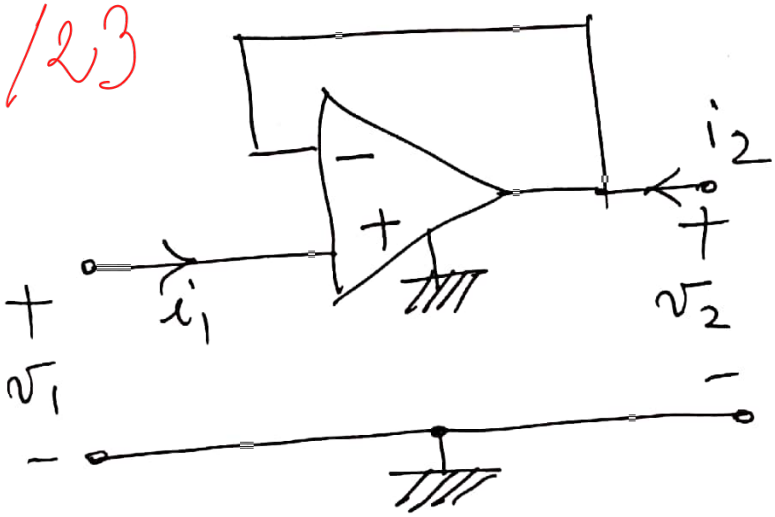
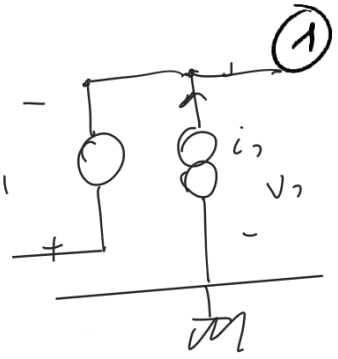
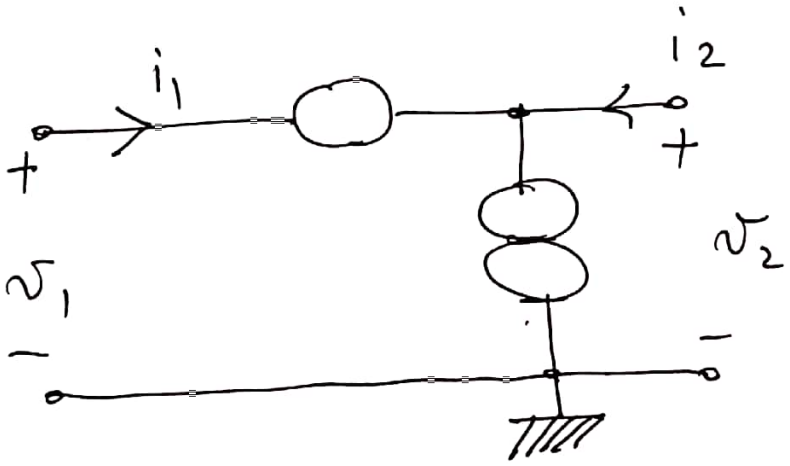
Esempio Circuito separatore (buffer)

17/04/23

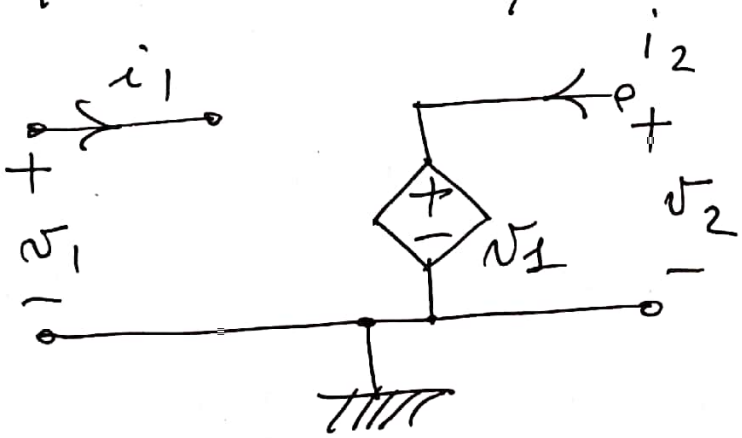






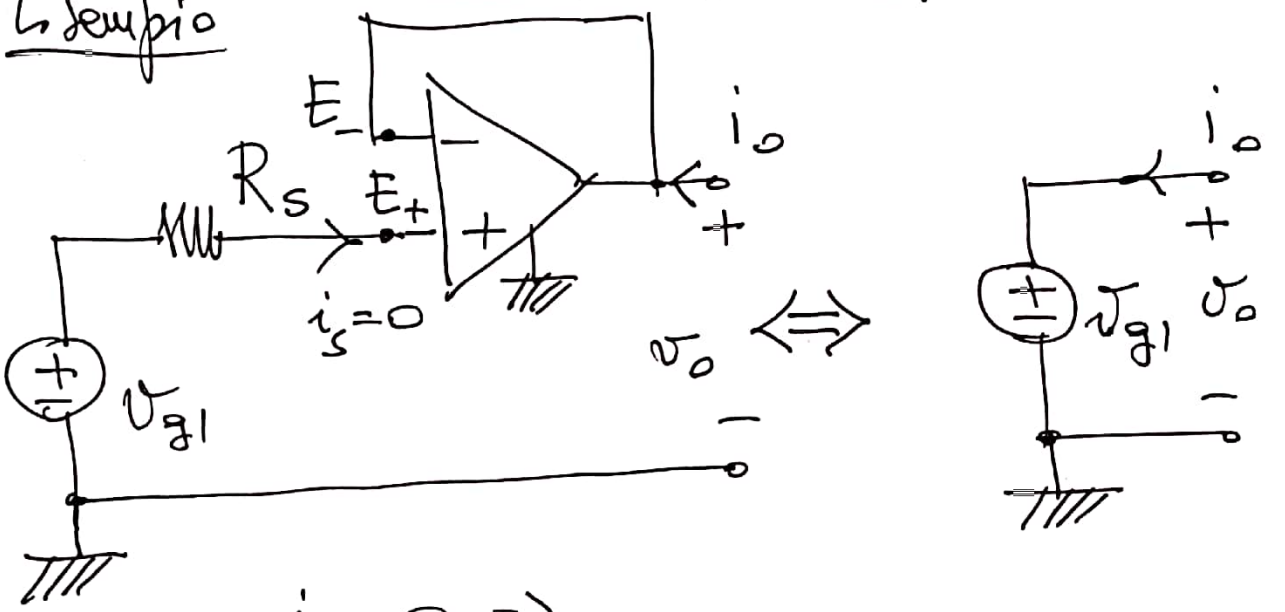
$$\begin{cases} v_2 = v_1 \\ i_1 = 0 \end{cases}$$

relazioni costitutive



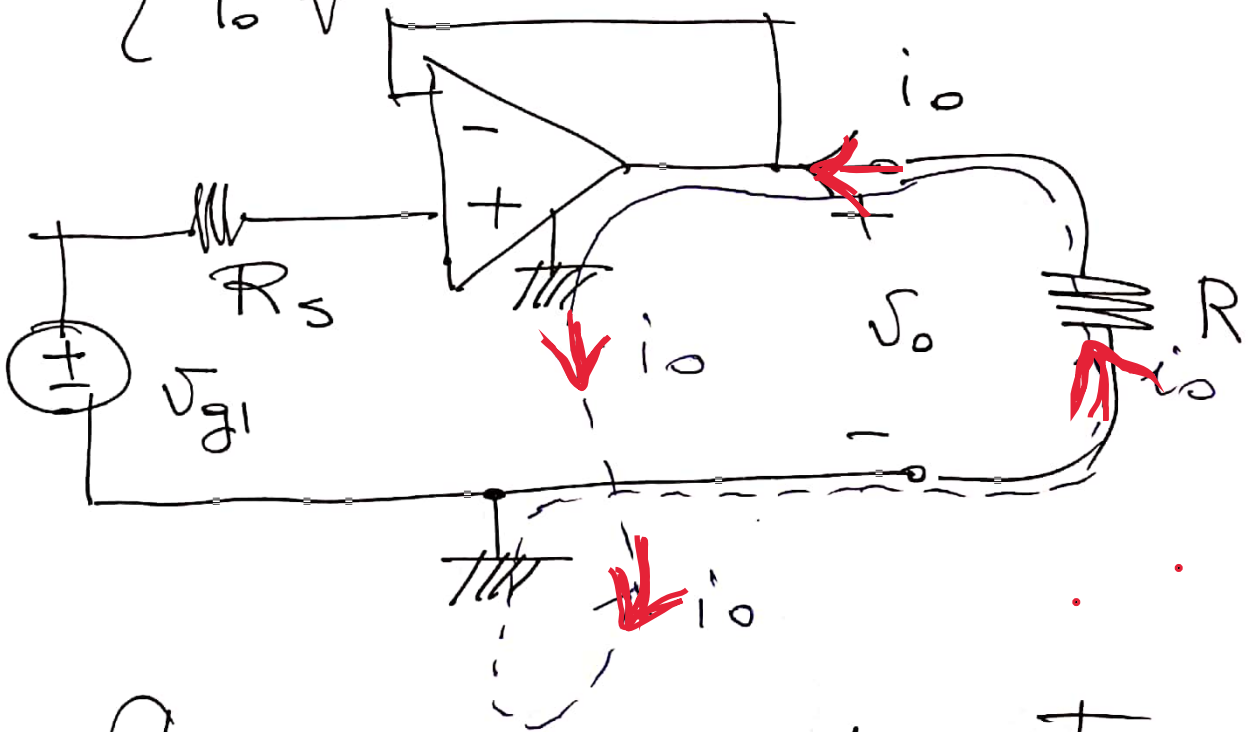
Impiego c.to ripetitore

Esempio



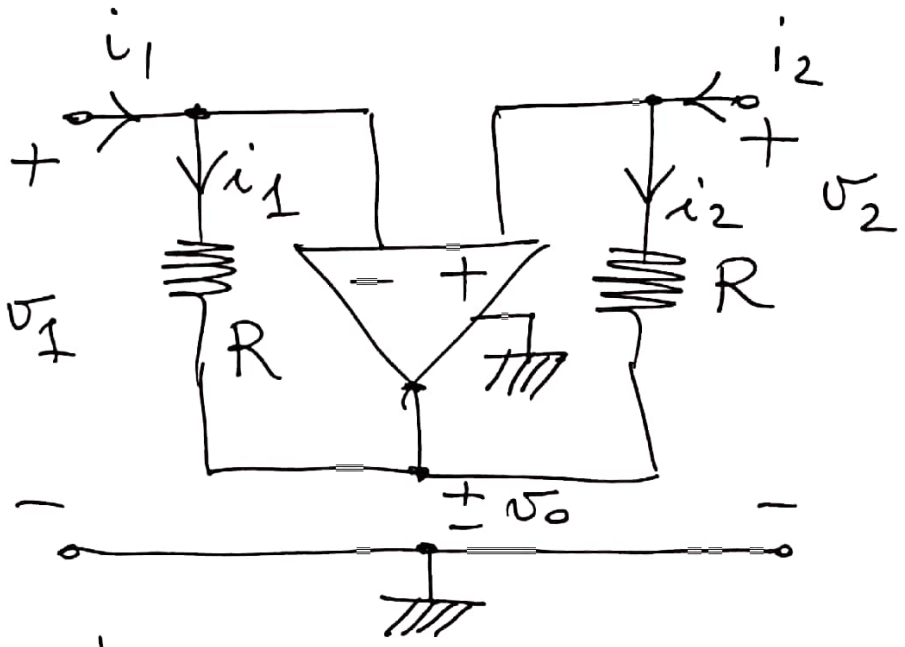
$i_s = 0 \Rightarrow$

$$\begin{cases} v_o = E_- = E_+ = v_{g1} \\ i_o \ \forall \end{cases}$$



Notare la circolazione di corrente nel circuito.

Inverritore di corrente (I-NIC)

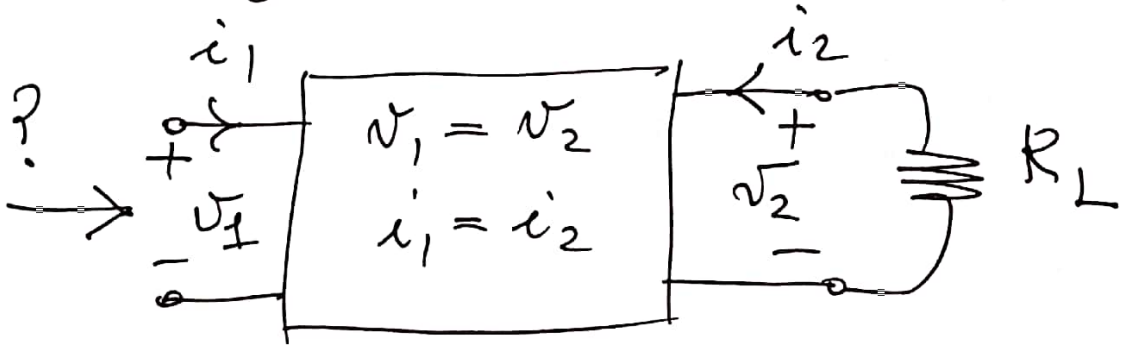


Si ha: $v_1 = v_2$

$$i_1 = \frac{v_1 - v_o}{R} \; ; \quad i_2 = \frac{v_2 - v_o}{R}$$

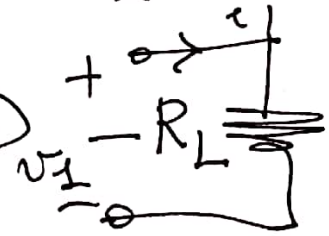
$$\Rightarrow \quad i_1 = i_2$$

$$\Rightarrow \begin{cases} v_1 = v_2 \\ i_1 = i_2 \end{cases} \quad \text{I-NIC}.$$

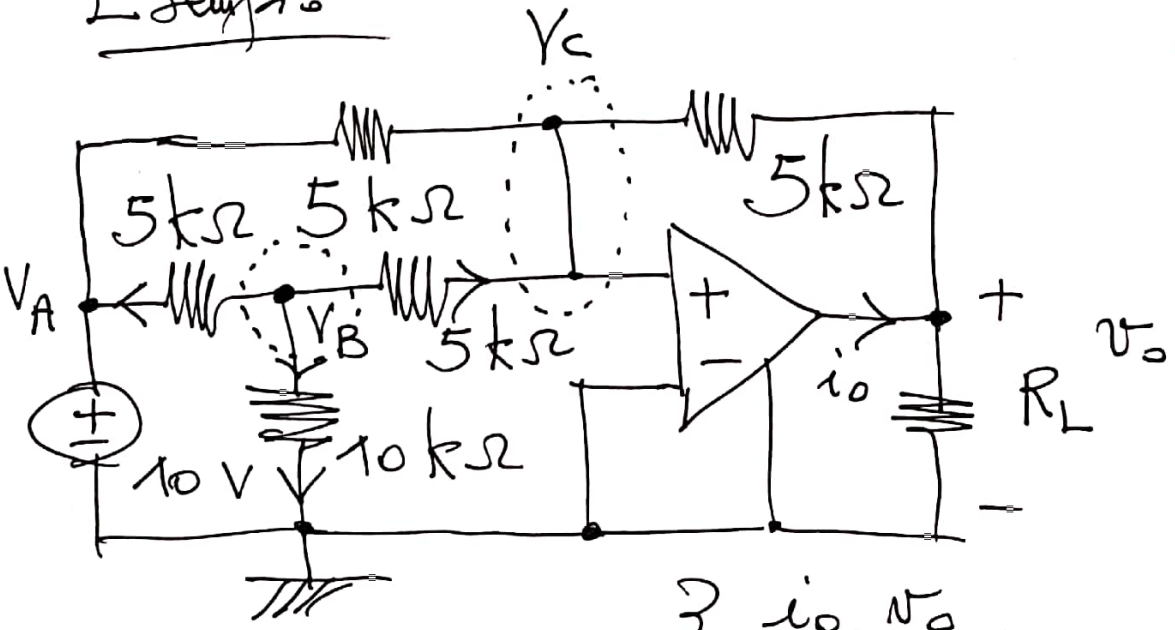


$$\frac{v_1}{i_1} = \frac{v_2}{i_2}, \quad \text{ma} \quad v_2 = -R_L i_2.$$

$$\Rightarrow \quad \frac{v_1}{i_1} = -R_L \quad \ldots \Leftrightarrow$$



Esempio



? i_o, v_o.

4 nodi A, B, C, D;
4 incognite V_A, V_B, V_C, V_D
Ma: $V_A = 10\ V$, $V_C = 0$.
$\Rightarrow$ 2 sole incognite V_B e V_o

KCL nodi B e C.

(B) $$\frac{v_B - 10}{5\times10^3} + \frac{v_B}{5\times10^3} + \frac{v_B}{10\times10^3} = 0$$

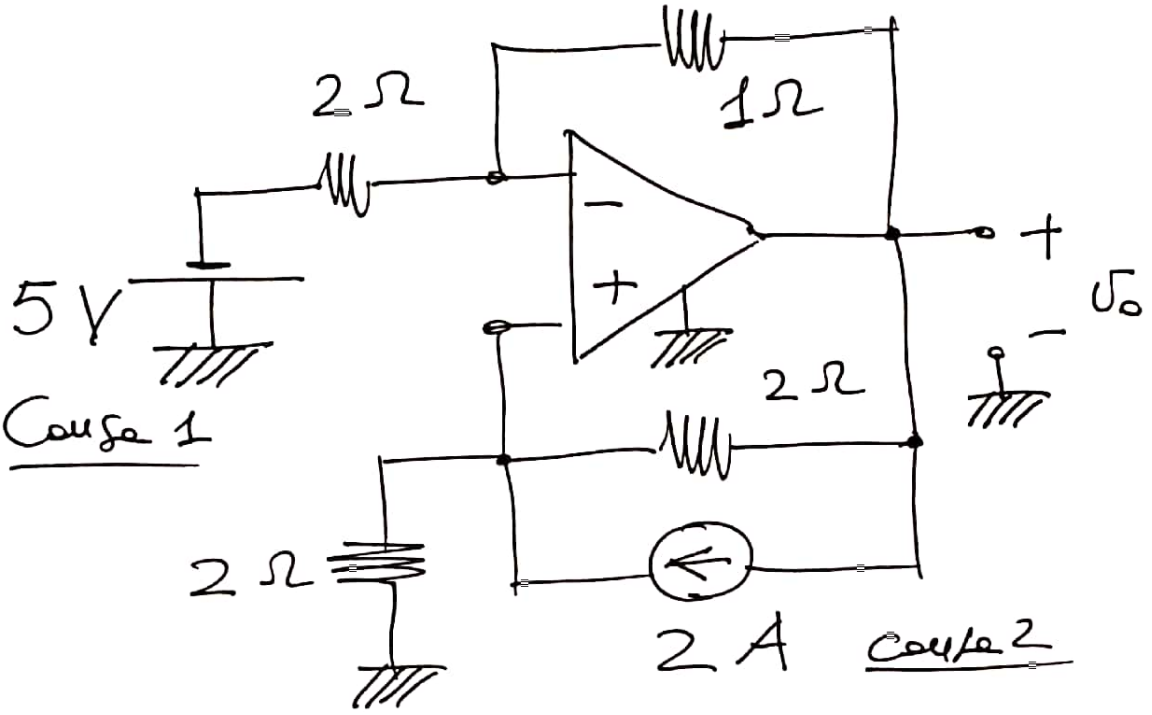
$$2v_B - 20 + 2v_B + v_B = 0 \Rightarrow$$

$$\boxed{v_B = 4\ V}$$

(C) $$\frac{10 - 0}{5\times10^3} + \frac{v_o - 0}{5\times10^3} + \frac{v_B - 0}{5\times10^3} + 0 = 0$$

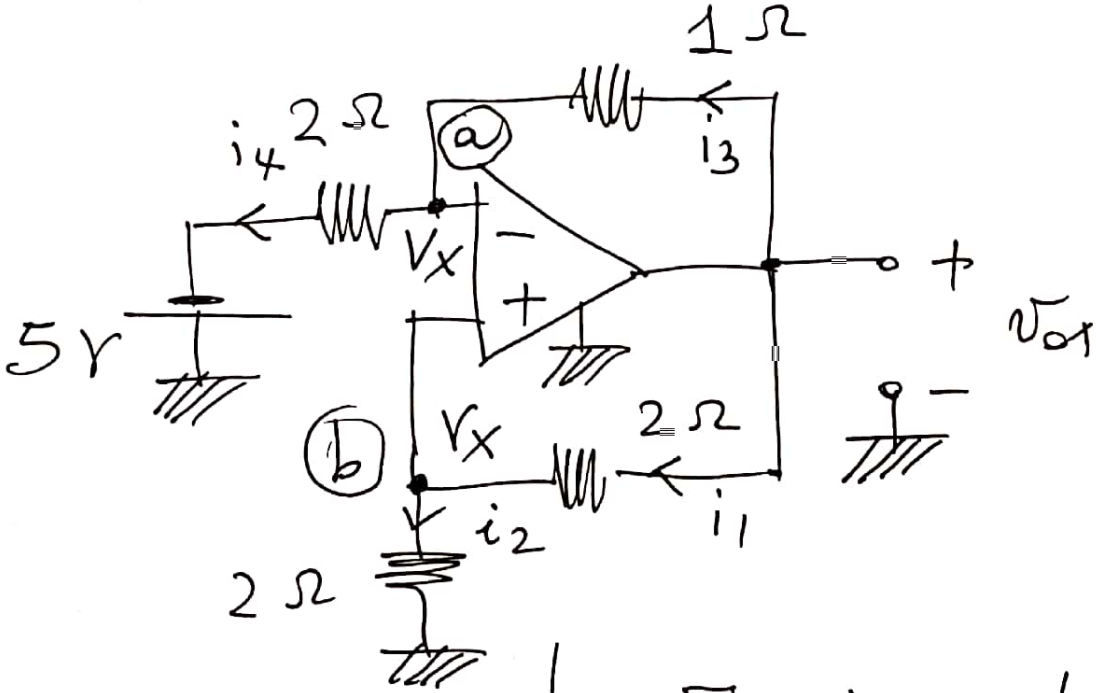
$$10 + v_o + 4 = 0 \qquad \boxed{v_o = -14\ V}.$$

Esempio Determinare v_o usando il p.s.e.



Causa 1 — Causa 2

$$v_o = v_{o1} + v_{o2}$$



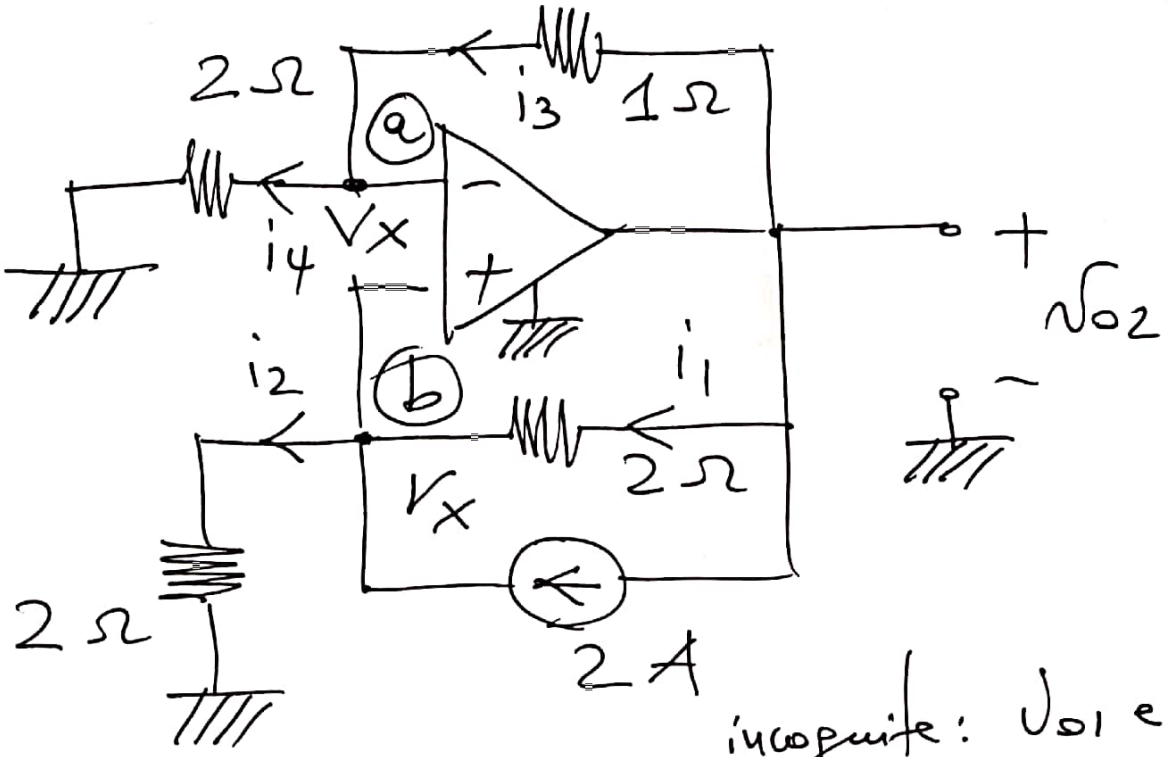
1 sola incognita V_x in effetti e V_{o1}

kI nodo, (b): $i'_1 = i'_2$, cioè

$$\frac{v_{o1} - V_x}{2} = \frac{V_x - 0}{2} \Rightarrow V_x = \frac{v_{o1}}{2}$$

kI nodo, (a): $i'_3 = i'_4$

$$v_{o1} - \frac{v_{o1}}{2} = \left[\frac{v_{o1}}{2} + 5\right]\frac{1}{2} \Rightarrow \boxed{v_{o1} = 10\ V}$$



incognite: V_{o1} e V_x

KI nodo (b): $i_1 + 2 = i_2$

$$2 + \frac{V_{o2} - V_x}{2} = \frac{V_x - 0}{2}$$

KI nodo (a): $i_3 = i_4$

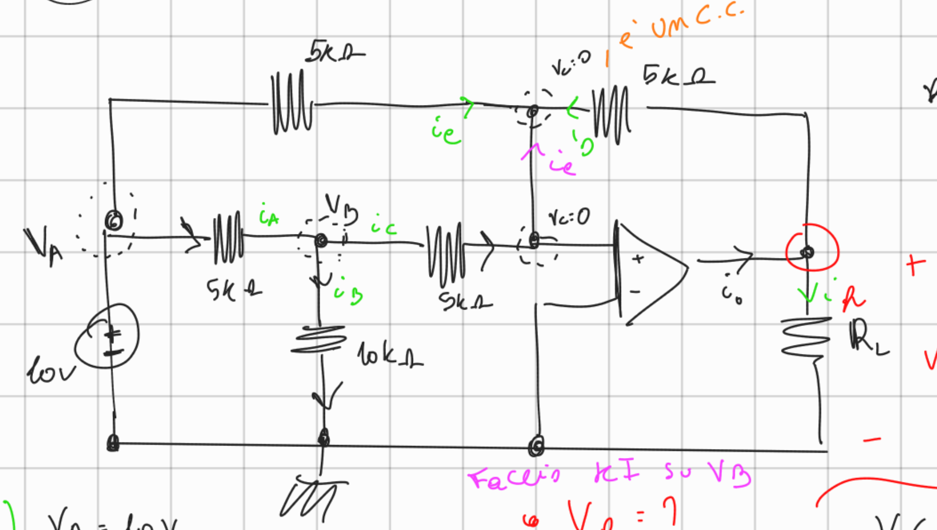
$$\frac{V_{o2} - V_x}{1} = \frac{V_x - 0}{2}$$

risolvendo ottengo: $V_{o2} = 12\ V.$

Allora

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

④ Esempio — Trovare V_O — 17/04



$RL = 5k\Omega$

① vedo nodi che hanno V incognita rispetto a terra, vedo le V incogn. e ...? nodi uscita e collegamenti ai gen.

Faccio KI su V_B

incognite V_o e V_B

1) $V_A = 10V$

• $V_B = ?$

$V_C = 0$

• $i_a = i_B + i_C$

per trovare V_B

Correnti messe non come da ex

per i_a

$$\underbrace{\frac{V_a - V_b}{5k\Omega}}_{i_a} = \underbrace{\frac{V_B - 0}{10k\Omega}}_{i_b} + \underbrace{\frac{V_B - V_C{=}0}{5k\Omega}}_{i_c} \Rightarrow V_A = V_b + \frac{3}{2} V_b$$

unica incognita è V_b

$$V_B = \frac{2}{5} V_A = 4\,V$$

svolgo i calcoli

KI al nodo di sopra per V_L

• $i_c + i_d + i_e = 0$

$$\frac{V_b}{5k\Omega} + \frac{V_o}{5k} + \frac{10}{5k} = \dots \qquad \left(\frac{10-0}{5k} + \frac{V_o - 0}{5\cdot 10^3} + \frac{V_B - 0}{5\times 10^3} \right.$$

(i_e, i_D)

KI a V_C in altro

$10 - 0$

$$10 + V_o + 4 = 0$$

$$V_o = -14\,V$$

Trovo ora corrente di uscita

$$i_c + i_d + i_e = 0 \quad V_C = 0$$

$$-\frac{V_o}{5k\Omega} + \frac{V_C - V_a}{5k\Omega} + \frac{V_b - V_c}{5k\Omega}$$

$$= \frac{V_o}{5k\Omega} - \frac{V_a}{5k\Omega} + \frac{V_b}{5k\Omega} = 0$$

$-V_o - 10 + 4 = 0 \Rightarrow V = -14$

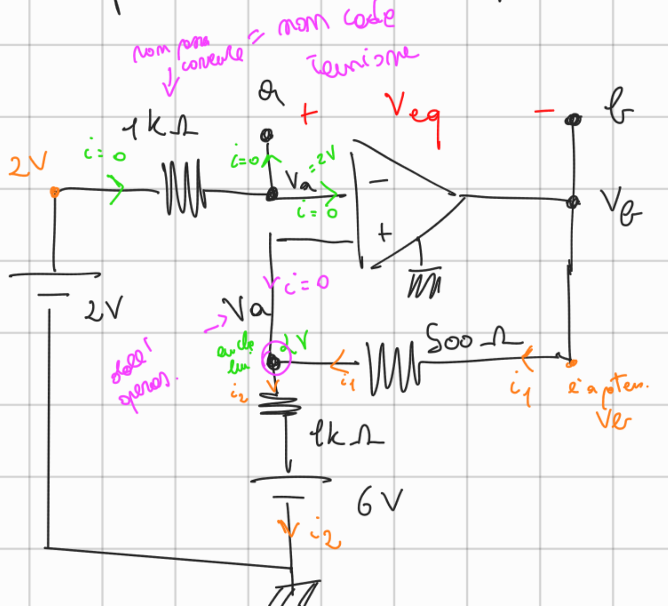
• TROVIAMO i_o

• $i_o = i_d + i_R = \frac{V_o}{5k\Omega} + \frac{V_o}{RL}$ (= 5kΩ) $= -\frac{28}{5}$ A

KI al nodo di uscita

4C N.7

Esempio ? Eq. di Thevenin bipolo a b con definiz.



① $V_{eq} = V_a - V_b$

posso anche fare KI al nodo

$V_a = 2V$ su R_1 1kΩ non passa corrente

• $i_1 = i_2$ KI ~~i~~ $-i_1 + i_2 = 0$

$$\underbrace{\frac{V_b - 2}{\cancel{500}}}_{i_1} = \underbrace{\frac{2 - 6}{\cancel{1000}\ 2}}_{i_2} \Rightarrow 2V_b - 4 = -4$$

DDF nodo

$$V_b = 0$$

rispetto a terra pot. di uscita è 0

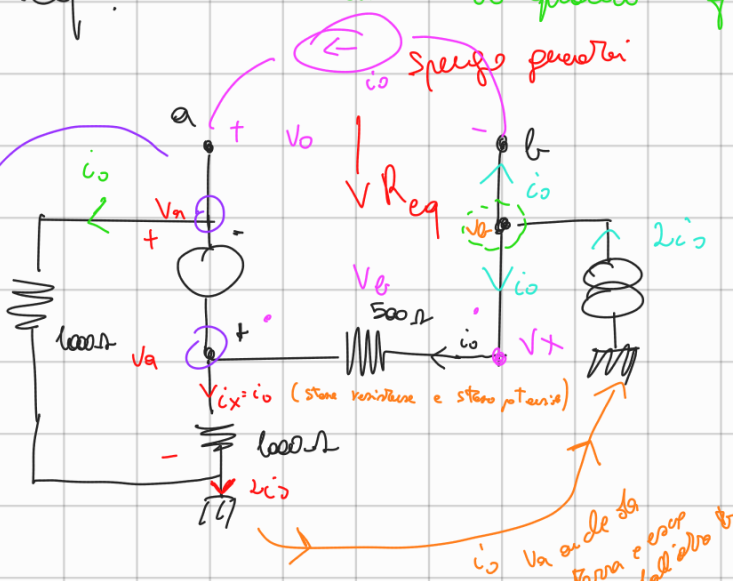
$V_{eq} = 2 - 0 = 2V$

Rappresenta. Nullatore Norator

Per Req faccio nullore, non mi alimenta corrente

Req ? Resistenza di quando spengo le batterie, uso nullatore per generatore

Def. operativo alimento con i_0, V_0 conv. Utilizz.



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

i_0 sull nullore non passa

$V_0 = V_a - V_b$ o scrivo 2 KVL Kirchoff o vedo come lavoro la corrente

scrivere Kirchoff

i_0 non può passare nel nullore

$V_a = 1000\, i_0$ sul resistore passa i_0, non va sul nullore

Ci sono due collegamenti a terra. Ce ne fosse solo uno, andrebbe per la resist., ma V_m può scappare a terra

$i_x = \frac{1000\, i_0}{1000} = i_0$ passa corrente uguale a i_0

a terra passa $i_0 + i_x = 2i_0$ e riesce

$V_b = 500\, i_0 + 1000\, i_0 = 1500\, i_0$

$V_b = V_x - V_a$

$500 \cdot i_0$ $1000\, i_0$

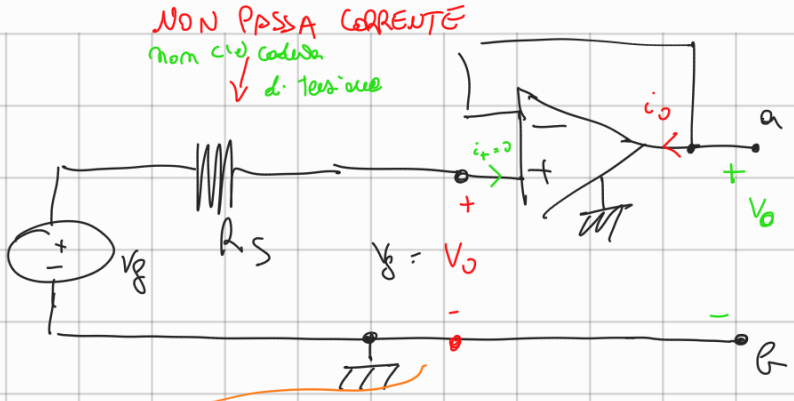
$V_0 = V_a - V_b = 1000\, i_0 - 1500 i_0 \Rightarrow$ $V_0 = -500 i_0$

o, con KT

$$R_{eq} = -500\,\Omega$$

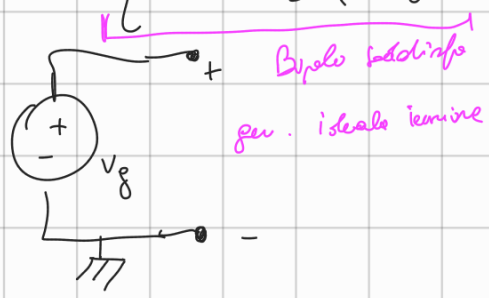
Configuraz. Buffer, trovare V_0

NON PASSA CORRENTE
non c'è caduta di tensione



$\Leftrightarrow$

$\begin{cases} V_o = V_g \ (\forall i_o) \end{cases}$

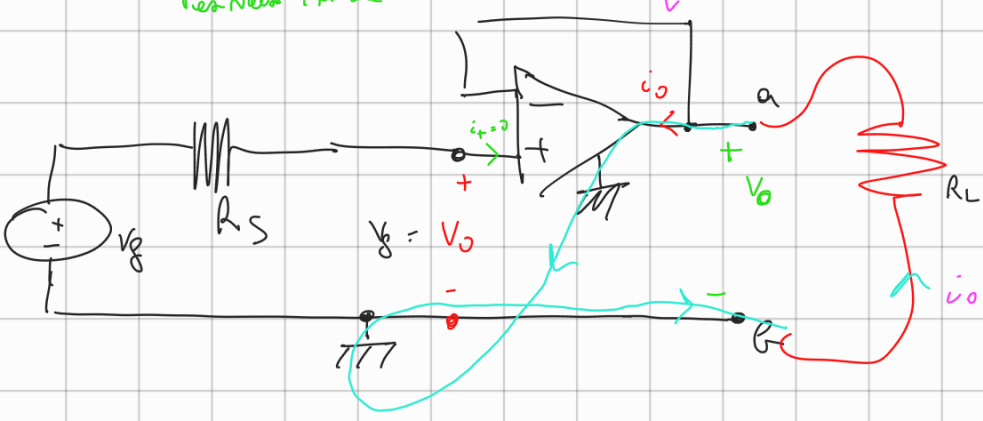


STESSA Tensione

Modo classico su come si realizza un generatore ideale
ora ci attacco un coso

da generatore reale passo ad uno ideale, non cambia più la resistenza interna

non passa corrente

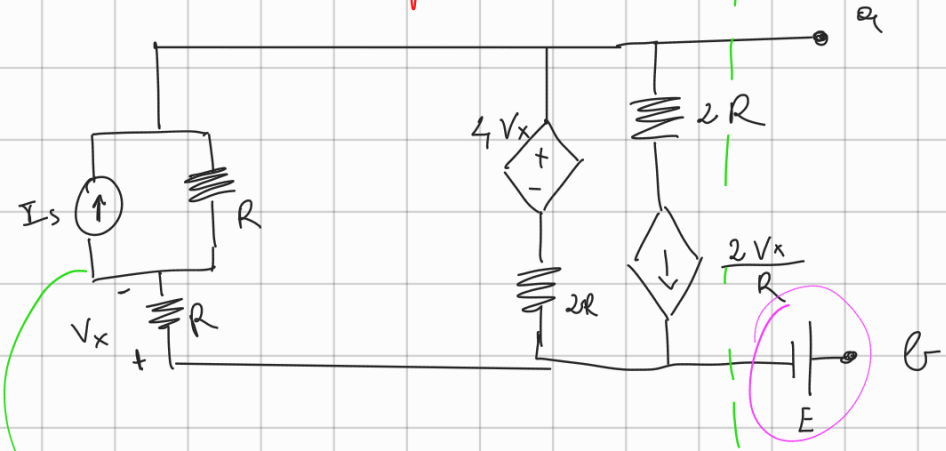


dove $i_o = -\frac{V_g}{R_L}$

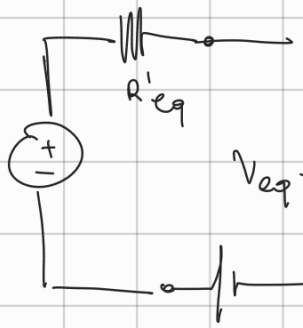
Negli operazionali ci deve essere almeno 2 a terra (la corrente fa giri strani

Devo trovare eq. Thevenin

Tolgo



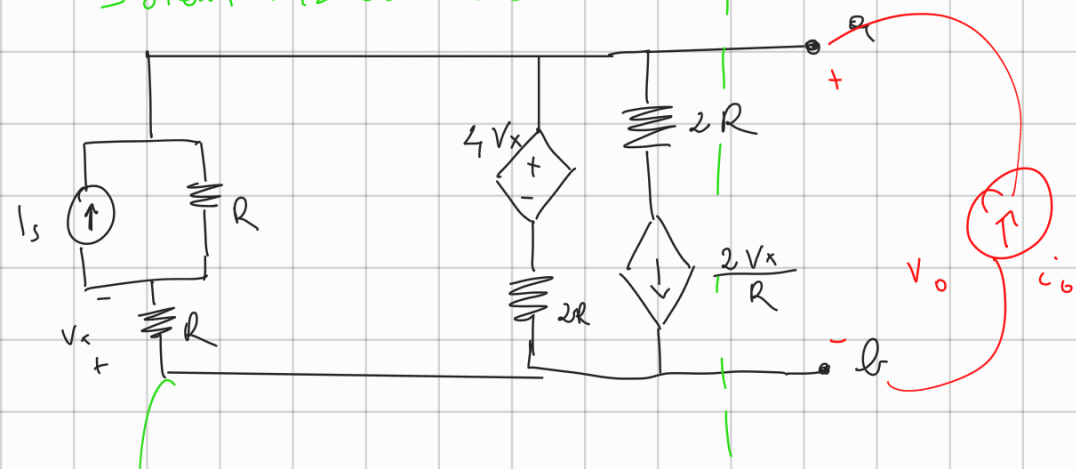
Faccio equivalere la batteria si sommerà a V_{eq}



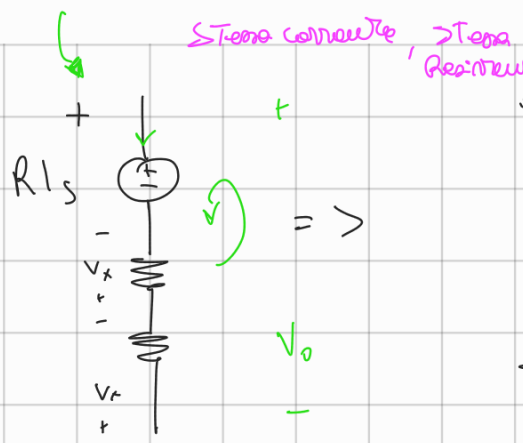
$V_{eq} = V'_{eq} + E$

È in serio la batteria, la R equivalente è la stessa e la V_o sarà uguale

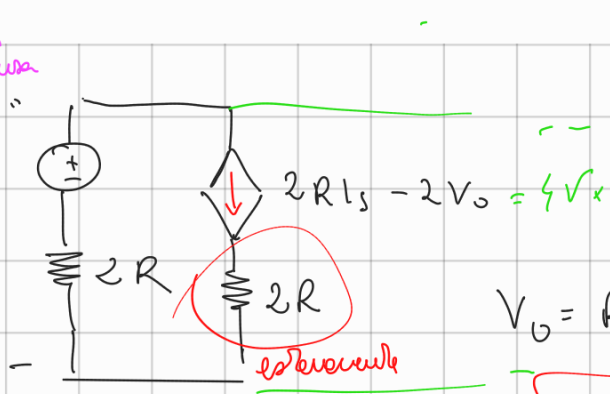
Stessa R, stessa corrente



resistore ridondante in serie a R_L ci



$V_o = RIs - 2V_x$



dall'alto verso il basso

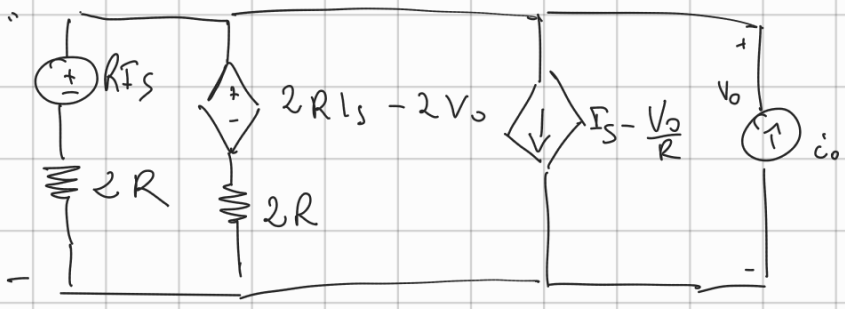
$V_o = RIs - 2V_x$

equivalente

ridondante $\Rightarrow$ $V_x = \frac{RIs - V_o}{2}$

$V_o = Ris - 2V_x$

↓ Millman



Una resistenza è ridondante (in serie al generatore di corrente controllato)

Vo ora unica incognita

procedo con il buono

*MILLMAN

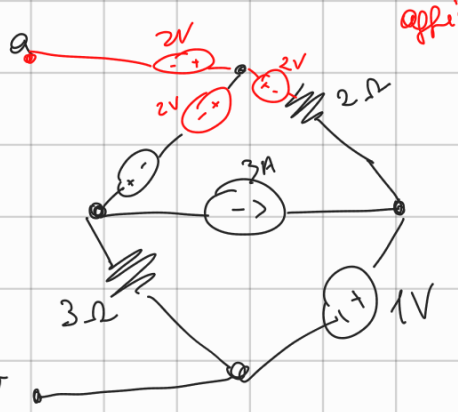
$$V_o = \frac{\frac{RIs}{2R} + \frac{2RIs - 2V_o}{2R} - Is + \frac{V_o}{R} + i_o}{\frac{1}{2R} + \frac{1}{2R}}$$

aggiungo un ramo modello di generatore

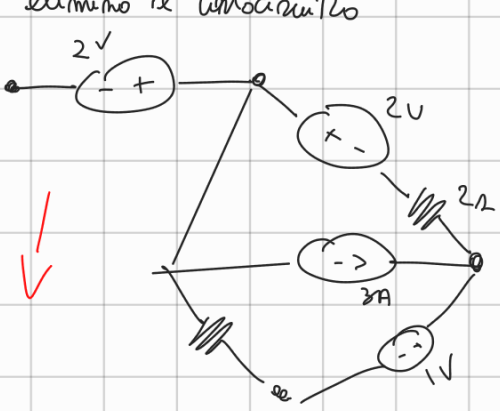
Norton Bipolo a b usando trasformazioni circuitali

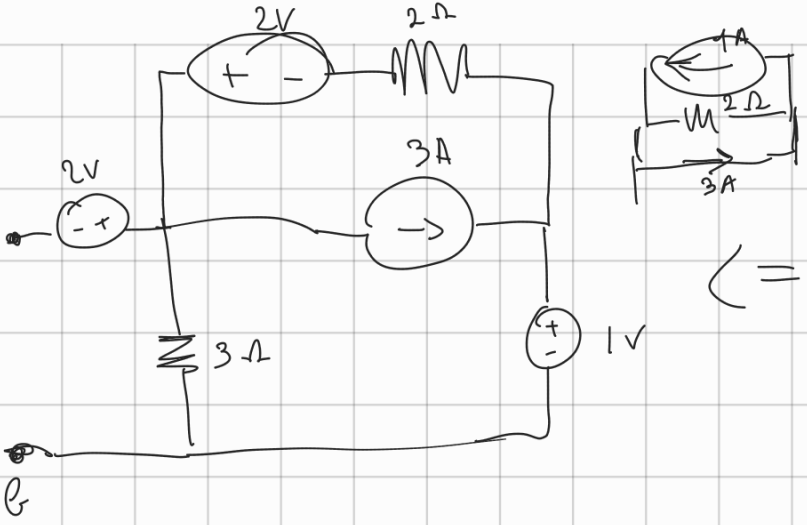
Thevenin (?)

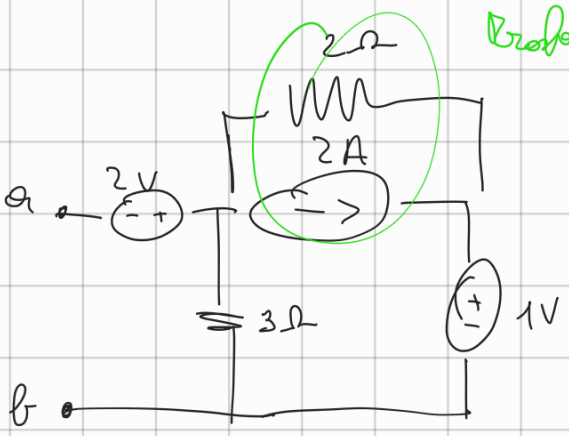
aggiungo un generatore

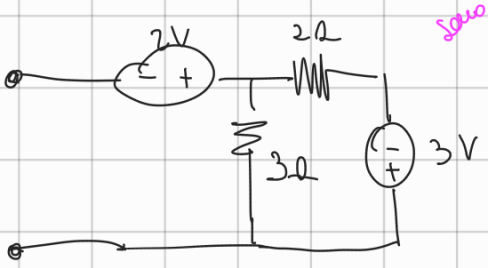


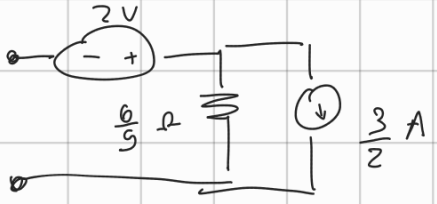
elimino il controcircuito

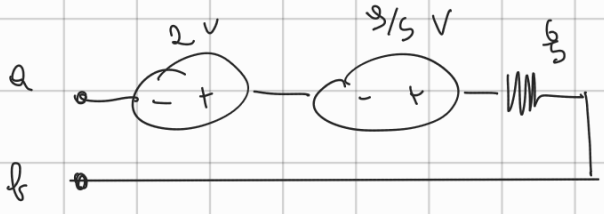












$V_{eq} = \frac{19}{5}$ V

R_{eq} $\frac{6}{5}\ \Omega$

Risolvere con trasformazione generatore di corrente.

$I_{eq} = \frac{V}{R} = \frac{19}{5} \cdot \frac{5}{6} = \frac{19}{6}$ A

$G_{eq} = \frac{5}{6}\ \Omega^{-1}$