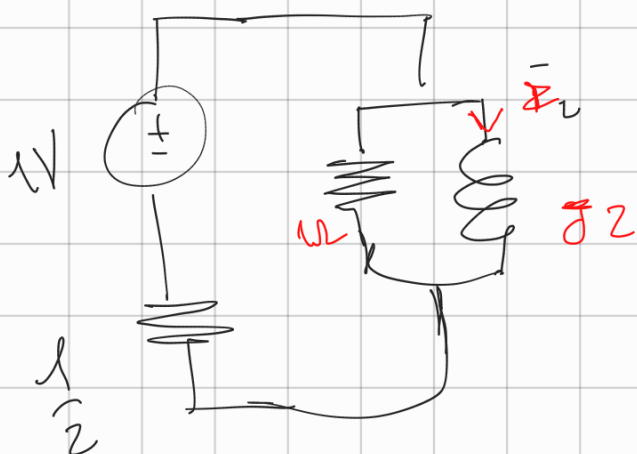
reg. Sin

res. cap

→ find i  
Barlow's new  
generator

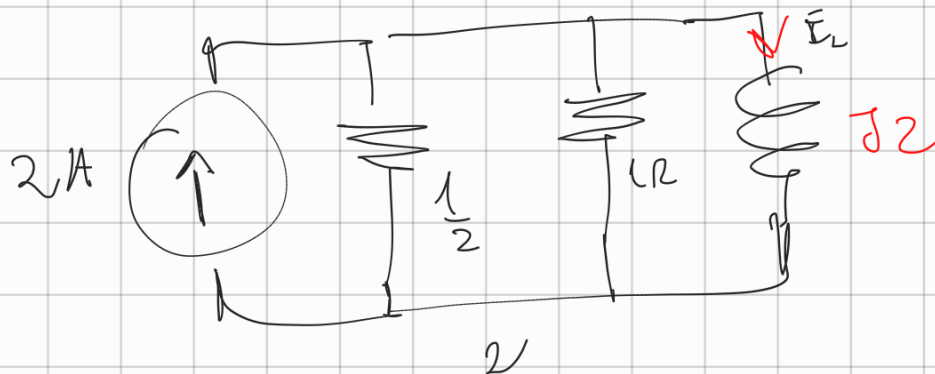
reg. Sin

$$\omega = 2$$



$$X_L = \omega L = 2$$

$$i_L = \frac{2 \cdot \frac{1}{j2}}{2 + 1 + \frac{1}{j2}} = \frac{2 - j \frac{1}{2}}{3 - j \frac{1}{2}}$$

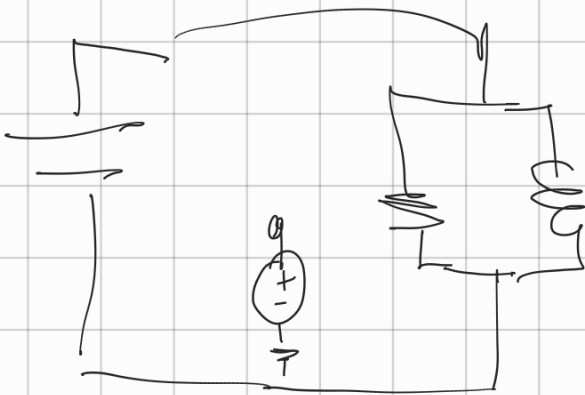


$$C_2 = \frac{2}{37}$$

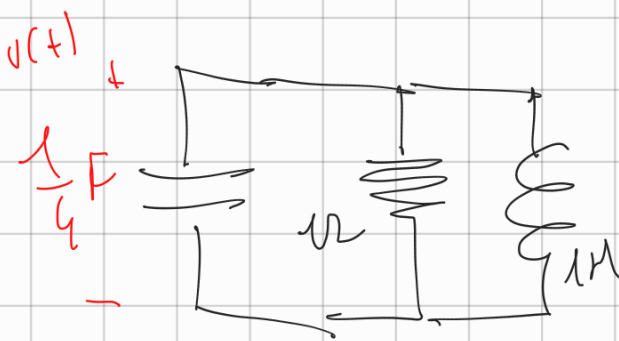
Circuit for step

$$V(t) = TC + V(\text{reg. sinus})$$

$$V_{\text{regue}} = 0 \quad \text{and also then } 0$$



$$V_c(t) = TC \Rightarrow \text{in each I has zero in RC parallel}$$



$$G_p = 1$$

$$\alpha_{\text{parallel}} = \frac{G_p}{2C} = 2 \text{ rad/sec}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = 2 \text{ rad/sec}$$

For RLC circuit for V(t)

$$RLC \parallel \quad \alpha_p = \omega_0$$



$$s_{1,2} = -\alpha = -\omega_0 = -2 \text{ rad/sec.}$$

$$V(t) = k_1 e^{-2t} + k_2 t e^{-2t}$$

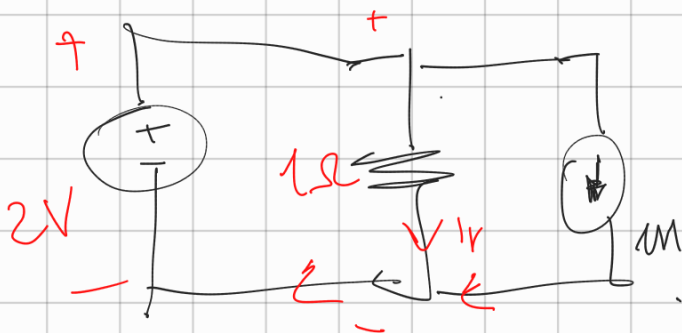
know c outline

$$\begin{cases} k_1 e^{-2t} + k_2 t e^{-2t} \\ V_C(0) = 2V \end{cases}$$

$$i_L(0) = \frac{2}{37} \text{ A}$$

$$\Rightarrow \frac{dV_C}{dt} = \frac{i_C}{C}$$

Circuit at  $t^+$



$$V_L = V_C$$

know  $i_L$

$$i_L = C \frac{dV_C}{dt}$$

$$i_r = \frac{2}{1} = 2 \text{ A}$$

$$i_C = 2 + \frac{2}{37}$$

$$= \frac{76}{37}$$

$$\bullet \frac{dV}{dt} = 0.21 = \frac{304}{37}$$

$$\begin{cases} k_1 e^{-2t} + k_2 t e^{-2t} \\ v_c(0^+) = 2V \\ \frac{dv}{dt} = 8.21 \end{cases}$$

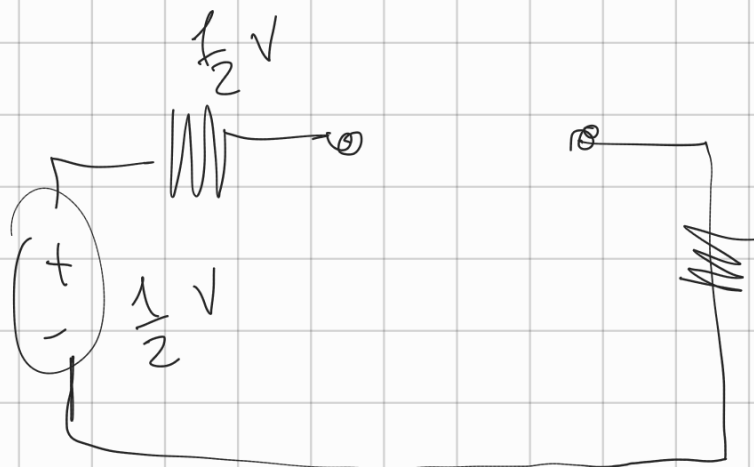
$$v(0) = k_1 = 2V$$

$$-2k_1 e^{-2t} + k_2 e^{-2t} + -2t k_2 e^{-2t}$$

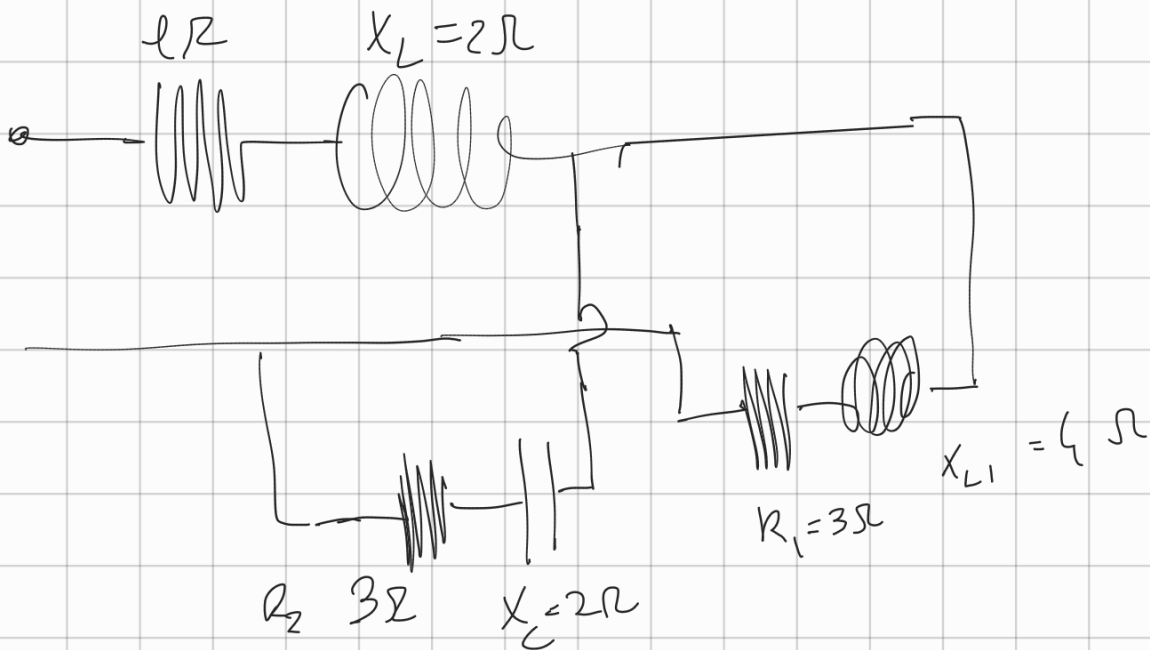
$$\frac{dv(0)}{dt} = -2k_1 + k_2 = 8.21$$

$$k_2 = 8.21 + 4 = 12.21$$

$$v(t) = 2e^{-2t} + 12.21 t e^{-2t}$$



Riforma



• A B, 50 Hz

$$Q_{XC} = -2000 \text{ kVAR}$$

$$Q_{XC} = -I^2 \cdot X_C = \dots$$

$$I = 31,62 \text{ A eff}$$

$$P_{RS_2} = 31,62^2 \cdot 3 = 3000 \text{ W}$$

$$A_{G_2} = 3162 \text{ V/A}$$

$$V_{E2} = 100 \text{ V eff}$$

Power inside.

$$\bar{Z}_A = 3 + j4, \quad Z_n = 5$$

$$I_A = 20 \text{ A eff}$$

$$P_A = 1200 \text{ W}$$

$$Q_A = 1600$$

Boucherot

$$P_{A+B} = 3000 + 1200 = 4200 \text{ W}$$

$$Q_{A+B} = -2000 + 1600 = -400 \text{ VAR}$$

$$A_{A+B} = 4218$$

$$I_{A+B} = 42.18 \text{ eff}$$

$$Q_{X_L} = 3558 \text{ VAR}$$

$$P_{in} = 1780 \text{ W}$$

$$Q_{AB} = 3159 \text{ VAR}$$

$$P_{AB} = 5980 \text{ W}$$

$$A_{AB} = 6763 \text{ VA}$$

$$V_{AB} = 160 \text{ Veff}$$

$$C_{con} = \frac{3159 + 5980 \cdot \tan(19,1^\circ)}{314 \cdot 160^2}$$

$$Q_{dpo} = 1964 \text{ VAR}$$

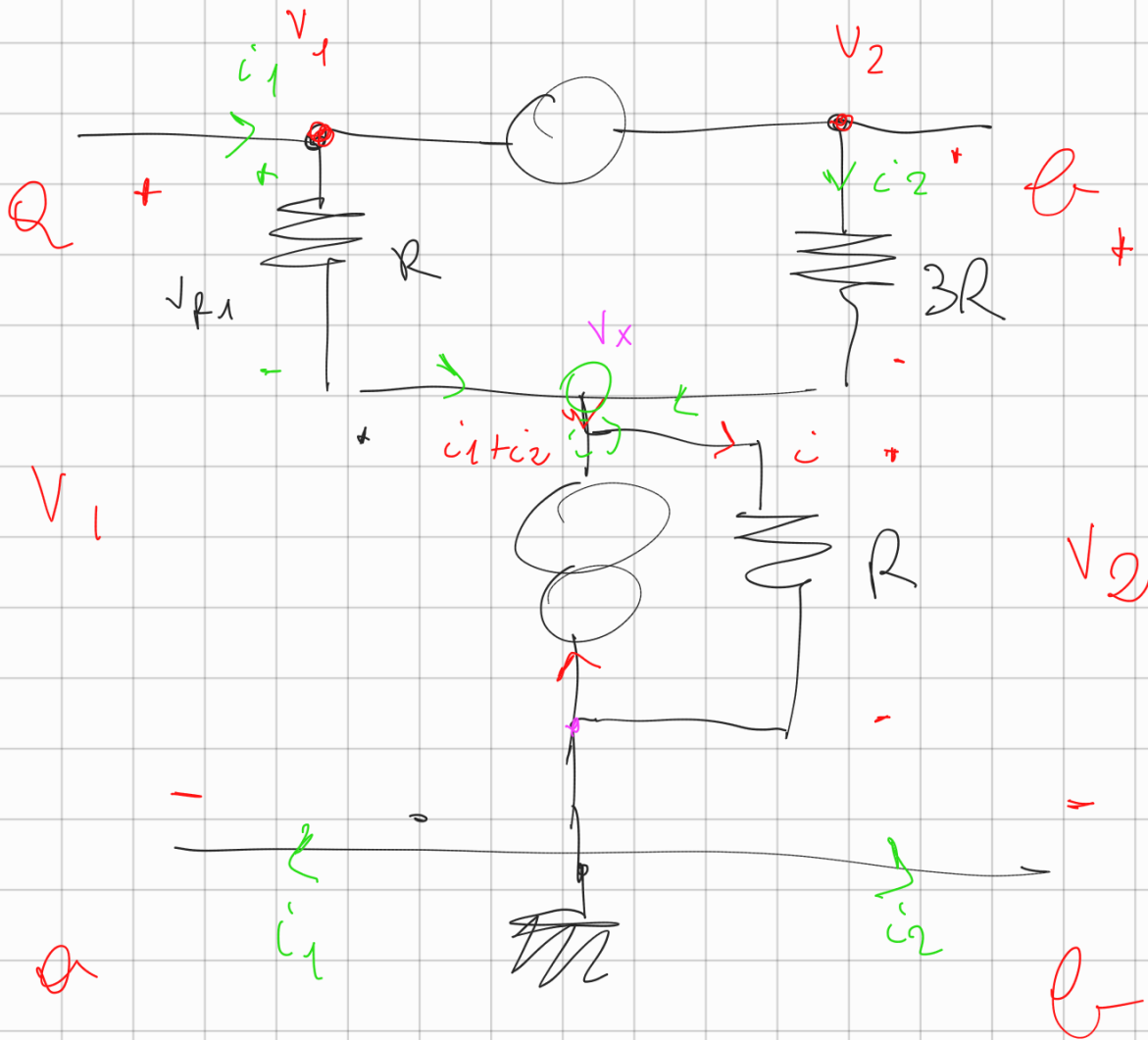
$$C_{con} = 637 \text{ }\mu\text{F}$$

$$A_{dpo} = \sqrt{1964^2 + 5980^2} = 6284$$

$$I_{dpo} = 39,33 \text{ Aeff}$$

$$\eta_{pa} = 27,8\%$$

$$V_{dep} = 18.19$$



Parametri h

$$V_1 = V_2$$

$$V_1 = R i_1 + i R$$

$$V_2 = 3R i_2 + i R$$

$$\Rightarrow R i_1 + \cancel{i R} = 3R i_2 + \cancel{i R}$$

$$R \dot{i}_1 = 3 R \dot{i}_2$$

$$\dot{i}_1 = 3 \dot{i}_2$$

da K1

$$\dot{i} = \frac{V_x - 0}{R}, \quad V_x = -R \dot{i}_1 + V_1$$

da K2,  $\dot{i}_1 = 3 \dot{i}_2$

$$\dot{i}_1 = \frac{V_1 - V_x}{R} = 3 \left( \frac{V_2 - V_x}{3R} \right)$$

$$\frac{V_1 - V_x}{R} = \dot{i}_1$$

$$\frac{-V_x}{R} = \dot{i}_1 - V_1$$

$$V_x = -R \dot{i}_1 + V_1$$

$$\dot{i} = -\dot{i}_1 + \frac{V_1}{R}$$

$$i_{\text{Nor}} = \rightarrow i_{\text{Nor}} = -i_1 - i_2 + i_3$$

$$= -\dot{c}_1 - \dot{c}_2 - \dot{c}_1 + \frac{V_1}{R}$$

$$= -2\dot{c}_1 - \dot{c}_2 + \frac{V_1}{R}$$

$$V_1 = h_{11} I_1 + h_{12} V_2$$

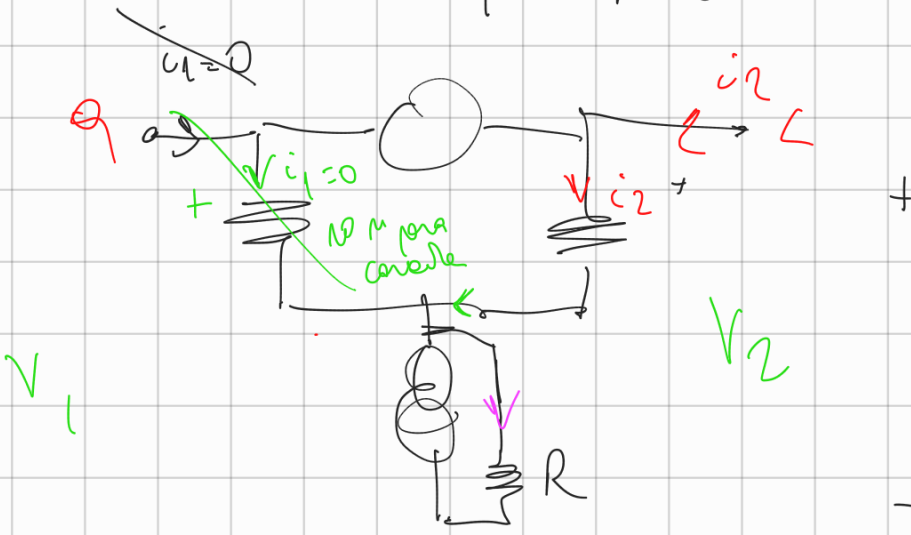
$$I_2 = h_{21} I_1 + h_{22} v_2$$

$$\overline{I}_2 = \frac{1}{3} i_1$$

$$V_1 = 1 V_2$$

Def  $\varphi$  evolve

$$h_{11} \frac{V_1}{I_1} \Big|_{V_2=0}$$







$$v_2 = 0, \quad v_1 = 0$$

$$h_{22} = \left. \frac{i_2}{V_2} \right|_{I_1 = 0}$$

$$i_2 = \frac{V_2 - V_x}{R}$$

$$i_p = \frac{V_x - 0}{R}$$

$$V_2 = i_2 R + i_p R + V_x$$

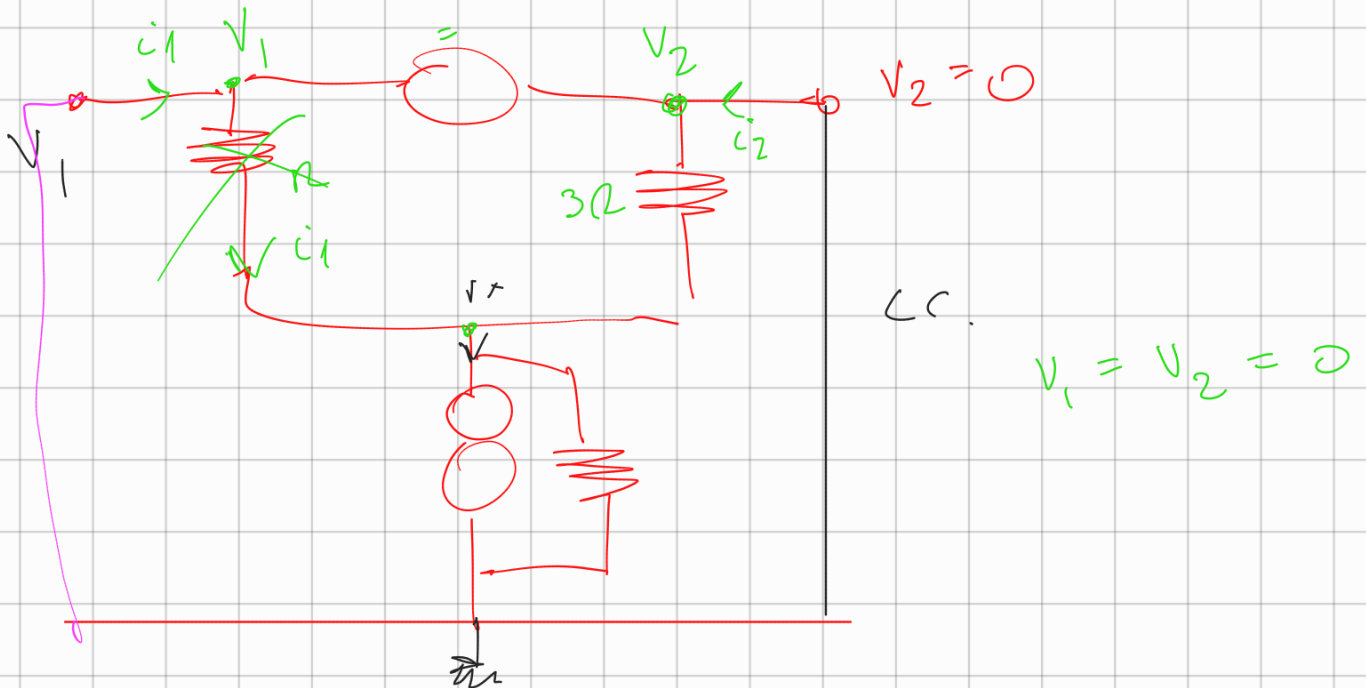
$$= (V_2 - V_x + V_x - 0)$$

$$V_a$$

$$V_1 = V_2, \quad i_2 = 0$$

$$i_2 = \frac{V_2 - V_a}{R}$$

$$h_{21} = \frac{I_2}{I_1}, V_2 = 0$$



$$0 - V_x = R i_1$$

$$R i_1 = 3 R i_2$$

$$0 - V_x = 3R i_2$$

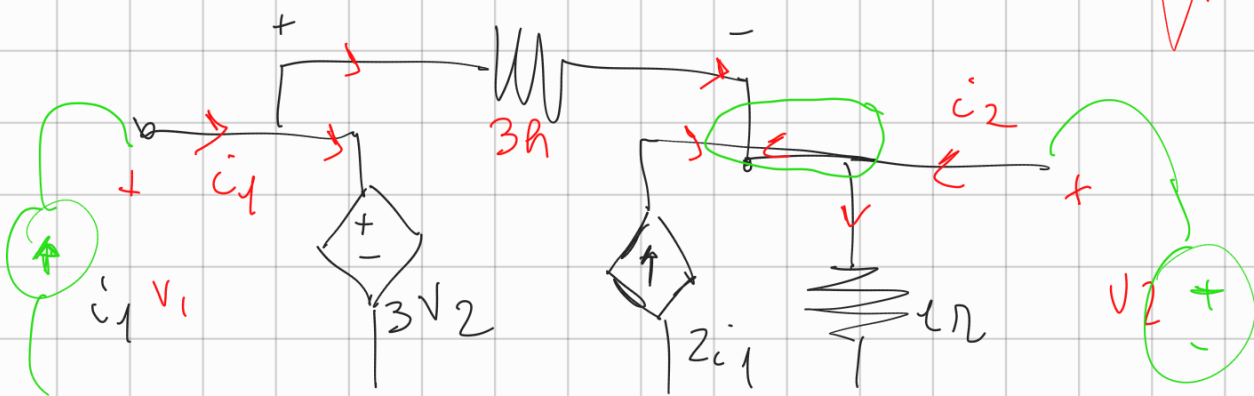
$$i_1 = 3 i_2$$

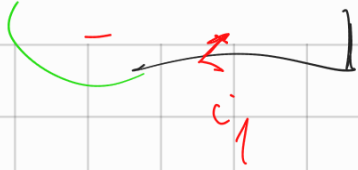
$$i_2 = \frac{1}{3} i_1$$

•  $\frac{V_1}{V_2}, I_1 = 0 = 1$

Paralleli ibridi R

Per def





$$V_1 = 3V_2$$

$$-i_2 + \frac{V_2}{1}$$

$$-2i_1 - \frac{V_1 - V_2}{3R}$$

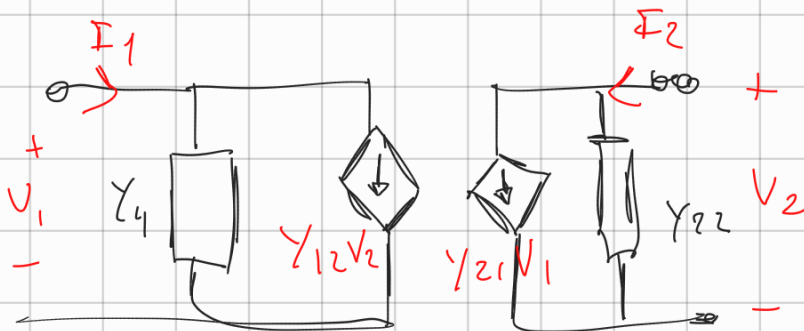
$$i_2 = \frac{V_2}{1} - 2i_1 - \frac{2V_2}{3}$$

$$i_2 = -2i_1 + \frac{1}{3}V_2$$

$$H = \begin{bmatrix} 0 & 3 \\ -2 & \frac{1}{3} \end{bmatrix}$$

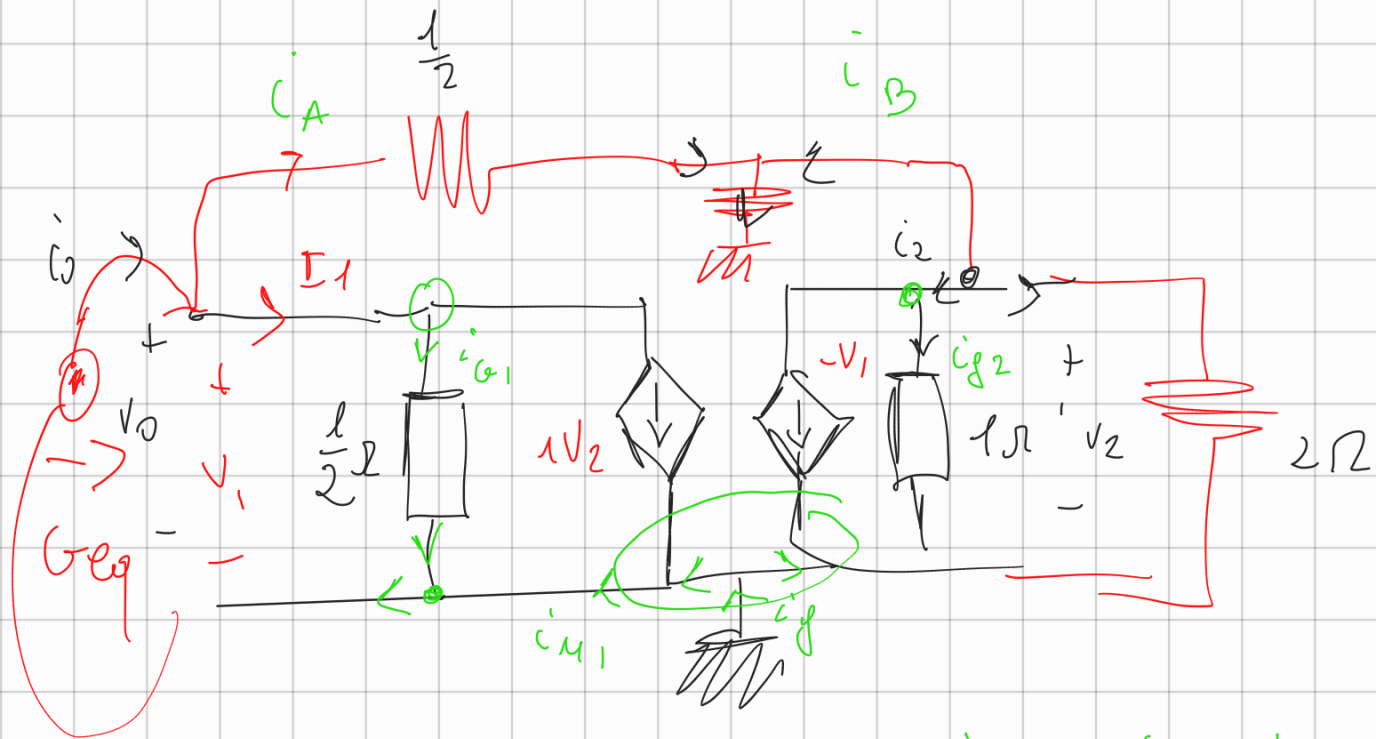
$$\begin{bmatrix} 0 & 3 \\ -2 & \frac{1}{3} \end{bmatrix}$$

$$Y = \begin{bmatrix} 2 & 1 \\ -1 & 1 \end{bmatrix}$$



$$\begin{aligned} I_1 &= Y_{11}V_1 + Y_{12}V_2 \\ &= 2V_1 + 1V_2 \end{aligned}$$

$$\underline{I}_2 = y_{21} v_1 + y_{22} v_2$$



$$V_0 = V_1$$

$$\dot{c}_0 = \mathbb{I}_1 + \dot{c}$$

$$c = \underline{V_2 - V_1}$$

$$\dot{y}_2 = \dot{y}_1 + v_1$$
$$v_2 = (\dot{y}_2 + v_1) dt$$

$$\dot{Q} = \dot{Q}_A + \dot{Q}_B$$

$$\dot{Q}_A = \dot{Q} - \dot{T}_1$$

$$C_B = V_1 + V_2 + \frac{V_2}{2} = 0$$

$$C_B = V_1 - \frac{3}{2} V_2$$

$$\vec{c}_g = \vec{c}_j - \vec{I}_1 + V_1 - \frac{3}{2} V_2$$

$$i_{G1} = \frac{V_1}{\frac{1}{2}} = 2V_1$$

$$i_{H1} = I_1 - i_{G1} =$$

$$V_0 = \frac{1}{2} \cdot i_{G1} = \frac{1}{2} ($$

$$i_{H1} - 1V_2 + i_g - V_1 = 0$$

$$i_{H1} = V_2 - i_g + V_1$$

$$= V_2 - i_0 + I_1 - V_1 + \frac{3}{2} V_2 + V_1$$

$$= \frac{5}{2} V_2 - i_0 + I_1$$

$$I_{g1} = i_0 - i_{H1}$$

$$= i_0 - \frac{5}{2} V_2 + i_0 - I_1$$

$$= 2i_0 - \frac{5}{2} V_2 - I_1$$

$$V_0 = \frac{1}{2} i_{g1} =$$

$$V_0 = i_0 - \frac{5}{4} V_2 - I_1$$

$$i_0 = V_0 + \frac{5}{4} V_2 - \overline{I}_1$$

$$V_0 = \frac{1}{2} i_0, \quad i_0 = \overline{I}_1 - V_2$$

$$V_0 = \frac{1}{2} (\overline{I}_1 - V_2)$$

$$V_2 = (i_2 + V_1) l$$

$$V_1 = V_0$$

$$V_2 = i_2 + V_1$$

$$V_0 = \frac{1}{2} (\overline{I}_1 - i_2 + V_0)$$

dalla rete, so che

$$i_2 = \gamma_{21} V_1 + \gamma_{22} V_2$$

$$i_2 = -V_1 + V_2$$

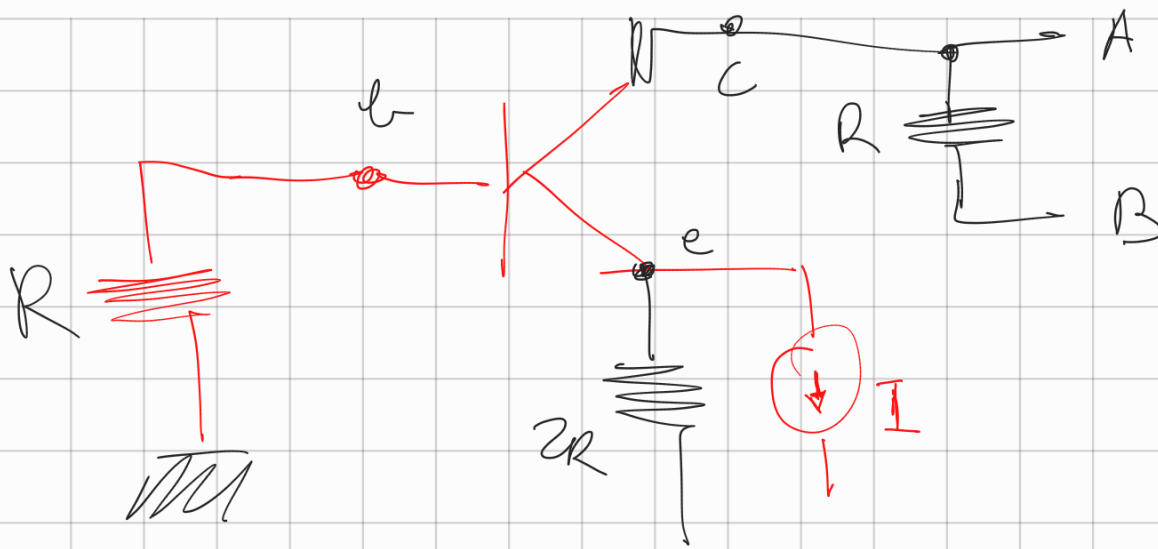
$$, V_1 = V_0$$

$$V_2 = i_2 + V_1$$

$$i_2 = -V_0 + V_2$$

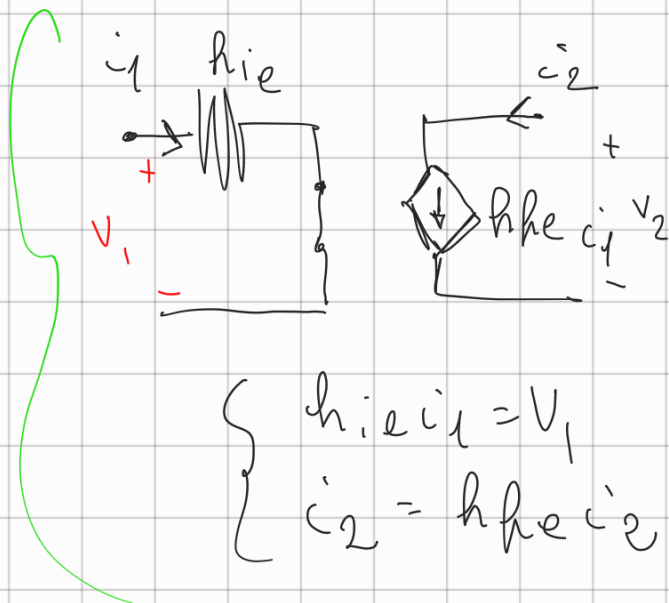
$$V_2 = i_2 + V_0$$



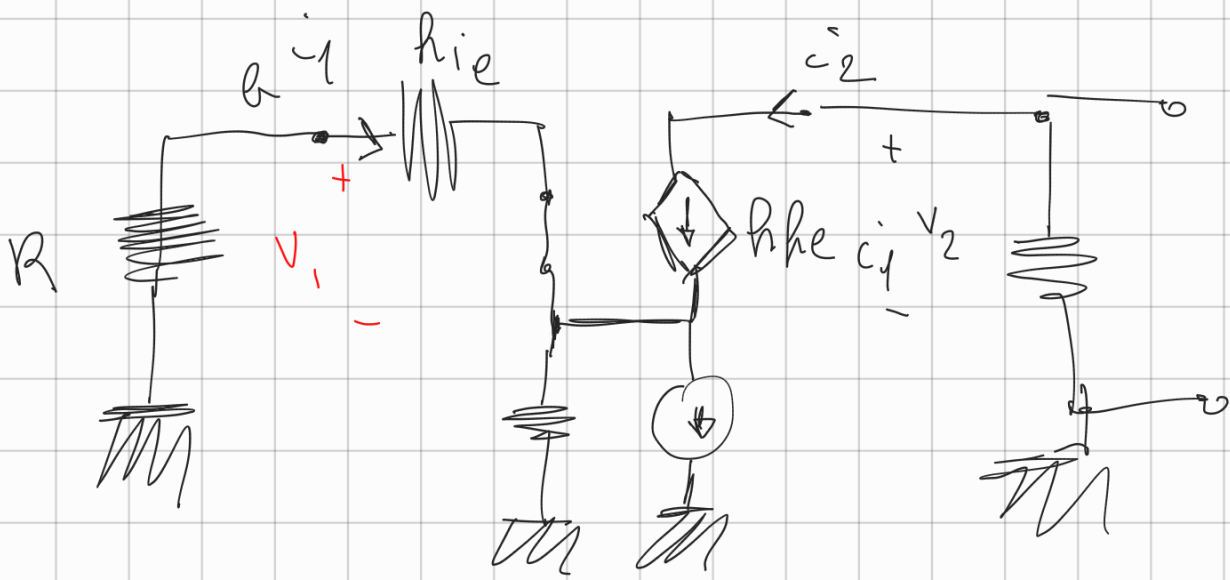


$$h_{ve} = 0, h_{oe} = 0$$

Methods required.



College





$$V_{2R} = i_r \cdot 2R = 2R (h_{fe} + 1) i_b - 2I$$

da KV alle loop in  $S_1$

$$\hat{c}_1 (h_{fe} + R) + V_{eR} = 0$$

$$i_1 h_{fe} + i_1 R + 2R (h_{fe} + 1) i_1 - 2I = 0$$

$$i_1 (h_{fe} + R + 2R h_{fe} + 2R) = 2I$$

$$i_1 = \frac{2R I}{R i_e + 2R h_{fe} + 3R}$$

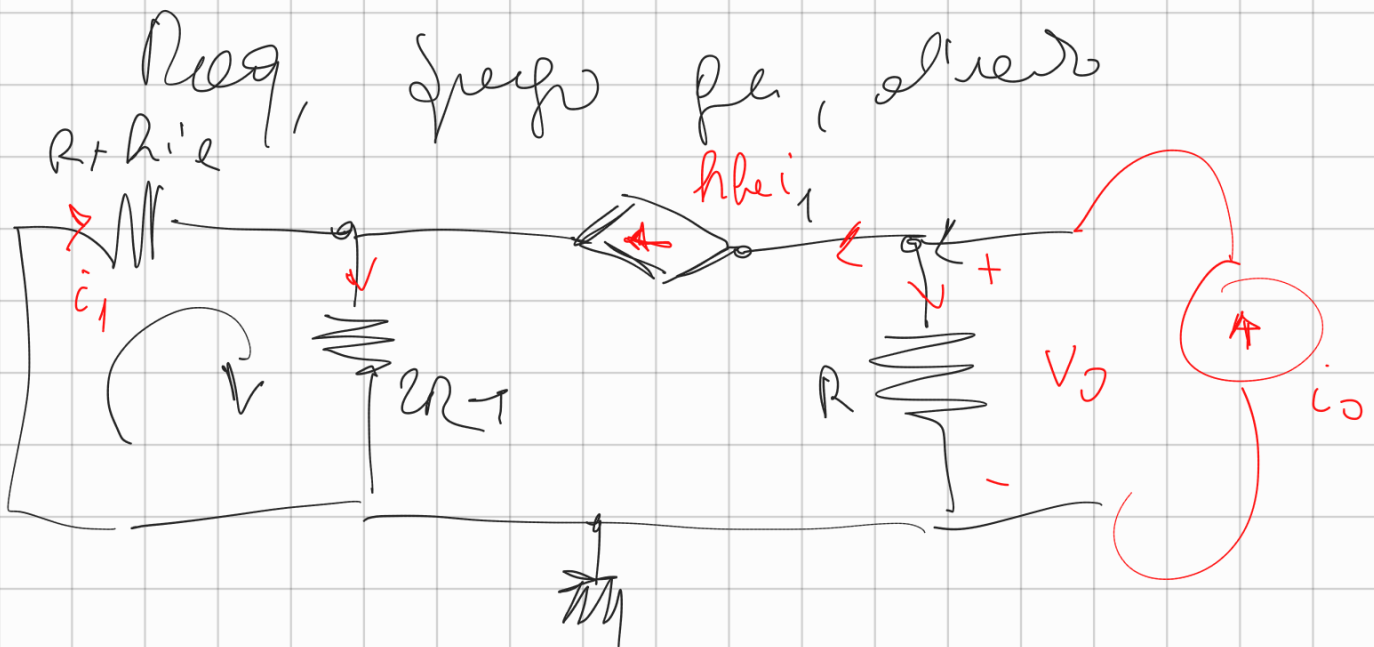
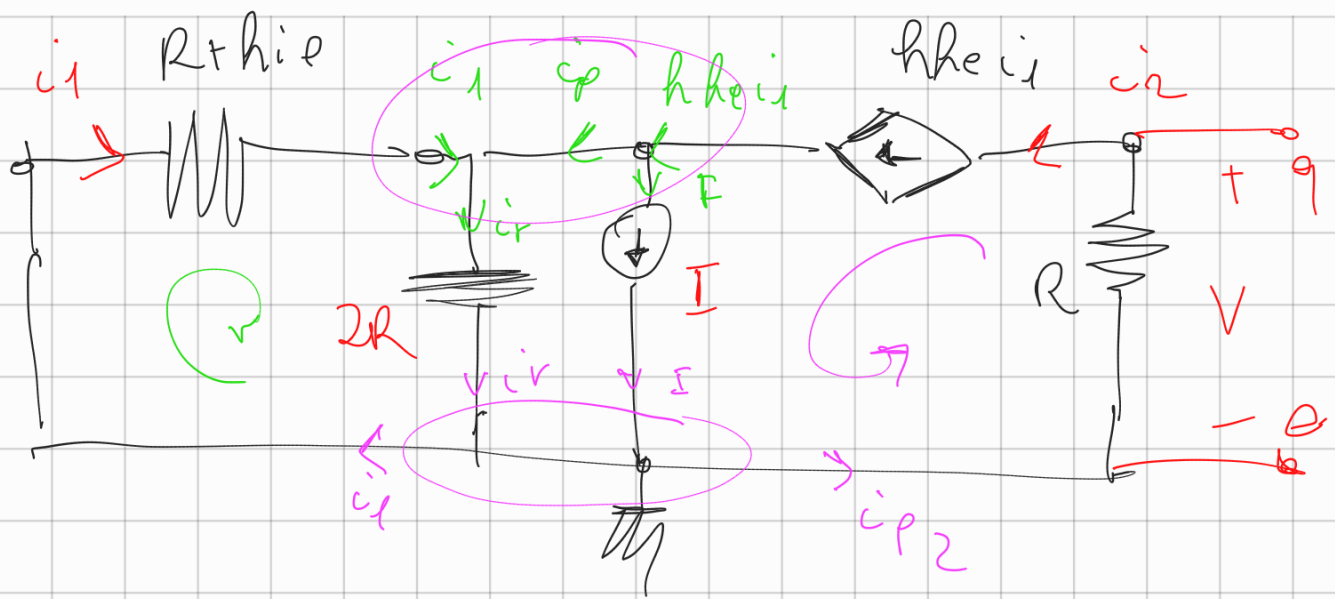
$$V = - \hat{c}_R 2 \cdot R$$

$$\hat{c}_2 = I + i_v - \hat{c}_1$$

$$V = \left( \cancel{-I} + \frac{2I}{R i_e + 2R h_{fe} + 3R} - i_v \right)$$

$$\hat{c}_r = i_1 + h_{fe} i_1 - I$$

$$= \frac{2I}{R i_e + 2R h_{fe} + 3R} (1 + h_{fe}) - I$$



$$-V_0 + V_A + 2R(i_1 + h_{fe} i_1)$$

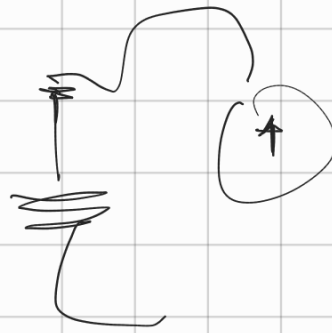
$$i_1 (R + h_{ie}) + 2R (h_{fe} i_1) = 0$$

$$i_1 R + h_{ie} i_1 + 2R h_{fe} i_1$$

$$i_1 (R + h_{ie} + 2R h_{fe}) = 0$$

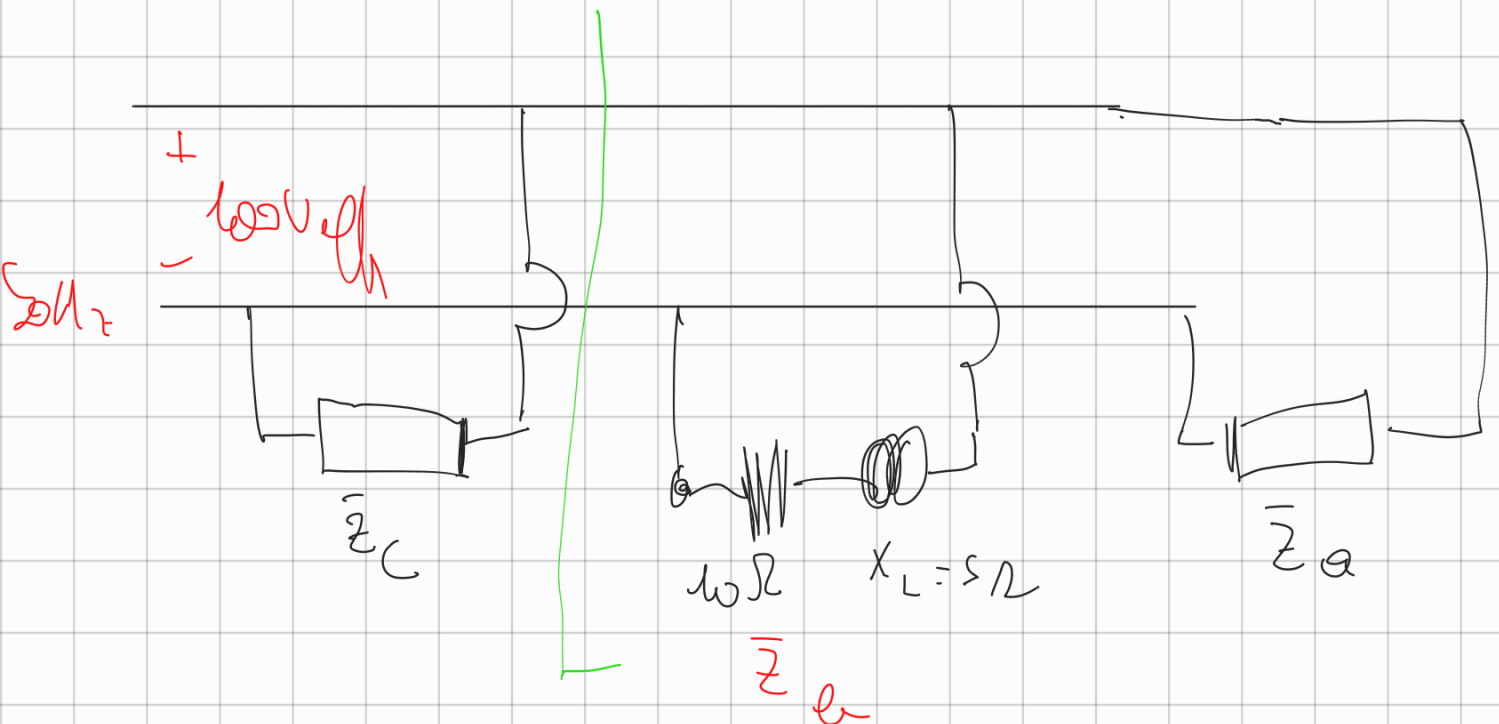
$$i_1 = 0$$

$\Rightarrow$



$$P_{\text{app}} = P$$

## RIFASAMENTO



$$Z_a \text{ snale } A = 2 \text{ kVA}, \quad \cos \varphi_{Z_A} = 0.8 \text{ in vir.}$$

$$A Z_C = 3 \text{ kVA}, \quad I_{\text{resist}} \text{ in } \omega R = 10 \text{ A ef}$$

definire potere reattivo del

coil

$$a + b, a + b + c$$

$$I_{ZA} = 20 \text{ A eff}$$

$$P_{ZA} = I_{ZA} \cdot \cos \phi_{ZA} = 1600 \text{ W}$$

$$Q_{ZA} = 1200 \text{ VAR}$$

---

$$V_B = 100 \text{ V}$$

$$\bar{Z} = 10 + j9, \quad Z = 5\sqrt{5}$$

$$I_{ZA} = 8.94 \text{ A eff} \quad V_{AN} = \frac{100}{5\sqrt{5}}$$

$$Q = 400 \text{ VAR}$$

$$P = 800 \text{ W}$$

---

$$P_{\text{Buck}} + P_{A+B} = 1600 + 826 = 2426 \text{ W}$$

$$Q_{A+B} = 1613 \text{ VAR}$$

$$A_{A+B} = 2913$$

$$\varphi_{A+B} = 33,62^\circ$$

$$\cos(\varphi_{A+B}) = 0,83$$

$$I_{A+B} = 29,132$$

$$A_{Z_c} = 3 \text{ kW}$$

$$Q = V_{eff} \cdot I_{react\ eff} = 1000$$

$$P^2 = A^2 - Q^2 \Rightarrow P = 2828$$

$$\varphi_z = 18,47^\circ$$

$$P_{TOT} = 2426 + 2828 = 5254$$

$$Q_{TOT} = 1613 + 1000 = 2613$$

$$A_{S_{TOT}} = 5868 \text{ VA} \quad \varphi_{TOT} = 26^\circ \quad A_{S_{TOT}} = 58,68$$

$$C_{cor} = \frac{2613 - 5254 \cdot \tan(18,18)}{100^2 \cdot 314}$$

$$Q_{dp} = 1726$$

$$C_{cor} = 282 \mu F$$

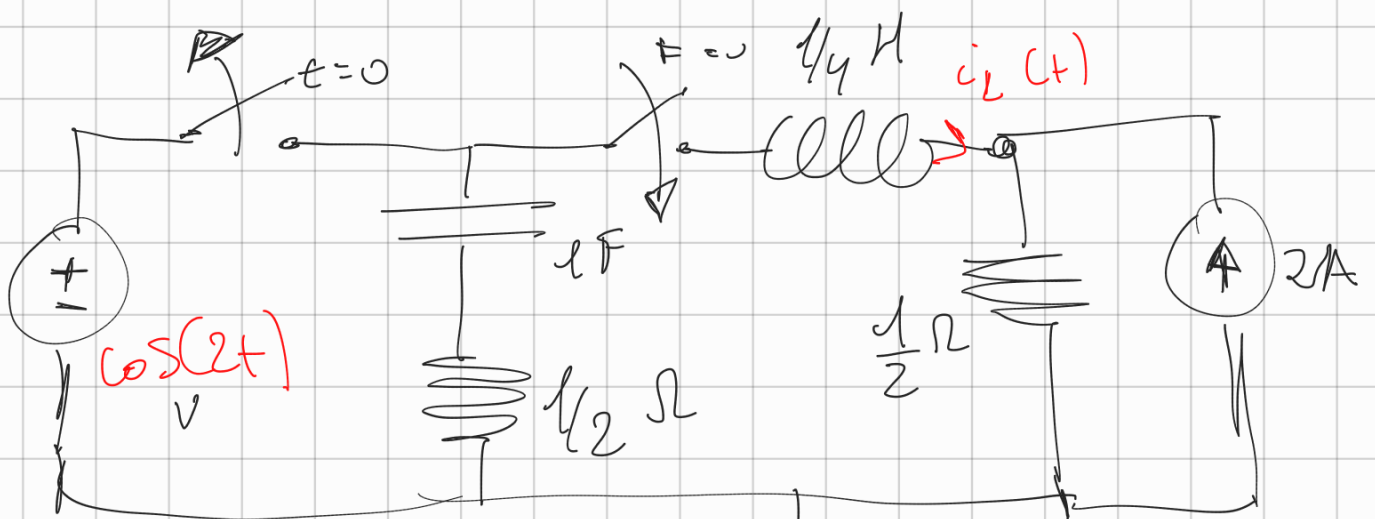
$$A_{dp} = \sqrt{5254^2 + 1726^2} = 5530$$

$$A_{dp} = 55.3$$

INTERMEDIATE SI AME A  $t=0$

$S_2$  & diode

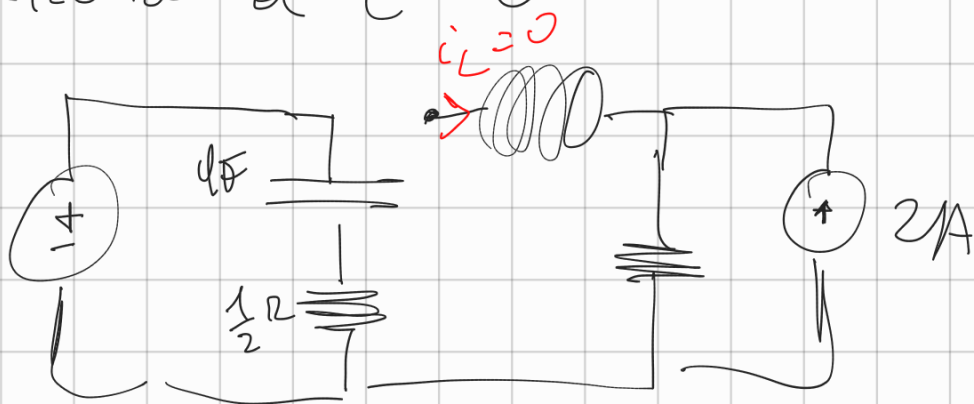
$i_L(t)$   $t \geq 0$ , complete



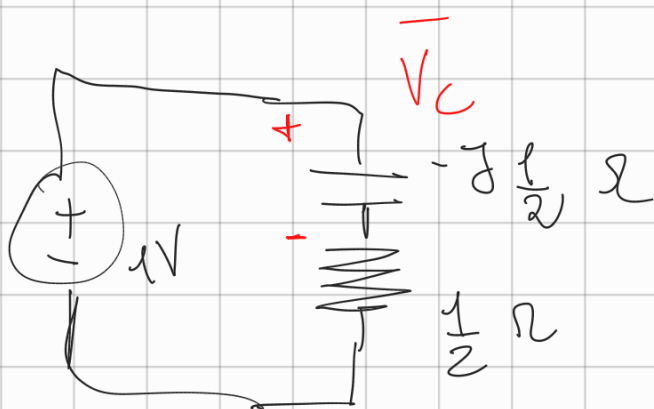
reg. s'm complete! reg. s'm.

var. s'm  $V_c$  &  $i_L$

Circuito a  $t = 0$



Circuito for  $\omega$  Forze



$$\omega = 2 \text{ rad/s}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2}$$

$$\bar{V}_C = \frac{-j \frac{1}{2}}{\frac{1}{2} - j \frac{1}{2}} = \frac{1 - j \frac{1}{2}}{\frac{1}{2}} = \frac{1 - j}{2}$$

$$V_C(t) = \text{Re} \left[ \bar{V}_C e^{j\omega t} \right]_{t=0} = \text{Re} \left[ \bar{V}_C \right] = \frac{1}{2} \text{ V}$$

\* Circuito non separare

$$V_C(0^-) = V_C(0^+) = \frac{1}{2} \text{ V}$$

$$i_L(0^-) = i_L(0^+) = 0 \text{ A}$$



$$i_L(t) = TC + \text{Reg. stor.}$$

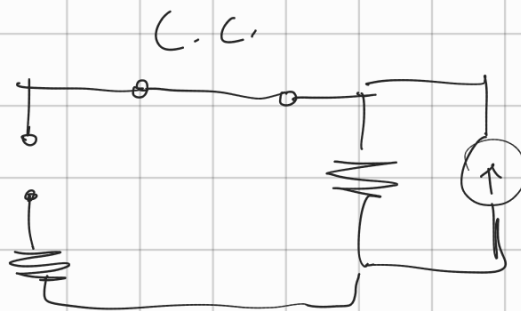
trovare  $i_L(t) \rightarrow \infty$

Circuito dato

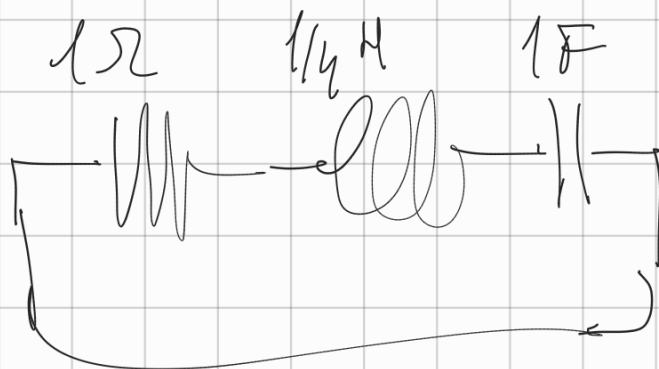


$t \rightarrow \infty$

$$i_L(\infty) = 0$$



$i_L(t) = TC$ , riguarda il loop, stesso  
in un RLC serie



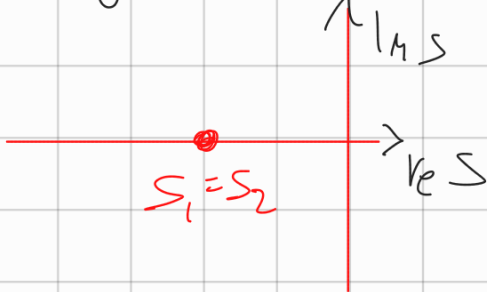
con L stesso,  
C uguale

$$\omega_z = \frac{R_s}{2L} = \frac{1}{\frac{2 \cdot 1}{4}} = 2 \text{ rad/sec}$$

$$\omega_0 = \frac{1}{\sqrt{2L}} = 2 \text{ rad/sec.}$$

Caso sovraz. critico

Rooti ci repli neg. e coincidenti.



$$s_{1,2} = -\alpha = -2 \text{ rad/sec}$$

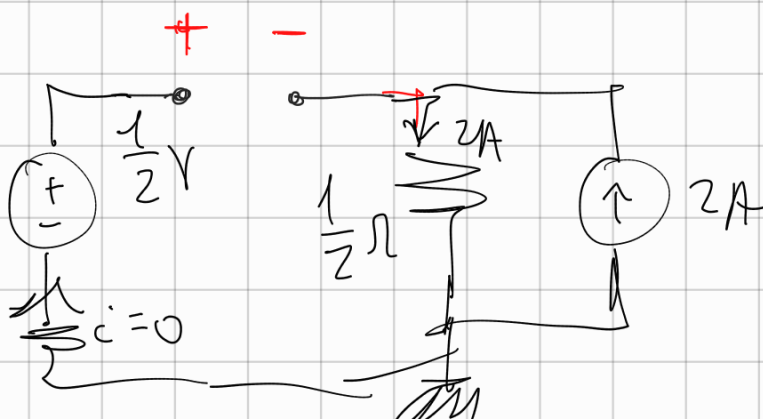
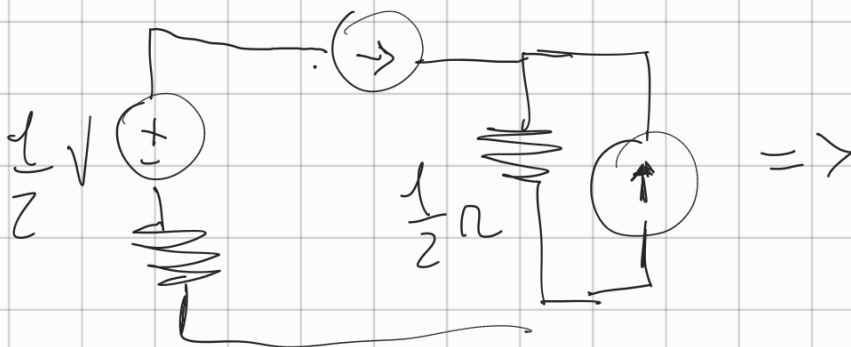
$$t \geq 0$$

in questo caso  $i_L(t) = k_1 e^{-2t} + k_2 t e^{-2t}$

dove  $i_L(0) = 0 \text{ V e}$

$$V_C(0) = \frac{1}{2} \text{ V}$$

per il calcolo del circuito a  $t=0$ , dove  $V_L$



$$V_R = 1 \text{ V}$$

$$V_L = \frac{1}{2} - 1 \text{ V} = -\frac{1}{2} \text{ V}$$

$$\frac{di_L(0)}{dt} = \frac{-1}{\frac{2}{\frac{1}{4}}} = -2 \text{ A/sec}$$

Impiego C. INIZIALE

$$\begin{cases} k_1 e^{-2t} + k_2 t e^{-2t} = 0 \\ i_L(0) = 0 \text{ A} \\ \frac{di_L(0)}{dt} = -2 \text{ A/sec} \end{cases}$$

$$\Rightarrow k_1 = 0$$

$$k_2 \Rightarrow -2t k_1 e^{-2t} + k_2 e^{-2t} + -2t k_2 t e^{-2t}$$

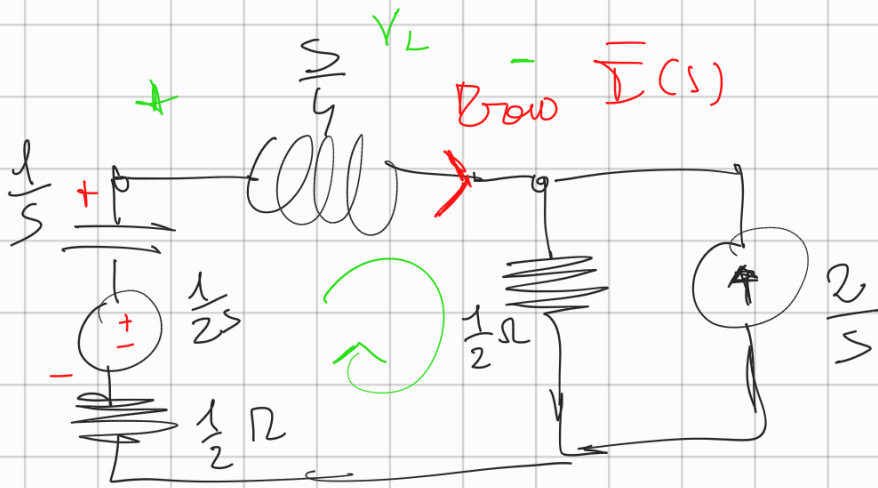
$$k_1 = 0$$

$$k_2 = -2A$$

$$i_L(t) = -2t e^{-2t} \quad t \geq 0$$

CALCOLO SIMBOLICO WP

Microfido u stepo polo u  $-\frac{1}{(s+2)^2}$



da kV

$$\frac{1}{2} I(s) - \frac{1}{2s} + \frac{1}{s} I(s) + V_L + \frac{1}{2} (I(s) + \frac{2}{s})$$

$$V_L = I(s) \cdot \frac{s}{4}$$

$$I(s) \left( \frac{1}{2} + \frac{1}{s} + \frac{s}{4} + \frac{1}{2} \right) = \frac{1}{2s} - \frac{1}{s}$$

$$\frac{\frac{1-2}{2s}}{\frac{1}{s} + \frac{s}{4} + 1} = \frac{\frac{-1}{2s}}{\frac{4+s^2+4s}{4s}}$$

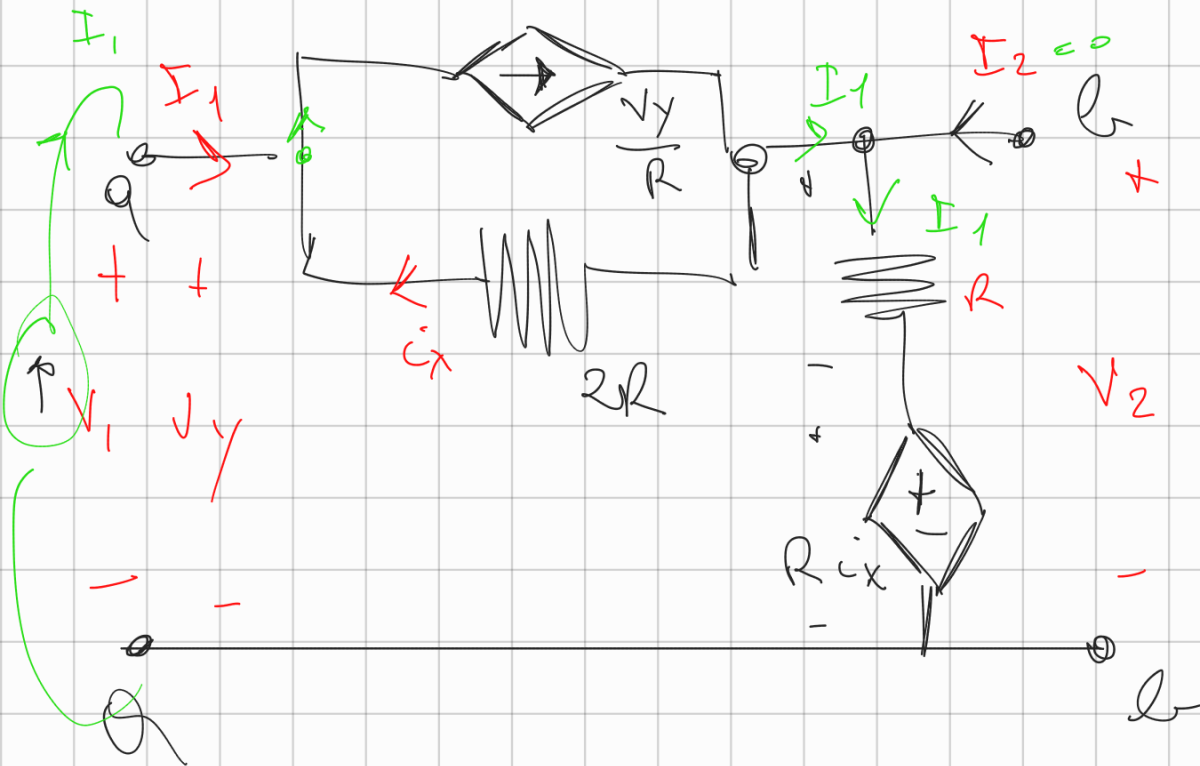
$$= \frac{-2}{s^2 + 4s + 4}$$

=

$$\frac{-2}{(s+2)^2}$$

$$\Rightarrow -2t e^{-2t} v(t)$$

Power di Z dell Res a 2 pole  
aa-bb. Cor self. quod lo



Power di Z Cor self quod lo

$$Z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2=0}$$

$$V_1 = R I_1 + R i_x$$

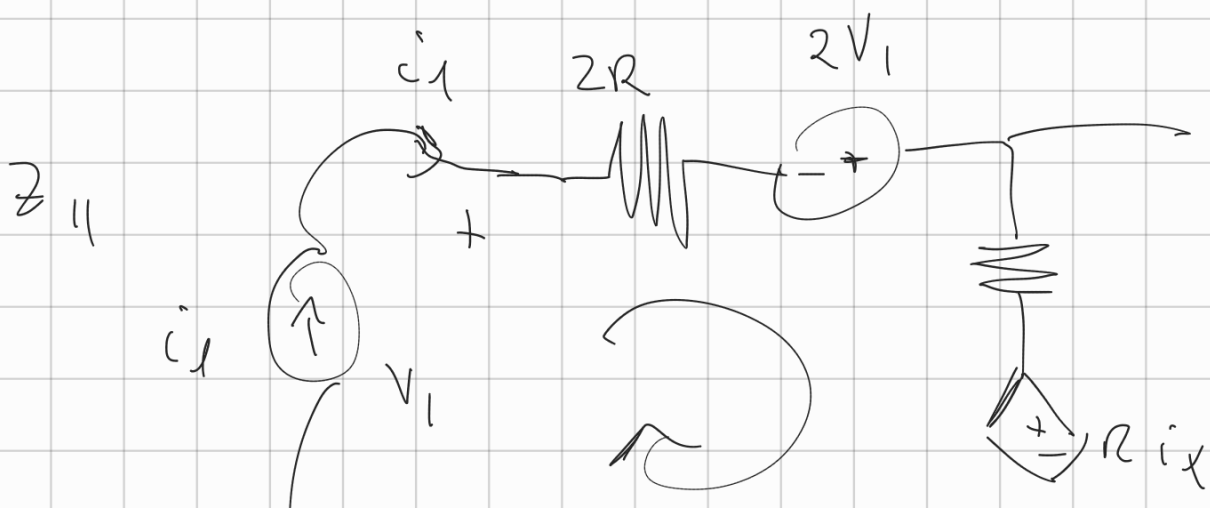
$$-i_x - I_1 + \frac{V_1}{R} = 0$$

$$i_x = \frac{V_1}{R} - I_1$$

$$V_1 = R I_1 + R I_1 - V_1$$

$$V_1 = R I_1$$

$$Z_{21} = R$$



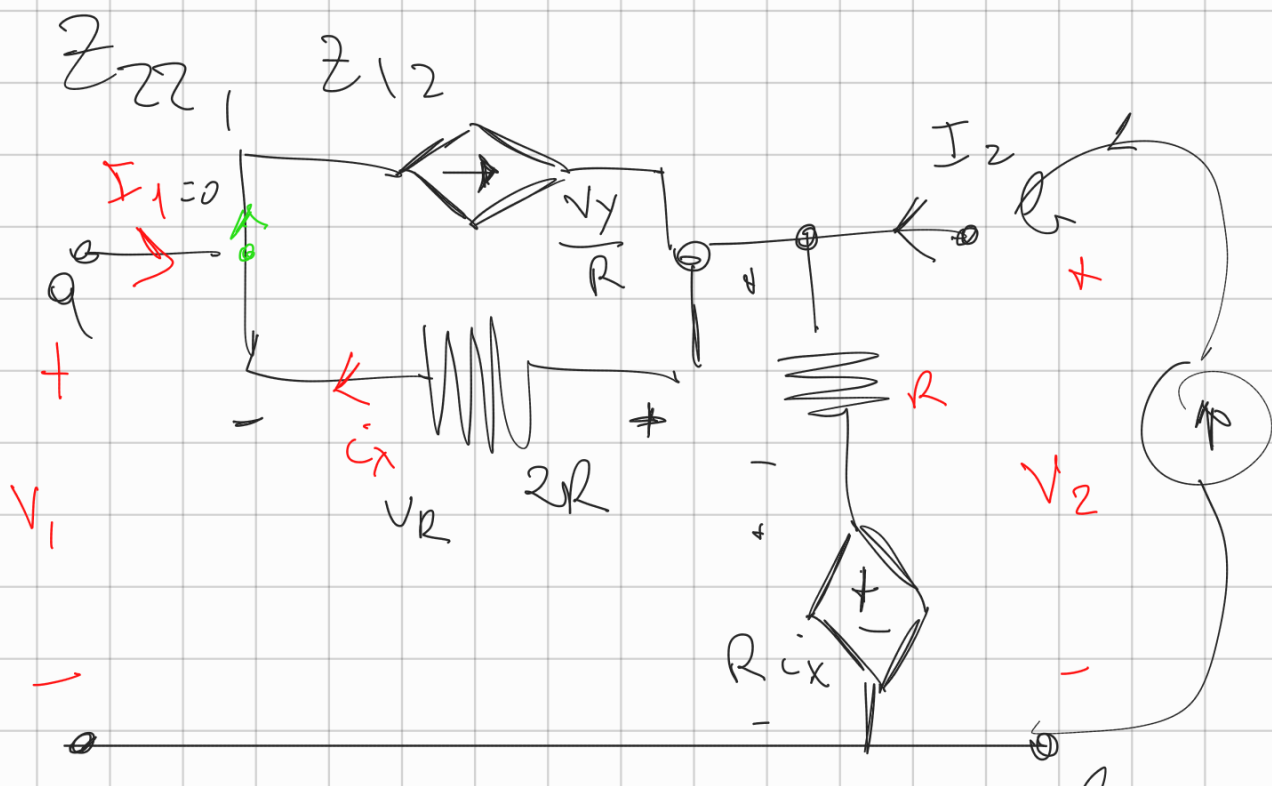
$$-V_1 + 2Ri_1 - 2V_1 + Ri_1 + R\left(\frac{V_1}{R} - i_1\right) = 0$$

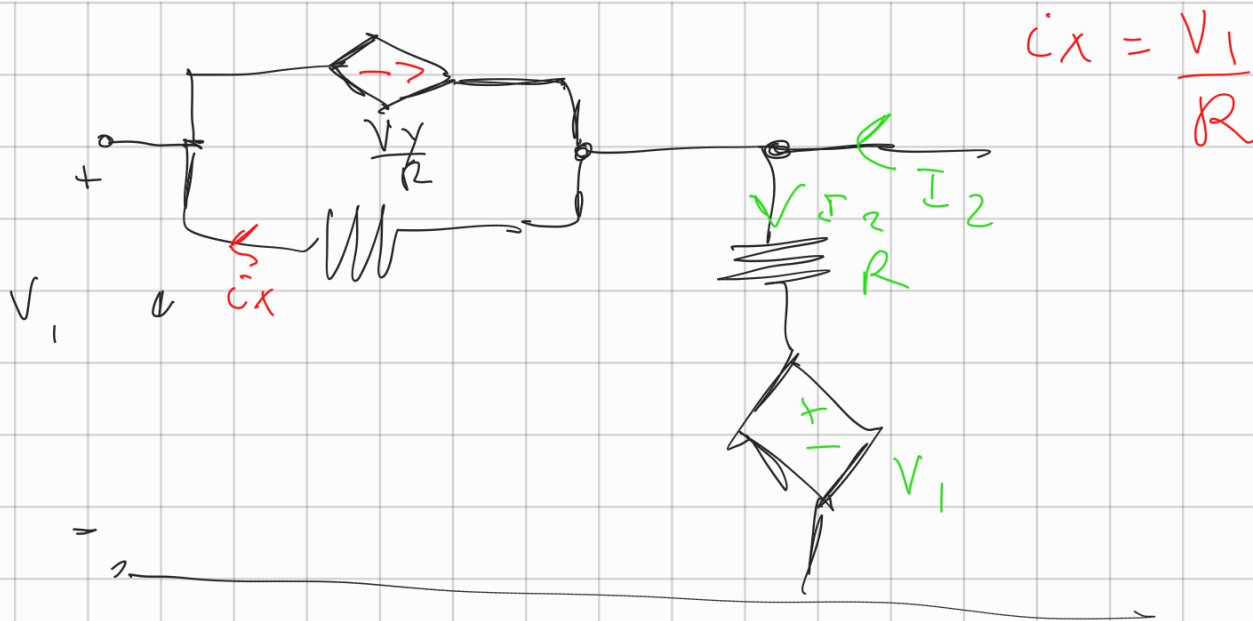
$$2V_1 = 2Ri_1 \quad V_1 = Ri_1$$

$$Z_{11} = R$$

$$\bullet V_2 = Ri_1 + Ri_x = Ri_1 + R\left(\frac{V_1}{R} - I_1\right)$$

$$V_2 = V_1, \quad V_2 = Ri_1 \quad Z_{21} = R$$





$$V_2 = R I_2 + V_1$$

$$V_R = 2 R i_x = 2 R \frac{V_1}{R}$$

$$V_1 = -V_R + R I_2 + V_1$$

$$V_1 = -2V_1 + V_1 + R I_2$$

$$2V_1 = R I_2 \quad V_1 = \frac{R}{2} I_2$$

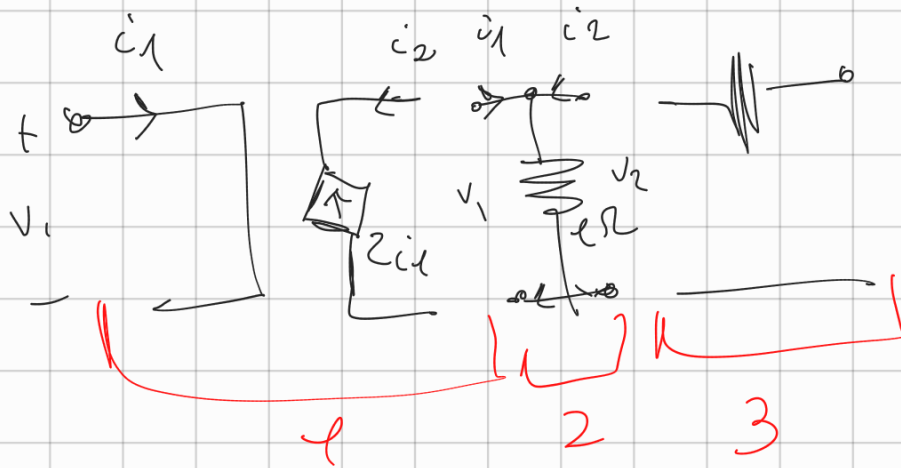
$$V_2 = R I_2 + \frac{R}{2} I_2$$

$$V_2 = \frac{3}{2} I_2$$



Porte di ABCD, con nota a

Costo di 3 note



$$V_1 = A V_2 + B (-I_2)$$

$$I_1 = C V_2 + D (-I_2)$$

(1)  $\Rightarrow V_1 = 0$

$$i_2 = -2i_1$$

$$i_1 = -\frac{1}{2} i_2$$

$$T_1 = \begin{pmatrix} 0 & 0 \\ 0 & \frac{1}{2} \end{pmatrix}$$

(2)

$$V_1 = V_2$$

$$V_1 = V_2 = (i_1 + i_2) \cdot 1$$

$$V_1 = i_1 + i_2$$

$$i_1 = V_2 - i_2$$

$$V_1 = V_2$$

$$T_2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$



$$i_1 = -i_2$$

$$T_3 = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$$

$$V_2 - V_1 = 3i_2$$

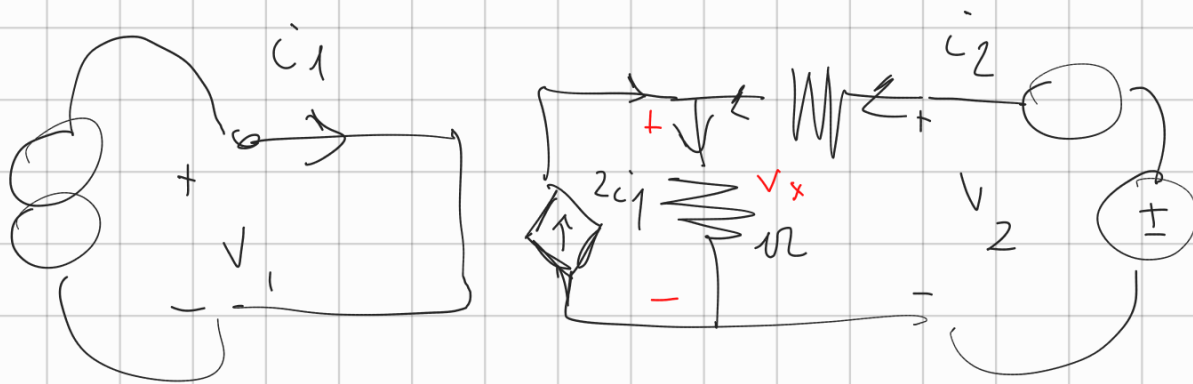
$$V_1 = V_2 - 3i_2$$

find

$$T = \begin{pmatrix} \times & \times \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ \frac{1}{2} & 2 \end{pmatrix}$$

Def. problema

Per A e C



$$A = \frac{V_1}{V_2} \Big|_{I_2 = 0}$$

$$V_1 \text{ e } u_{CC} = 0$$

$$C = \frac{I_1}{V_2} \Big|_{I_2 = 0}$$

$$I_1 = 0$$

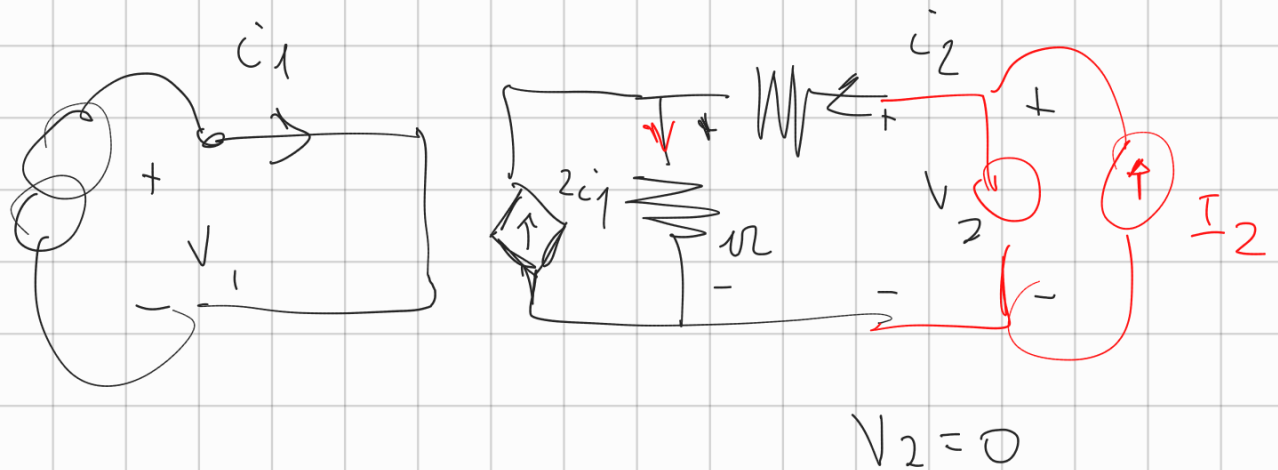
$$V_x = 2i_1 \cdot 1 = V_2$$

$$V_2 = 2i_1$$

$$i_1 = \frac{V_2}{2}$$

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

Per B e D



$$V_1 = 0, B = 0$$

$$V_X = 2i_1 + i_2$$

$$V_2 = 3i_2 + 2i_1 + i_2 = 0$$

$$i_1 = -2i_2$$

$$D = 2$$

$$I(s) = \frac{3s^2 + 8}{s^2 + s + 8}$$

$$V(s) = -\frac{2}{s} + \frac{\partial}{\partial s} \left( \frac{3s^2 + 8}{s^2 + s + 8} \right)$$