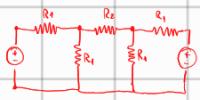
ALCUNE CONSIDERAZIONI:

- É possibile che una piccola parte degli esercizi sia scorretta
- Alcuni esercizi possono essere risolti in modi diversi, ma ugualmente corretti
- Gli esercizi sono svolti in ordine cronologico, quindi più si va in fondo nel file più sarà probabile che con più esperienza alle spalle saranno corretti.

BUON LAVORO!

5.2)



$R_1 = 2\Omega$
$R_2 = 1\Omega$

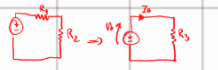
$\underline{I} = \underline{G}\,\underline{V}$

$I_A = G_{11} V_A + G_{12} V_B$
$I_B = G_{21} V_A + G_{22} V_B$

$G_{11} = \left.\frac{I_A}{V_A}\right|_{V_B=0}$

$R_{eq} = \frac{1}{2} + 1 = 1.5\Omega$

$R_3 = 3\Omega$



$I_A = \frac{V_A}{R_3} = \frac{10}{3} A \rightarrow \frac{I_A}{V_A} = \frac{1}{3} S = G_{11}$

$G_{12} = \left.\frac{I_A}{V_B}\right|_{V_A=0}$

$I_A = I_B$ ~~nell'esempio precedente.~~

- $I_B = -\frac{I_2}{2}$
- $I_2 = \frac{G_2}{G_1+G_2} I_A = \frac{1}{1+\frac{1}{2}} \cdot \frac{10}{3} = \frac{2}{3}\cdot\frac{10}{3} = \frac{20}{9}$

$I_B = -\frac{10}{9} A \rightarrow G_{12} = -\frac{1}{9}$

$G_{22} = \left.\frac{I_B}{V_B}\right|_{V_A=0} = G_{11} = \frac{1}{3}$

$G_{21} = \left.\frac{I_B}{V_A}\right|_{V_B=0} = G_{12} = -\frac{1}{9}$

$$\underline{G} = \begin{pmatrix} \frac{1}{3} & -\frac{1}{9} \\ -\frac{1}{9} & \frac{1}{3} \end{pmatrix}$$

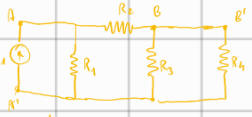
NOT OK!

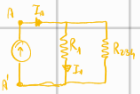
$$\begin{bmatrix} V_A \\ I_B \end{bmatrix} = H \begin{bmatrix} I_A \\ V_B \end{bmatrix}$$

$V_A = h_{11} I_A + h_{12} V_B$

$I_B = h_{21} I_A + h_{22} V_B$

$h_{11} = \left.\frac{V_A}{I_A}\right|_{V_B=0}$





$G_{3//4} = \frac{1}{5}$

$R_{3//4} = 5$

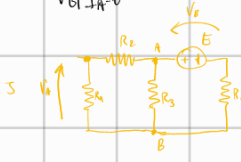
$R_{2,3,4} = 10\,\Omega$

$I_1 = I_A \cdot \frac{G_1}{G_1 + G_{2,3,4}} = \frac{1}{1+\frac{1}{10}} \cdot 20 = \frac{10}{11} 20\ A$

$V_{AB} = G_1 I_1 = \frac{10}{11} 20$

$h_{11} = \frac{10}{11}\,\Omega$

$h_{12} = \left.\frac{V_A}{V_B}\right|_{I_A=0}$



$U_B = 0$

$U_A(G_{12} + G_3 + G_4) = E G_4$

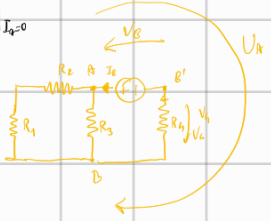
$U_A = \frac{E G_4}{G_{12} + G_3 + G_4} = \frac{50 \cdot \frac{1}{10}}{\frac{1}{5} + \frac{1}{20} + \frac{1}{10}} =$

$\frac{5}{\frac{5+2+1}{20}} = \frac{5 \cdot 20}{11} = \frac{100}{11}$

$V_A = \frac{R_1}{R_1 + R_2} \cdot U_A = \frac{1}{20} \cdot \frac{100}{11} = \frac{25}{11}$

$h_{12} = \frac{V_A}{V_B} = \frac{25}{11} \cdot \frac{1}{50} = \frac{1}{22}$

$h_{22} = \left.\frac{I_B}{V_B}\right|_{I_A=0}$



$I_B = G_4 V_4$

$-V_4 + V_B + U_A = 0$

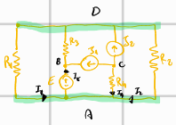
$V_4 = \frac{150}{11} + 50$

$I_B = \frac{700}{11} \cdot \frac{1}{10} = \frac{70}{11}$

$h_{22} = \frac{70}{11} \cdot \frac{1}{50} = \frac{7}{55}$

NOT OK!

4.6) OK!



2 equations.

$U_A = 0 \quad U_B = 2\,mV$

$U_B(G_3 + G_1 + G_2) - U_C G_3 = J_2$

$U_C G_4 = -J_1 - J_2$

$U_B = \frac{J_2 + U_C G_3}{G_1 + G_2 + G_3} = \frac{1 + 2 \cdot \frac{10}{4}}{\frac{10}{3} + \frac{10}{2} + \frac{10}{4}} =$

$= 6 \cdot \frac{6}{65} = \frac{36}{65}\,mV$

$U_C = \frac{-J_1 - J_2}{G_4} = \frac{-2\,mA}{2,3} = -1\,mV$

$P_{J_2} = (U_B - U_C)\,J_2 = 1,55\,\mu W \approx 1,6\,\mu W$

$P_{J_1} = (U_B - U_C)\,J_1 = 3\,mV \cdot 1\,mA = 3\,\mu W$

$I_1 + J_2 + I_4 = I_B$

$I_1 = U_B G_1 = \frac{10}{3} \cdot \frac{36}{65} = \frac{24}{13}\,mA$

$I_2 = U_B G_2 = 5 \cdot \frac{36}{65} = \frac{36}{13}\,mA$

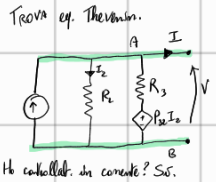
$I_4 = U_C G_4 = -2\,mA$

$I_B = \frac{24}{13} + \frac{36}{13} - \frac{26}{13} = \frac{34}{13}\,mA$

$P_E = U_B I_E = 2 \cdot \frac{34}{13}\,\mu W = 5,23\,\mu W$

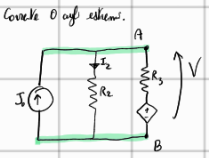
ES. ESAME

TROVA eq. Thevenin.



Ho calcolato: in corrente? Sì.

Conviene 0 agli estremi.



Ho 2 modi: 1 equaz.
$U_B = 0$

$U_A(G_3+G_2) = J_0 + P_{32}I_2G_3$

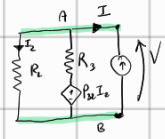
$U_A(G_3+G_4) = I_0 + P_{32}U_AG_2G_3$

$U_A(G_3+G_2-P_{32}G_2G_3) = J_0$

$$U_A = \frac{J_0}{G_3+G_2-P_{32}G_2G_3} = E_{TH}$$

Non ho calcolato: in Ryome se $P_{32} = \frac{G_3+G_2}{G_2G_3}$

CALCOLO R_{TH}

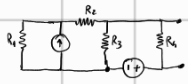


Tensione già calcolata prima!

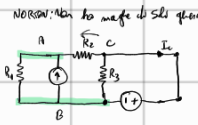
$$R_{TH} = \frac{1}{G_3+G_2-P_{32}G_2G_3}$$

GOOD JOB!

3.2)



NORTON: Non ho maglie di soli generatori di V.



1 equazione. $U_B = 0$ $U_C = E$

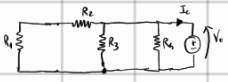
$U_A(G_1+G_2) - U_C G_2 = J$

$U_A = \frac{J+EG_2}{G_1+G_2} = \frac{20+5}{4} = 25\ V$ ✓

$I_2 = \frac{U_A - U_C}{R_2} = \frac{25-10}{2} = \frac{15}{2}\ A$

$I_3 = -\frac{U_C}{R_3} = -\frac{10}{4} = -\frac{5}{2}\ A$

$I_C = I_3 + I_2 = +5A$



$R_{eq} \| R_3 \| R_4 \Rightarrow$

$G_{eq} = G_2 + G_3 + G_4 = \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = \frac{3}{4}\ \Omega$

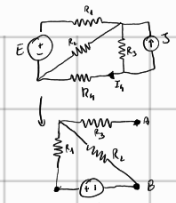
$R_{eq} = \frac{4}{3}\ \Omega$

$I_C = \frac{E_G}{R_{eq}} \cdot \frac{1}{L_G} = \frac{3}{4} S$

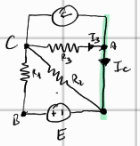
$I = J_C - G_2 V$

$I = +5 - \frac{3}{4} V$

GOOD SOB!



Passo applicare Norton: No pacli di controllati.



$U_B = 0$ $U_B = +5A\ V$

$U_C(G_1+G_2+G_3) - U_B G_1 = J$

$U_C = \frac{J+U_B G_1}{G_1+G_2+G_3} = \frac{19}{\frac{2}{3}} =$

$= \frac{3 \cdot 19}{2} = \frac{57}{2}$

$I_3 = U_B G_3 = \frac{57}{2} \cdot \frac{1}{4} = \frac{57}{8} A$

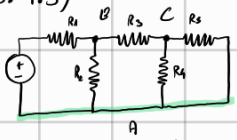
$= \frac{57}{8} - 10 = -\frac{23}{8} A$

$I_1 = \frac{I_{CC} G_1}{G_1 + G_{eq}}$ $R_{eq} = \frac{12}{5} + 4 = \frac{32}{5}$

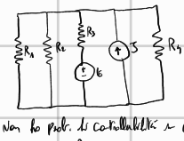
$= \frac{\frac{23}{8} \cdot \frac{1}{12}}{\frac{5}{32} + \frac{1}{12}} = -1\ A$ ✓

CORRECT

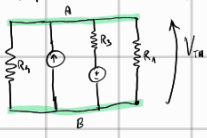
ES. 1.9)



2 equazioni $U_A = 0$



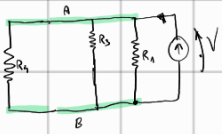
Non ho pacli di controllati e corrente.



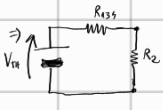
$U_B = 0$

$U_A(G_4+G_3+G_1) = J + EG_3$

$U_A = \frac{J+EG_3}{G_4+G_3+G_1} = \frac{\frac{5}{2}+3}{\frac{11}{20}} = \frac{25}{11} V$



$R_{234} = (G_4+G_3+G_2)^{-1} = (1+\frac{1}{2}+\frac{1}{5})^{-1} = \frac{10}{17}\ K\Omega$

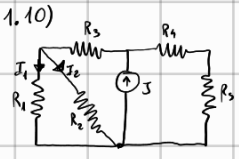


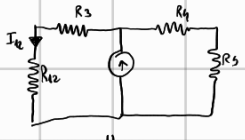
$V_{eq} = V_{TH} \cdot \frac{R_2}{R_2 + R_{234}} = \frac{25}{17} \cdot \left(\frac{1}{1+\frac{10}{17}}\right) = \frac{25}{17} \cdot \frac{17}{27} = \frac{25}{27} V$

$P_{R_2} = V_{eq}^2 G_2 = 0,925\ mW$

Well done! (0,857 → 0,925 Suppose all's ok)

1.10)





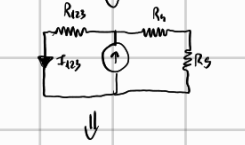
$R_{eq} = (G_1+G_2)^{-1} = (\frac{1}{5}+\frac{1}{3})^{-1} = (\frac{3+5}{15})^{-1} = \frac{15}{8}$

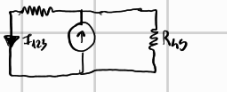
$R_{123} = \frac{15}{8} + 2 + \frac{31}{8}\ \Omega$

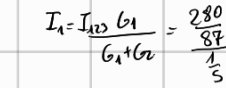
$R_{45} = 7\ \Omega$

$R_{12345} = \left(\frac{1}{7} + \frac{8}{31}\right)^{-1} = \frac{217}{87}\ \Omega$

$P_{gen} = R\, I^2 = 62,35\ W$





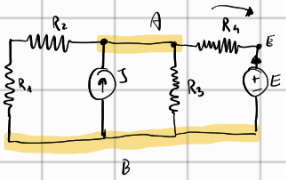


$I_{123} = \frac{J G_{123}}{G_{123} + G_{45}} = \frac{5 \cdot \frac{8}{31}}{\frac{8}{31} + \frac{1}{7}} = \frac{280}{87} A$

$I_1 = \frac{I_{123} G_1}{G_1 + G_2} = \frac{\frac{280}{87} \cdot \frac{1}{5}}{\frac{1}{5} + \frac{1}{3}} = \frac{35}{29} A$

$P_{dissipata} = R_1 I_1^2 = 7,28\ W$

Very Good!



$E=50V$
$J=20A$
$R_1=1\Omega$ $R_2=5\Omega$
$R_3=R_4=10\Omega$

$G_{12}=\frac{1}{6}\Omega$

$U_B=0$

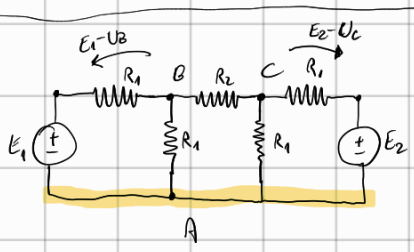
$U_A(G_{12}+G_3+G_4)=J+EG_4$

$U_A=\frac{J+EG_4}{G_{12}+G_3+G_4}=\frac{20+5}{\frac{1}{6}+\frac{1}{5}}=\frac{25}{\frac{5+6}{30}}=\frac{30\cdot25}{11}\ V$

$P_J=U_A\cdot J=\frac{20\cdot30\cdot25}{11}\ W=1363W$

$I_4=G_4(E-U_A)=\frac{1}{10}(50-\frac{30\cdot25}{11})=-1,8V$

$P_E=EI_4=-90W$



$E_1=10V$ $E_2=20V$
$R_1=2\Omega$ $R_2=1\Omega$
$G_1=\frac{1}{2}S$ $G_2=1S$

$U_B(G_1+G_1+G_2)-U_cG_2=E_1G_1$

$U_c(G_1+G_1+G_2)-U_BG_2=E_2G_1$

$2U_B-U_c=5$
$2U_c-U_B=10$ $\Rightarrow$ $U_B=2U_c-10$

$4U_c-20-U_c=5$

$3U_c=25 \Rightarrow U_c=\frac{25}{3}=8,3V$

$U_B=\frac{50}{3}-10=\frac{20}{3}=6,7V$

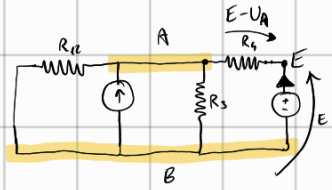
$I_2=G_1(E_2-U_c)=\frac{1}{2}(20-8,3)=5,85\ A$

$P_{E_2}=E_2I_2=20\cdot5,85=117W$

$I_1=G_1(E_1-U_B)=\frac{1}{2}(10-6,7)=1,65A$

$P_{E_1}=E_1I_1=16,5W$

3.3)



$E=50V$ $J=20A$
$R_1=1\Omega$ $R_2=5\Omega$
$R_3=R_4=10\Omega$
$R_{12}=6\Omega$

$U_A(G_{12}+G_3+G_4)=J+EG_4$

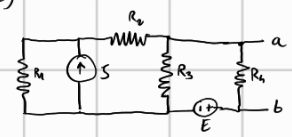
$U_A=\frac{J+EG_4}{G_{12}+G_3+G_4}=\frac{20+\frac{50}{10}}{\frac{1}{6}+\frac{1}{10}+\frac{1}{10}}=\frac{25}{\frac{5+6}{30}}=\frac{25}{\frac{11}{30}}=\frac{25\cdot30}{11}=68,2V$

$P_J=VJ=68,2\cdot20=1.36KW$

$I_4=G_4(E-U_A)=\frac{1}{10}\cdot(50-68,2)=-1,82\ A$

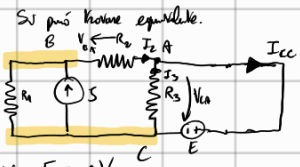
$P_E=EI_4=50\cdot(-1,82)=-91\ W=-0.09KW$

4.2)



$J = 20A \quad E = 10V$
$R_1 = R_2 = 2\Omega$
$R_3 = R_4 = 4\Omega$

Si può trovare equivalente.



$V_N = E = 10V$

$U_C = 0 \quad U_A = E$

$U_B(G_1+G_2) - EG_2 = J$

$U_B - 5 = 20 \Rightarrow U_B = 25V$

$V_{CA} = U_C - U_A = -E = -10V$

$V_{BA} = U_B - U_A = 25 - 10 = 15V$

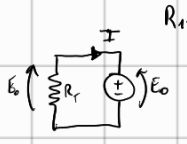
$I_2 = G_2 V_{BA} = \frac{15}{2} = 7,5A$

$I_3 = G_3 V_{CA} = \frac{-10}{4} = -\frac{5}{2} = -2,5A$

$I_{cc} = I_2 + I_3 = 5A$

$R_{12} = 4\Omega \qquad G_{1234} = (G_{12} + G_3 + G_4) = \left(\frac{1}{4} + \frac{1}{4} + \frac{1}{4}\right) = \frac{3}{4}S$

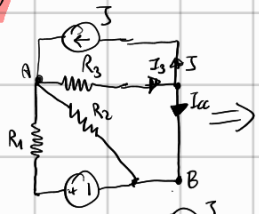
$R_{1234} = \frac{4}{3}\Omega$



$V = -RI \Rightarrow I = \frac{V}{-R_T} = \frac{E_0}{-R_T} \rightarrow \frac{E_0}{-R_T}\frac{1}{E_0} = G_N = -\frac{1}{R_T}$

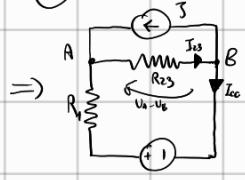
$I = I_{cc} - G_N V \qquad G_N = \frac{3}{4}S$

4.3)



$R_{23} = (G_2 + G_3)^{-1} = 2\Omega$

$E = 54V$
$J = 10A \quad R_1 = 6\Omega \quad R_2 = R_3 = 4\Omega$
$R_4 = 12\Omega$



$U_A = 0$

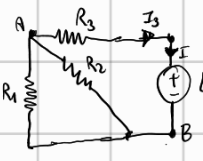
$U_B G_{23} = -J - EG_1$

$U_B = \frac{-J - EG_1}{G_{23}} = \frac{-10 - 54\cdot\frac{1}{6}}{\frac{1}{2}} = -19 \cdot 2 = -38V$

$I_{23} = G_{23}(-U_B) = 38 \cdot \frac{1}{2} = 19A$

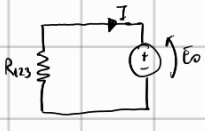
$I_3 = \frac{I_{23} \cdot G_3}{G_2 + G_3} = \frac{19 \cdot \frac{1}{4}}{\frac{1}{4} + \frac{1}{4}} = 19 \cdot 2 \cdot \frac{1}{4} = \frac{19}{2}A = 9,5A$

$I_3 = J + I_{cc} \Rightarrow \quad I_{cc} = I_3 - J = 9,5 - 10 = -0,5A$



$R_{12} = (G_1 + G_2)^{-1} = \left(\frac{1}{6} + \frac{1}{4}\right)^{-1} = \left(\frac{2+3}{12}\right)^{-1} = \frac{12}{5}\Omega$

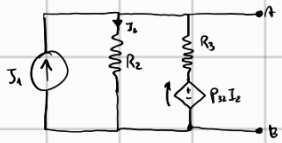
$\Rightarrow \quad R_{123} = R_{12} + R_3 = \frac{12}{5} + 4 = \frac{32}{5}\Omega$



$V = -R_{123} I \qquad I = I_{cc} - G_N V = -\frac{1}{2} - \frac{5}{32}V$

$\Rightarrow G_N = -\frac{1}{R_{123}}$

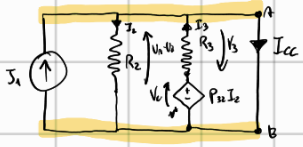
$I_4 = \frac{I_{cc} G_4}{G_N + G_4} = \frac{-0,5 \cdot \frac{1}{12}}{\frac{1}{12} + \frac{5}{32}} =$



$R_3 = 10k\Omega \quad R_2 = 20k\Omega$

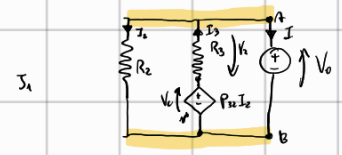
$P_{32} = -5k\Omega$

$J_1 = 10mA$



$E = P_{32} I_2 \quad I_2 = U_n G_2$

$I_{CC} = J_1$



$I_2 = G_2 V_0$

$V_C = P_{32} I_2 = P_{32} G_2 V_0$

$V_0 + V_3 - V_C = 0$

$V_3 = V_C - V_0 = V_0 (P_{32} G_2 - 1)$

$I_3 = G_3 V_3 = G_3 V_0 (P_{32} G_2 - 1)$

$$I = I_3 - I_2 = G_3 V_0 (P_{32} G_2 - 1) - G_2 V_0 = V_0 \left[G_3 (P_{32} G_2 - 1) - G_2 \right]$$

$$G_N = G_3 (P_{32} G_2 - 1) - G_2 = + \frac{1}{10000} \cdot \left(-5000 \cdot \frac{1}{20000} - 1 \right) - \frac{1}{20000} = -0,000175$$

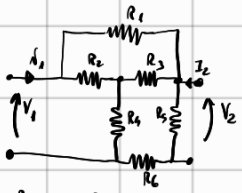
$$= -0,175 mS$$

$I = J_1 - G_N V$

$$V_{TH} = \frac{J_1}{G_N} = \frac{2}{35}$$

$$V_{TH} = \frac{R_2 R_3}{R_2 + R_3 - P_{32}} J_1$$

$$R_{TH} = \frac{R_2 R_3}{R_2 + R_3 - P_{32}} = \frac{\cancel{20} \cdot \cancel{10} \cdot 10^6}{\cancel{25} \cdot 10^3} = 8 \cdot 10^3 \Omega$$



$R_1 = R_2 = R_3 = R_4 = R$

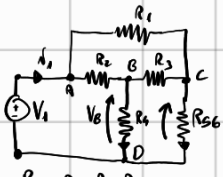
$R_5 = \frac{2}{3}R \quad R_6 = \frac{1}{3}R \quad R = 24\,\Omega$

$$\underline{V} = \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix} \underline{I}$$

$V_1 = R_{11} I_1 + R_{12} I_2$

$V_2 = R_{21} I_1 + R_{22} I_2$

$$R_{11} = \left. \frac{V_1}{I_1} \right|_{I_2 = 0}$$



$R_{56} = R_5 + R_6 = R$

$U_D = 0 \quad U_A = E$

$U_B (G_2 + G_3 + G_4) - U_C G_3 - E G_2 = 0$

$U_C (G_{56} + G_3 + G_1) - U_B G_3 - E G_1 = 0$

$\Rightarrow \frac{U_B}{8} - \frac{U_C}{24} = E G_2$ Suppongo per semplicità $E = 1$

$\frac{U_B}{8} - \frac{U_C}{24} = \frac{1}{24} \Rightarrow 3U_B - U_C = 1$

$U_C = 3U_B - 1$

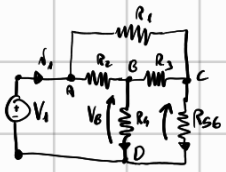
$\frac{U_C}{8} - \frac{U_B}{24} - \frac{1}{24} = 0$

$3U_C - U_B - 1 = 0 \Rightarrow$

$\Rightarrow 9U_B - 3 - U_B - 1 = 0$

$U_B = \frac{1}{2} V$

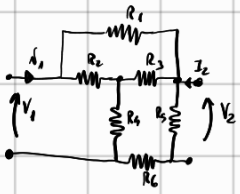
$U_C = \frac{1}{2} V$



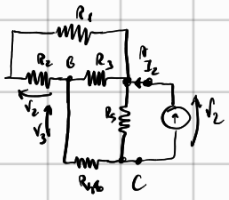
$I_4 = U_B G_4 = \frac{1}{48} \Rightarrow I_1 = I_4 + I_{56} = \frac{1}{24}$

$I_{56} = U_C G_{56} = \frac{1}{48}$

$R_{11} = \left. \frac{V_1}{I_1} \right|_{I_2 = 0} = \left. \frac{1}{\frac{1}{24}} \right|_{I_2 = 0} = 24\,\Omega$

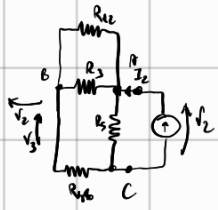


$$R_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

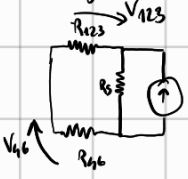


$V_1 = V_2 + V_3$

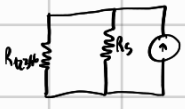
$R_{456} = R_4 + R_6 = \frac{5}{3}R = 32\,\Omega$



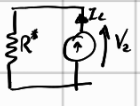
$R_{23} = 2R = 48\,\Omega$



$R_{123} = (G_{23} + G_3)^{-1} = \left(\frac{1}{48} + \frac{1}{24}\right)^{-1} = 16\,\Omega$



$R_{12346} = R_{123} + R_{456} = 48\,\Omega$



$R^* = (G_{12346} + G_5)^{-1} = \left(\frac{1}{48} + \frac{1}{16}\right)^{-1} = 12\,\Omega$

$V_2 = RI_2$ Supponiamo $I_2 = 1$

$V_2 = 12\,V$

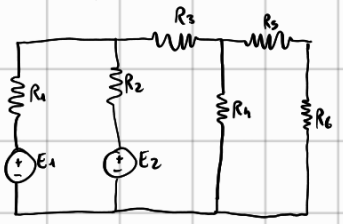
$$V_{456} = \frac{V_2 R_{456}}{R_{456} + R_{123}} = \frac{12 \cdot 32}{32 + 16} = \frac{12 \cdot 32}{48_3} = 4\,V$$

$$V_4 = \frac{V_{456} \cdot R_4}{R_4 + R_6} = \frac{4 \cdot 24}{24 + 8} = \frac{4 \cdot 24}{32_8} = 3\,V$$

$V_{123} = +8\,V = V_{12}$

$$V_2 = \frac{V_{12} R_2}{R_2 + R_1} = \frac{8 \cdot 24}{24 + 24} = 4\,V$$

ES. ONLINE: Usa Norton

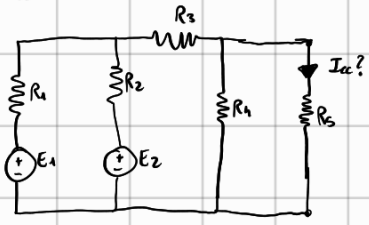


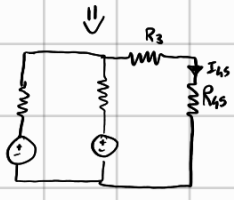
$R = 100\,\Omega$
$E_1 = E_2 = 5V$ I_6?

$I_6 = 7{,}7\,mA$

Per usare Norton ho controll. in tensione? Sì.

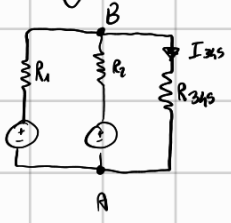
I_{cc}?





$I_{cc} = I_{45}\dfrac{R_4}{R_4 + R_5}$

$R_{45} = 50\,\Omega$



$R_{345} = 150\,\Omega$

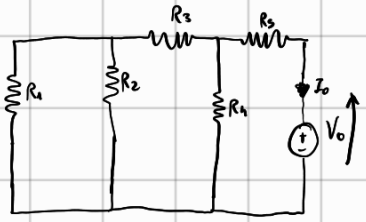
$I_{345} = I_{45}$

$$U_B\left(G_1 + G_2 + G_{345}\right) = E_1 G_1 + E_2 G_2$$

$$U_B = \frac{5\cdot\frac{1}{100} + \frac{3}{100}}{\frac{1}{50} + \frac{1}{150}} = \frac{\frac{1}{20} + \frac{1}{10}}{\frac{2}{75}} = \frac{1}{10}\cdot\frac{75}{2} = \frac{75}{20}V$$

$$I_R = U_B G_{345} = \frac{1}{150}\cdot\frac{75}{20} = \frac{1}{40}\,A$$

$$I_{cc} = \frac{1}{40}\cdot\frac{100}{200} = \frac{1}{80}\,A$$



$G_N = \frac{I_o}{V_o}$ //

$R_{12} = (6{,}16\Omega)^{-1} = 50\,\Omega$

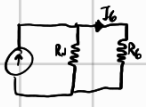
$R_{123} = 150\,\Omega$

$R_{1231} = \left(\frac{1}{150} + \frac{1}{300}\right)^{-1} = \left(\frac{2+1}{300}\right)^{-1} = \frac{300}{3} = 60\,\Omega$

$R_{12345} = 160\,\Omega$

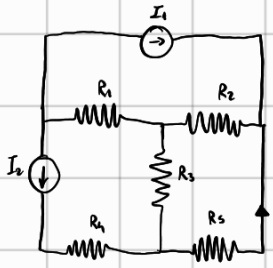
$G_N = \frac{1}{160}\,S$

$I = I_{cc} - G_N V$



$$I_6 = \frac{I_{cc}\,R_N}{R_N + R_6} = \frac{\frac{1}{80}\cdot 160}{160+100} = \frac{2}{260} = \frac{1}{140} = 0{,}0071\,A$$

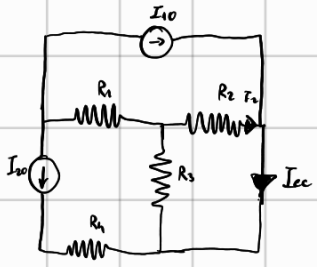
Ok!

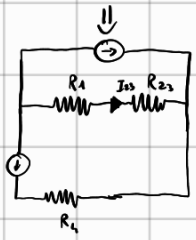


$I_1 = 2A \quad I_2 = 3A \quad R_1 = 7\Omega \quad R_2 = 4\Omega$

$R_3 = 6\Omega \quad R_4 = 5\Omega \quad R_5 = 2\Omega$ Norton:

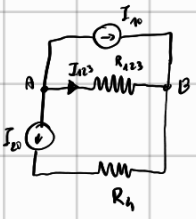
$I_5 = ? \quad P_{gen} = ?$





$I_2 = \frac{I_{23} R_3}{R_2 + R_3}$

$R_{23} = \left(\frac{1}{1} + \frac{1}{6}\right)^{-1} = \frac{12}{5}\Omega$



$R_{123} = \frac{47}{5}\Omega$

WRONG

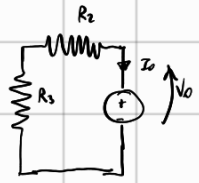
$U_B (G_{123} + G_4) = I_{20} + I_{10}$

$U_B = \frac{I_{10} + I_{20}}{G_{123} + G_4} = \frac{5}{\frac{5}{47} + \frac{1}{5}} = 16{,}3 \text{ V}$

$I_{123} = U_B G_{123} = \frac{5}{47} \cdot 16{,}3 = 1{,}74 \text{ A}$

$I_2 = \frac{1{,}74 \cdot 6}{10} = 1 \text{ A}$

$I_{cc} = I_2 + I_{10} = 1 + 2 = 3 \text{ A}$

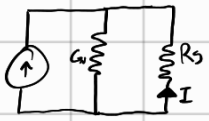


$G_N = (R_2 + R_3)^{-1} = \frac{1}{10}\ S$

$I = I_{cc} - G_N V$

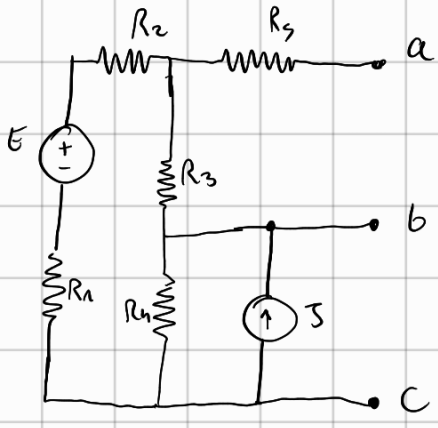
$I = 3 - \frac{1}{10} V$

$R_S = 2\Omega$



$I_S = -I_{cc} \frac{R_N}{R_N + R_S} = -\frac{3 \cdot 10}{10+2} = \frac{-30}{12} = -\frac{15}{6} = -\frac{5}{2} A = -2{,}5\ A$

6.2) Equivalente Thevenin a-b, b-c?

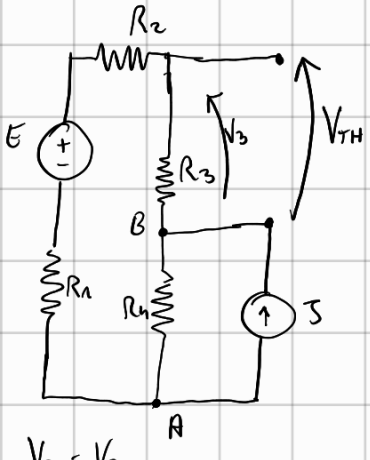


$R_1 = 4\,\Omega$ $R_2 = 6\,\Omega$ $E = 48\,V$

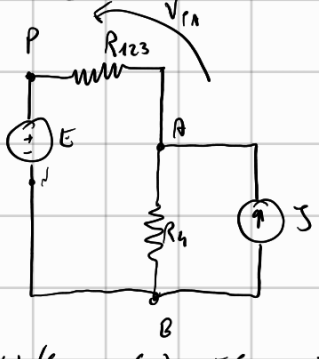
$R_3 = 8\,\Omega$ $R_4 = 10\,\Omega$ $J = 2\,A$

$R_5 = 2\,\Omega$

MORSETTI A-B



$V_{TH} = V_3$



$R_{123} = 18\,\Omega$

$E - V_{PA} - V_{AB} = 0$

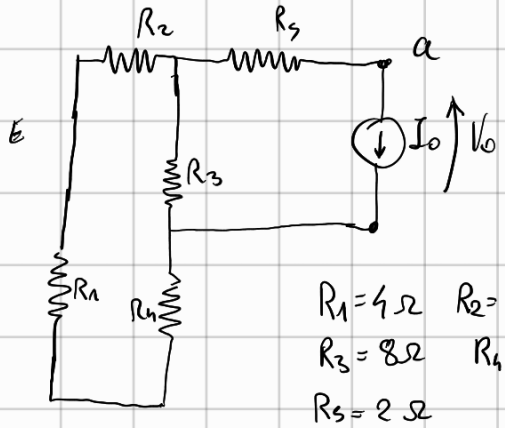
$V_{PA} = E - V_{AB}$

$U_A(G_{123} + G_4) = E G_{123} + J$

$$U_A = \frac{E G_{123} + J}{G_{123} + G_4} = \frac{\frac{48}{18} + 2}{\frac{1}{18} + \frac{1}{10}} = 30\,V$$

$V_{PA} = V_{BA} - E = 48 - 30 = 18\,V$

$$V_3 = \frac{V_{PA} \cdot R_3}{R_3 + R_1 // R_2} = \frac{18 \cdot 8}{18} = 8\,V = V_{TH}$$



$R_1 = 4\,\Omega \quad R_2 = 6\,\Omega$

$R_3 = 8\,\Omega \quad R_4 = 10\,\Omega$

$R_5 = 2\,\Omega$

$R_{14} = R_1 + R_4 = 14\,\Omega$

$R_{124} = 20\,\Omega$

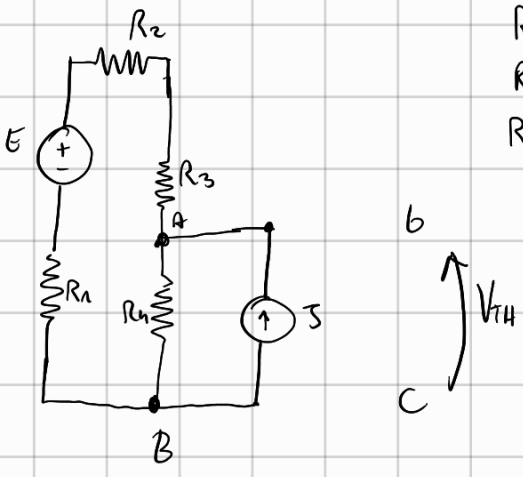
$R_{1234} = \left(G_{124} + G_3\right)^{-1} = \left(\frac{1}{20} + \frac{1}{8}\right)^{-1} = \frac{40}{7}\,\Omega$

$R_{TH} = R_{12345} = R_{1234} + R_5 = \frac{54}{7}\,\Omega$

$V = V_{TH} - R_{TH} I$

$V = 8 - 7{,}7 I$

NOD1 b-c

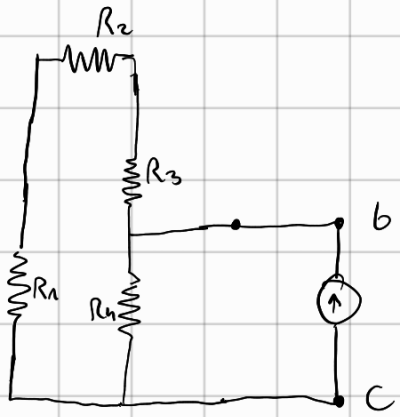


$R_1 = 4\,\Omega \quad R_2 = 6\,\Omega \quad E = 48\,V$

$R_3 = 8\,\Omega \quad R_4 = 10\,\Omega \quad J = 2\,A$

$R_5 = 2\,\Omega$

$U_A = 30\,V \qquad U_A - U_B = 30V = V_{TH}$

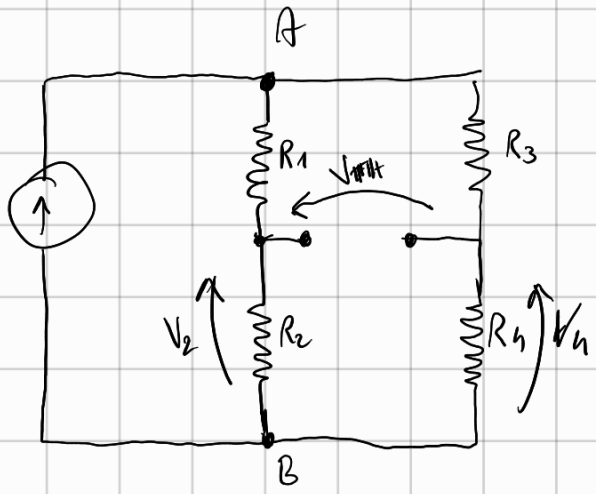


$R_{123} = 18\,\Omega$

$R_{TH} = (G_{123} + G_4)^{-1} = \frac{45}{7}\,\Omega$

Date Roma

6.4)



THEVENIN!

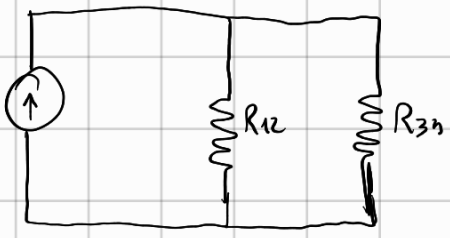
$R_1 = 1\,\Omega$

$R_2 = 5\,\Omega$

$R_3 = 2\,\Omega$

$R_4 = 4\,\Omega$

$I = 8\,A$



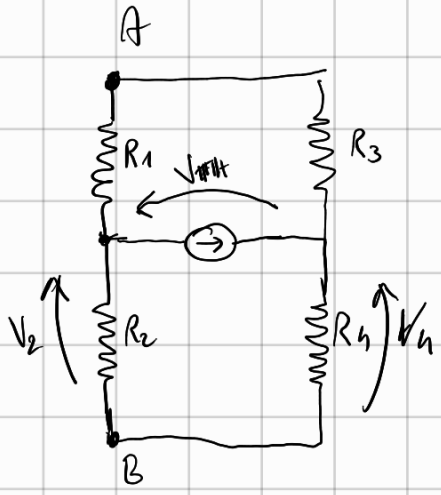
$$V = R_{TOT}\, I = (G_{12} + G_{34})^{-1} I = \left(\frac{1}{6} + \frac{1}{6}\right)^{-1} \cdot 8 = 24\,V$$

$$V_2 = V_{TOT} \cdot \frac{R_2}{R_2 + R_1} = 24 \cdot \frac{5}{6} = 20\,V$$

$$V_4 = V_{TOT} \cdot \frac{R_4}{R_4 + R_3} = 24 \cdot \frac{4}{6} = 16\,V$$

$$V_4 + V_{TH} - V_2 = 0$$

$$V_{TH} = V_2 - V_4 = 4\,V$$



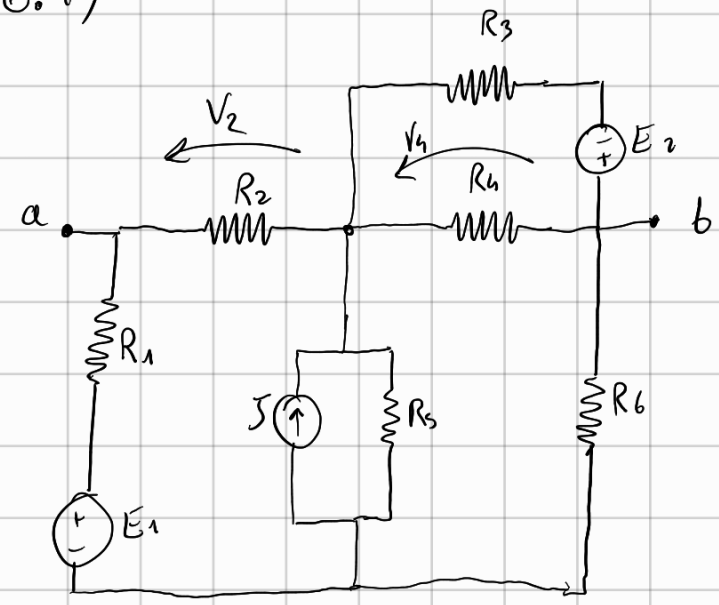
$R_{24} = 9\,\Omega \qquad R_{13} = 3\,\Omega$

$$R_{TH} = (G_{24} + G_{13})^{-1} = \left(\frac{1}{9} + \frac{1}{3}\right)^{-1} = \frac{9}{4}\,\Omega$$

$$G_N = \frac{1}{R_{TH}} = \frac{4}{9}\,S$$

$$I_{CC} = \frac{V_{TH}}{R_{TH}} = \frac{4}{\frac{9}{4}} = \frac{16}{9}\,A$$

6.1)



$R_1 = 1\Omega$

$R_2 = 1\Omega$

$R_3 = 2\Omega$

$R_4 = 2\Omega$

$R_5 = 1\Omega$

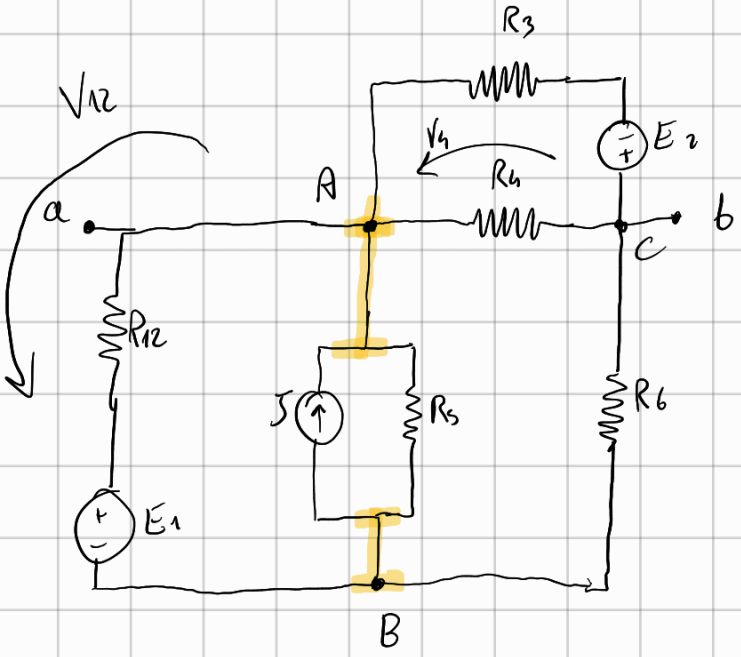
$R_6 = 1\Omega$

THEVENIN

$E_1 = 3V$

$E_2 = 2V$ $J = 5A$

$V_{ab} = V_2 + V_4$



$R_{12} = 2\,\Omega$ $\quad U_A = 0$

$$U_B(G_{12} + G_5 + G_6) - U_C G_6 = -J - E_1 G_{12}$$

$$U_C(G_4 + G_3 + G_6) - U_B G_6 = E_2 G_3$$

$\Rightarrow$

$$5U_B - 2U_C = -13$$

$$2U_C - U_B = 1$$

$$\Rightarrow U_B = 2U_C - 1$$

$$\Rightarrow 10U_C - 5 - 2U_C = -13$$

$$8U_C = -8$$

$$U_C = -1\,V$$

$$U_B = -3V$$

$$\Rightarrow U_A - U_C = 1\,V = V_4$$

$$V_{AB} - V_{12} + E = 0$$

$$V_{12} = E - V_{AB}$$

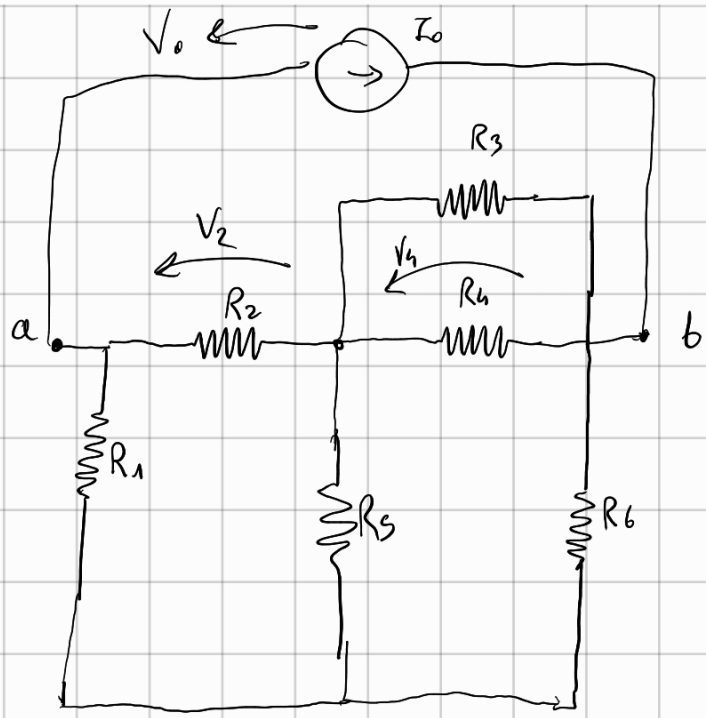
$=$

$$V_{AB} - V_{12} + E_1 = 0$$

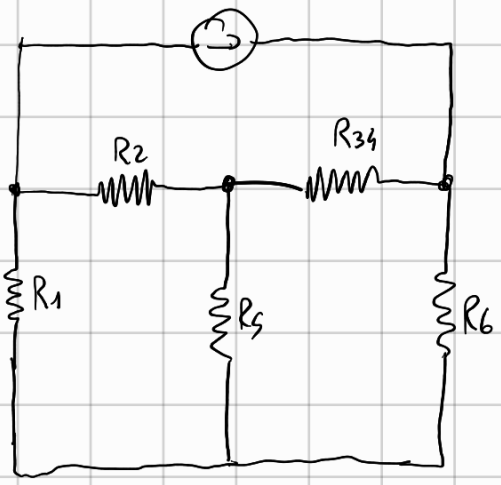
$$V_{12} = E_1 + V_{AB} = 3 + (-3) = 0\,V$$

$$V_2 = V_{12} \cdot \frac{R_2}{R_1 + R_2} = \frac{6 \cdot 1}{2} = 0V$$

$$V_{TH} = 4\,V$$



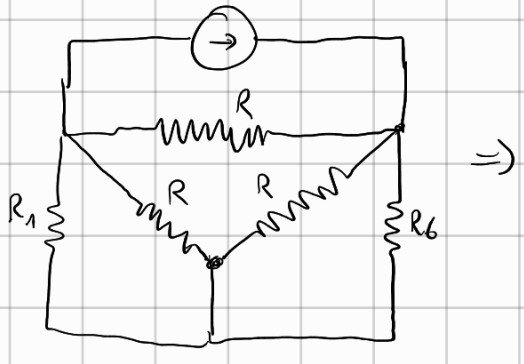
⇓



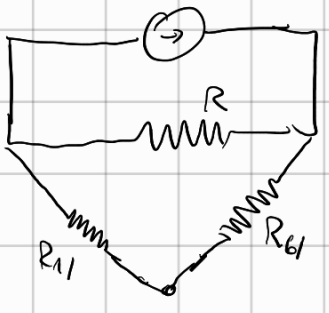
$$R_{34} = (G_3 + G_4)^{-1} = \left(\frac{1}{2} + \frac{1}{2}\right)^{-1} = 1\,\Omega$$

$$R_\Delta = 3R_1 = 3\,\Omega \qquad R = 3\,\Omega$$

⇓



⇒



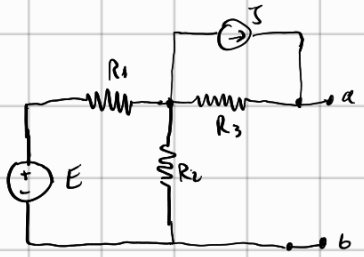
$$R_{11} = \left(\frac{1}{3} + 1\right)^{-1} = \frac{3}{4}\,\Omega$$

$$R_{61} = \frac{3}{4}\,\Omega$$

$$\Rightarrow R_{TOT1} = R_{11} + R_{21} = \frac{3}{2}\,\Omega$$

$$R_{TOTALE} = \left(\frac{2}{3} + \frac{1}{3}\right)^{-1} = 1\,\Omega$$

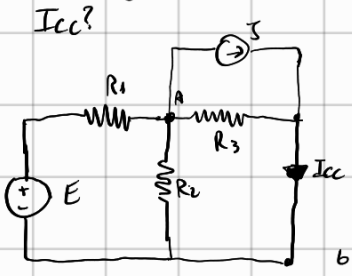
ES. 6.3



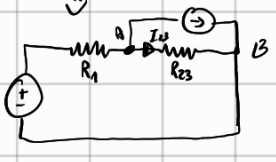
$R_1 = 1\Omega$ $R_3 = 2\Omega$ $J = 3A$ NORTON
$R_2 = 4\Omega$ $E = 4V$

$\Downarrow$

I_{cc}?



$\Downarrow$



$R_{23} = \left(\frac{1}{2} + \frac{1}{4}\right)^{-1} = \frac{4}{3}\Omega$

$U_A(G_1 + G_{23}) = EG_1 - J$

$U_A = \frac{4 \cdot 1 - 3}{1 + \frac{3}{4}} = \frac{1}{\frac{7}{4}} = \frac{4}{7} V$

$I_{23} = (U_A - U_B) G_{23} = -\frac{4}{7} \cdot \frac{3}{4} = +\frac{3}{7} A$

$I_3 = \frac{I_{23} R_2}{R_2 + R_3} = \frac{+\frac{3}{7} \cdot 4}{6} = +\frac{2}{7} A$

$I_{cc} = J + I_3 = 3 + \frac{2}{7} = \frac{23}{7} A$

$I = J - GV$

$V = JR - RI$

$\uparrow \quad \uparrow$

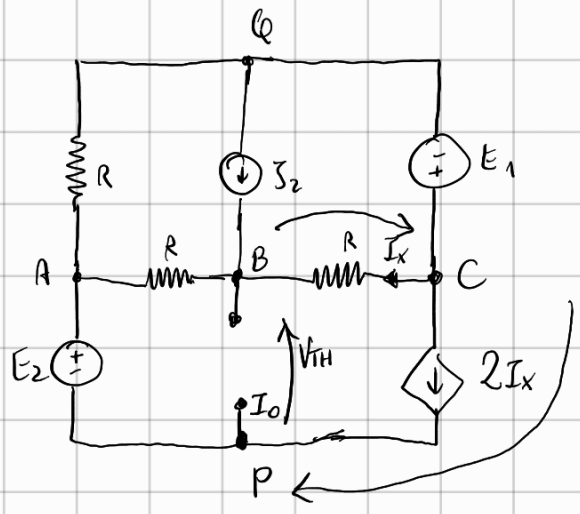
V_{TH}

$R_{12} = (G_1 + G_2)^{-1} = \frac{4}{5}\,\Omega$

$R_{123} = \frac{14}{5}\,\Omega \Rightarrow G_N = \frac{5}{14}\,S$

ES. di Bro 💀

THEVENIN



$R=1$

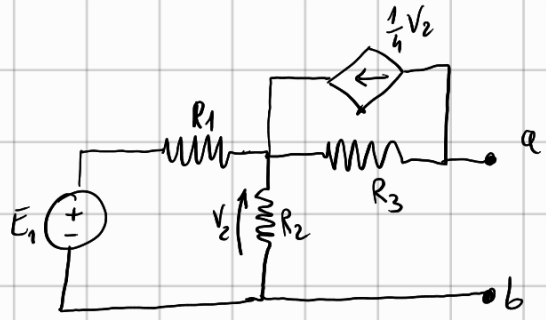
$I_2=4A \quad E_2=6V \quad E_1=12V$

ASK!

$U_B=0$

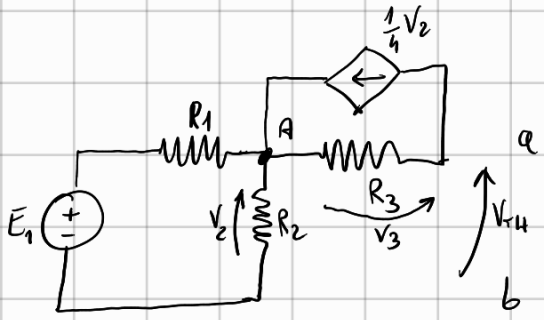
$U_A(G+G)+U_C G$

ES. 4A



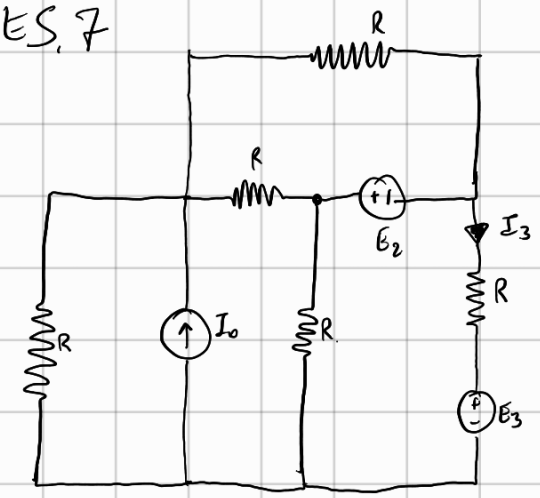
$R_1 = 6\Omega$ $R_2 = 3\Omega$ $R_3 = 2\Omega$

$E_1 = 18\,V$ THEVENIN



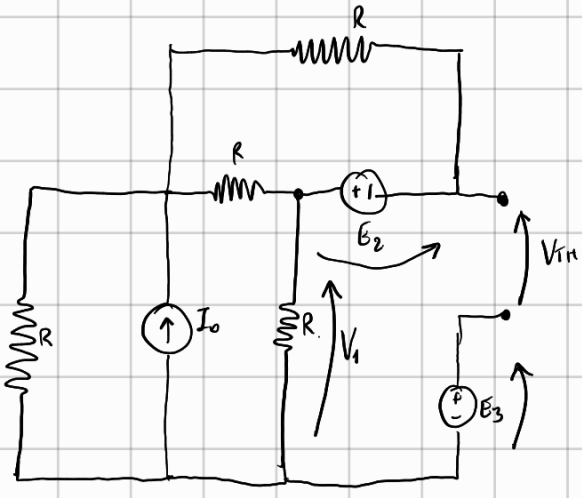
$V_{TH} = V_2 + V_3$

ES. 7

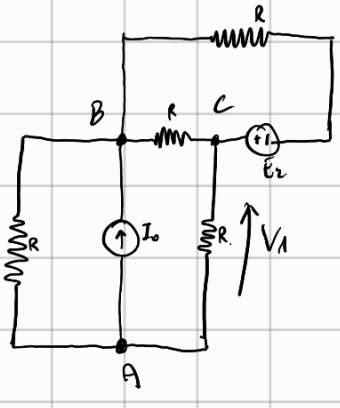


$R_0 = R_1 = R_2 = R_3 = R_4 = 2\,\Omega$

$I_0 = 15\,A \qquad E_2 = E_3 = 1\,V \qquad I_3 = ?$



$V_{TH} + E_3 - V_1 - E_2 = 0 \Rightarrow V_{TH} = V_1 + E_2 - E_3$



$3U_B G - U_C G = J_0 - E_2 G$

$3U_C \not{G} - U_B \not{G} = E_2 \not{G} \Rightarrow U_B = 3U_C - E_2$

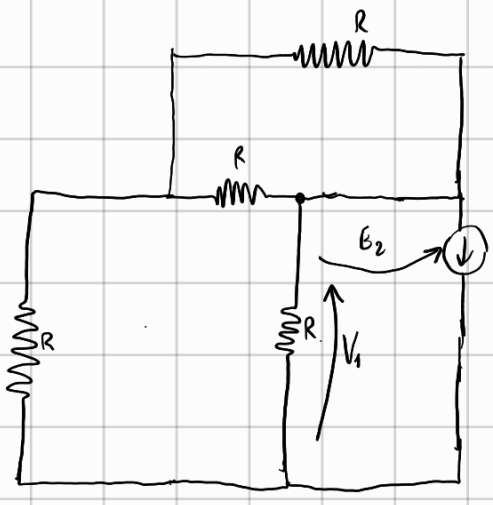
$\Rightarrow 9U_C G - 3E_2 G - U_C G = J_0 - E_2 G$

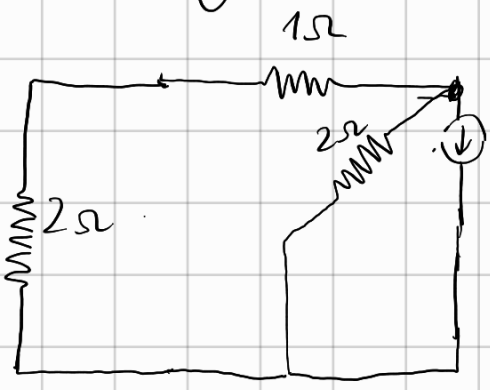
$8U_C G = 2E_2 G + J_0$

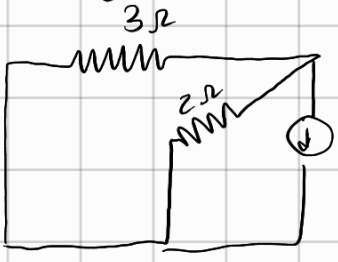
$\Rightarrow U_C = \frac{E_2}{4} + \frac{J_0}{8G} = \frac{1}{4} + \frac{15}{4} = 4\,V$

$U_B = 1V \Rightarrow V_1 = U_C = 4V$

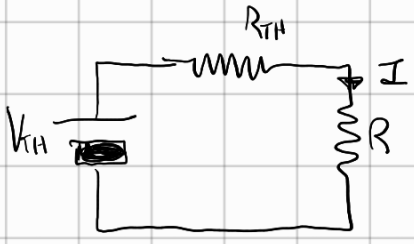
$V_{TH} = 4 + 1 - 1 = 4V$





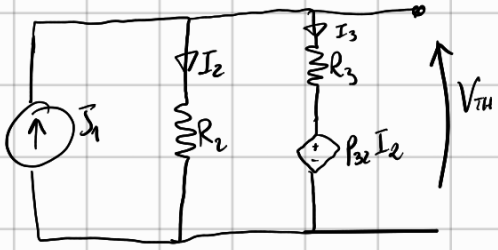


$$R_{TH} = \left(\frac{1}{3} + \frac{1}{2}\right)^{-1} = \left(\frac{2+3}{6}\right)^{-1} = \frac{6}{5}\Omega$$

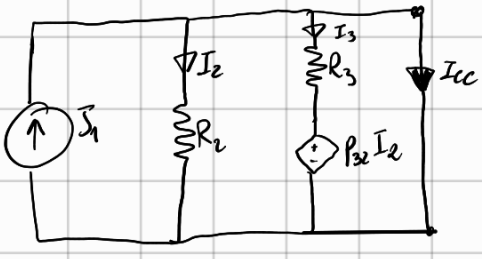


$$I = \frac{V_{TH}}{R_{TH}+R} = \frac{4}{\frac{6}{5}+2} = \frac{4}{\frac{16}{5}} = \frac{20}{16} = \frac{5}{4}$$

ES. ESAME

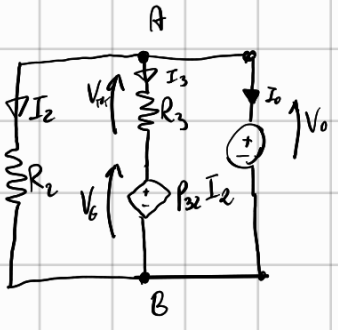


NORTON



Tensione ai capi del parallelo è 0.

$I_{CC} = J_1$



$U_A = V_0 \quad U_B = 0$

$I_2 = G_2 V_0$

$\Rightarrow V_G = \beta_{32} G_2 V_0$

$V_3 = V_0 - V_G = V_0 (1 - \beta_{32} G_2)$

$I_3 = G_3 V_0 (1 - \beta_{32} G_2)$

$I_0 = -I_3 - I_2 = -G_3 V_0 (1 - \beta_{32} G_2) - G_2 V_0$

$G_N = \frac{I_0}{V_0} = -G_3 (1 - \beta_{32} G_2) - G_2$

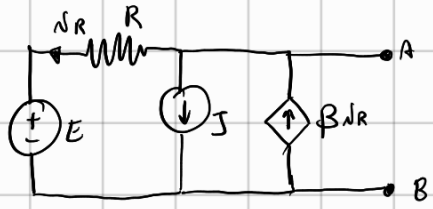
$I = J_1 - [G_2 + G_3 (1 - \beta_{32} G_2)] V$

$R_{TH} = \frac{1}{G_N} = \left[\frac{1}{R_2} + \frac{1}{R_3} \left(1 - \beta_{32} \frac{1}{R_2}\right) \right]^{-1} =$

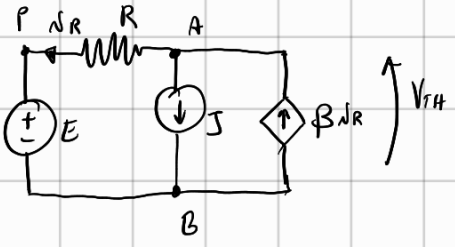
$= \left[\frac{1}{R_2} + \frac{1}{R_3} - \frac{\beta_{32}}{R_2 R_3} \right]^{-1} =$

$$= \left[\frac{R_3 + R_2 - P_{32}}{R_2 R_3} \right]$$

6.1)



THEVENIN:

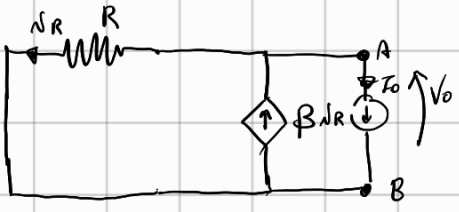


$\lambda_R = (U_A - E)G$

$$U_A G = EG - J + \beta G(U_A - E)$$

$$G U_A (1-\beta) = EG - J - \beta GE$$

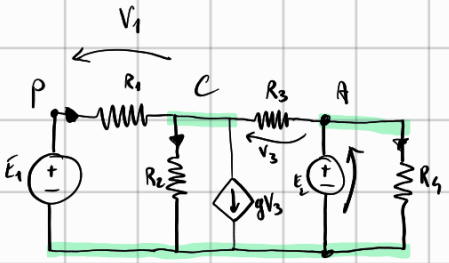
$$U_A = \frac{E}{1-\beta} - \frac{J}{G(1-\beta)} - \frac{E\beta}{1-\beta} = E - \frac{J}{G(1-\beta)}$$



$$U_A G = -I_0 + \beta U_A G$$

$$U_A G(1-\beta) = -I_0$$

$$U_A = \frac{-I_0}{G(1-\beta)} \Rightarrow R_{TH} = -\frac{1}{G(1-\beta)}$$



$E_1 = 12V \quad E_2 = 12V$

$R_1 = 4\Omega \quad R_2 = 2\Omega$

$R_3 = 4\Omega \quad R_4 = 6\Omega$

$g = \frac{1}{2} S$

$U_B = 0 \quad U_A = 12V$

$U_C(G_1 + G_2 + G_3) - U_A G_3 = E_1 G_1 - gV_3$

$U_C\left(\frac{1}{4} + \frac{1}{2} + \frac{1}{4}\right) - 12 \cdot \frac{1}{4} = 12 \cdot \frac{1}{4} - \frac{1}{2}(U_C - 12)$

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

$\frac{3}{2}U_C = 12$

$\Rightarrow U_C = 8V$

$I_3 = G_3(U_C - U_A) = -1\,A$

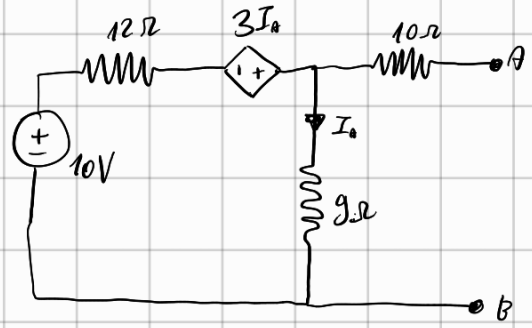
$-V_1 = U_C - U_P = U_C - E_1 = 8 - 12 = -4A \Rightarrow V_1 = 4A$

$I_1 = +1\,A$

$I_2 = G_2 U_C = 4A$

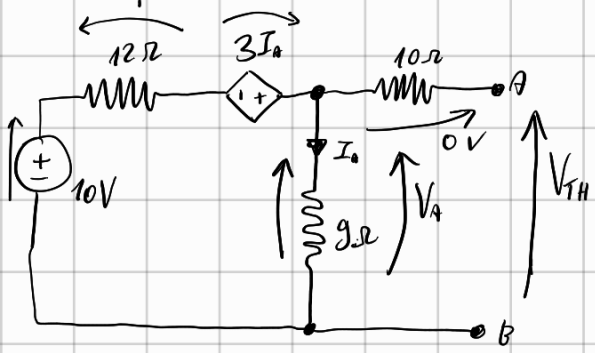
$I_4 = G_4 U_A = 2A$

1)



THEVENIN: Non ho vaghi ca prob. di corrente.

Lasso aperto e stesso Versore.



$V_{TH} = V_A$

$E - R_1 I_A + 3I_A - R_2 I_A = 0$

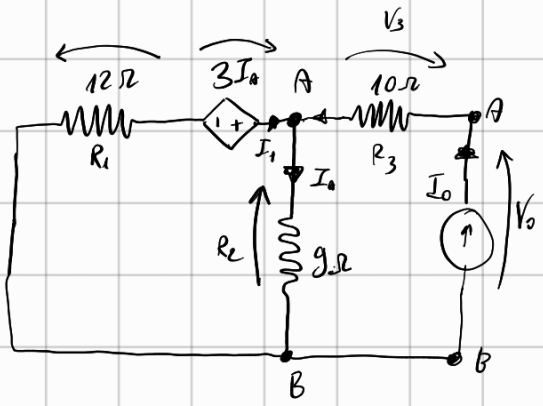
$E = I_A(R_1 + R_2 - 3)$

NOTA: Se $3 = R_1 + R_2$ perdo controllabilità di corrente

$I_A = \frac{10}{18} = \frac{5}{9} A$

$V_A = R_A I_A = 5V = V_{TH}$

Calcolo R_{TH}



$$\begin{cases} I_1 + I_0 - I_A = 0 \\ -R_1 I_1 + 3I_A - R_2 I_A = 0 \\ R_2 I_A + R_2 I_0 - V_0 = 0 \end{cases}$$

$I_A = I_1 + I_0$

$\Rightarrow -R_1 I_1 + 3I_1 + 3I_0 - R_2 I_1 - R_2 I_0 = 0$

Suppose $I_0 = 1A$

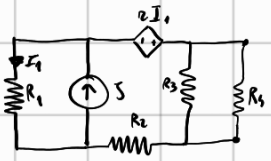
$I_1(3 - R_1 - R_2) = R_2 - 3$

$I_1 = \frac{6}{-18} = -\frac{1}{3} A$

$I_A = -\frac{1}{3} + 1 = \frac{2}{3} A$

$V_0 = 9 \cdot \frac{2}{3} + 10 = 16V \rightarrow R_{TH} = 16\Omega$

2.16)



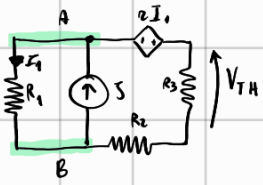
$R_1 = R_2 = 2\,\Omega$

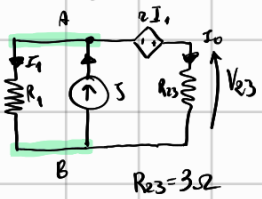
$R_3 = R_4 = 1\,\Omega$

$\alpha = 2$

$J = 1\,A$

THEVENIN:





$R_{23} = 3\,\Omega$

$I_1 = U_A G_1 = \frac{3}{7}$

NODO A:

$J - I_1 - I_0 = 0$

$I_0 = J - I_1 = \frac{4}{7}\,A$

$V_{23} = R_{23} I_0 = 3 \cdot \frac{4}{7} = \frac{12}{7}\,V$

$V_3 = \frac{V_{23} R_3}{R_2 + R_3} = \frac{4}{7}\,V = V_{TH}$

$U_B = 0$

$U_A (G_1 + G_{23}) = J - (2I_1) G_{23}$

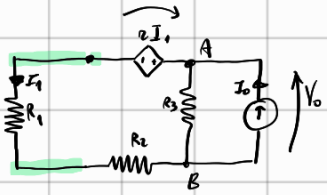
$U_A (G_1 + G_{23}) = J - G_{23} 2 U_A G_1$

$U_A (G_1 + G_{23} + G_1 G_{23} 2) = J$

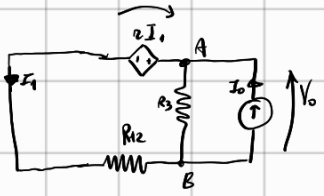
Nota: $G_1 + G_{23} + G_1 G_{23} 2 \neq 0$ per avere controllabilità.

$U_A \left(\frac{1}{2} + \frac{1}{3} + \frac{1}{6} \cdot 2\right) = 1$

$U_A = \frac{1}{\left(\frac{1}{2} + \frac{2}{3}\right)} = \frac{6}{7}\,V$

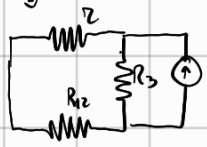


⇓



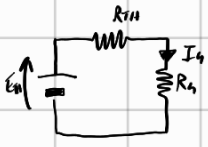
Il generatore controllato si comporta come Resistore.

⇓



$R_T = R_{12} + 2 = 6\,\Omega$

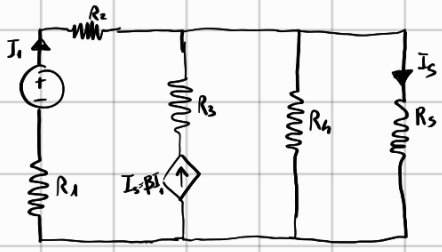
$R_{TH} = \left(\frac{1}{R_T} + \frac{1}{R_3}\right)^{-1} = \left(\frac{1}{6} + 1\right)^{-1} = \frac{6}{7}\,\Omega$



$I_4 = \frac{E_{TH}}{R_{TH} + R_4} = \frac{\frac{4}{7}}{\frac{6}{7} + 1} = \frac{4}{7}\cdot\frac{7}{13} = 0{,}31\,A$

□

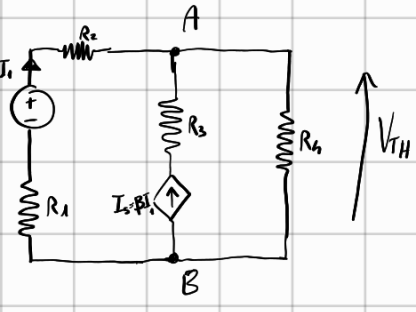
1)

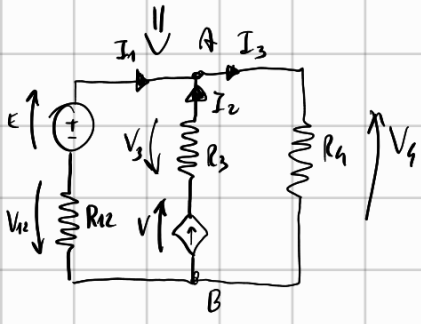


$E = 10\,V \quad \beta = 10 \quad R_1 = 10\,k\Omega \quad R_2 = 10\,k\Omega$

$R_3 = 20\,k\Omega \quad R_4 = 20\,k\Omega \quad R_5 = k\Omega$

Thevenin: Non ho problemi di corrente.





$I_1 + I_2 = I_3$

$E + V_3 - V - V_{12} = 0$

$V_3 + V_4 - V = 0$

$V_{12} = G_{12} I_1$

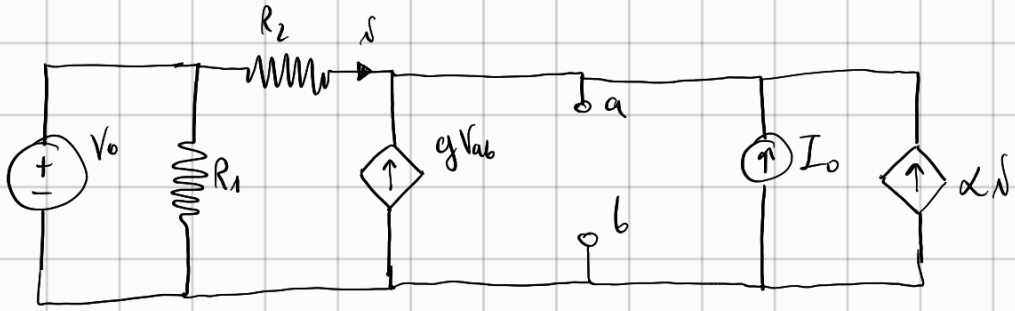
$V_3 = G_3 I_2$

$I_2 = \beta I_1$

$V_3 = G_3 I_2$

$V_4 = G_4 I_3$

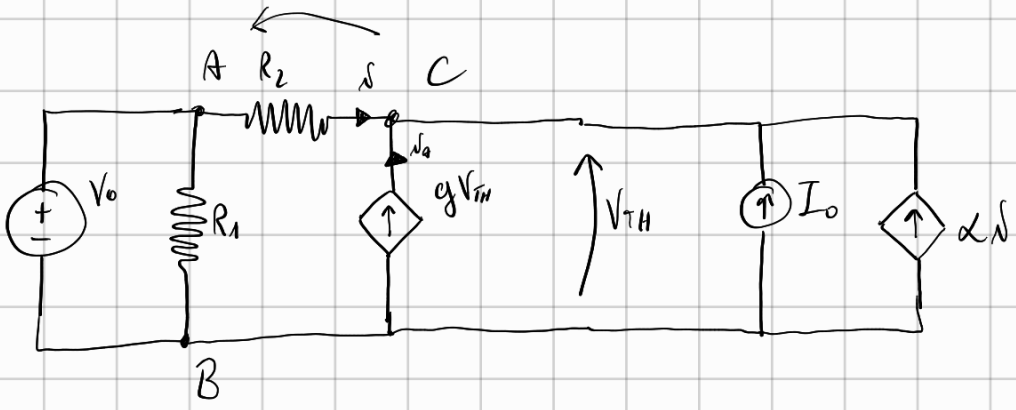
1.2)



$V_0 = 50V$ $R_1 = 50\Omega$ $g = 20mS$

$I_0 = 2A$ $R_2 = 100\Omega$ $\alpha = 3$ $R_L = 200\Omega$

Posso applicare TH.



$U_B = 0$

$U_A = 50V$

$$U_C G_2 - U_A G_2 = g U_C + I_0 + \alpha G_2 (U_A - U_C)$$

$$U_C G_2 - U_A G_2 = g U_C + I_0 + \alpha G_2 U_A - \alpha G_2 U_C$$

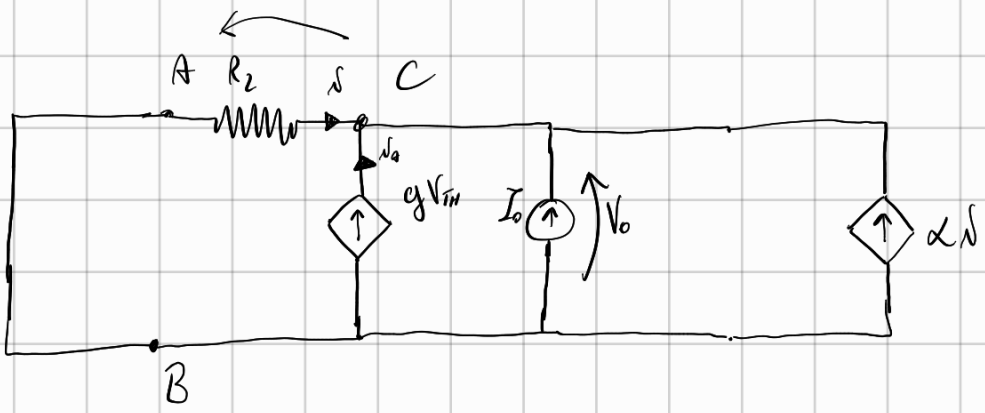
$$U_C (G_2 - g + \alpha G_2) - U_A G_2 = I_0 + \alpha G_2 U_A$$

$$U_C = \frac{I_0 + \alpha G_2 U_A + U_A G_2}{G_2(\alpha+1) - g}$$

Perdo controll. se $g = G_2(\alpha+1)$

$$V_C = \frac{2 + 3 \cdot 50 \cdot \frac{1}{100} + 50 \cdot \frac{1}{100}}{\frac{1}{100}(4) - \frac{1}{50}} = \frac{2 + \frac{3}{2} + \frac{1}{2}}{\frac{1}{50}} = \frac{4}{\frac{1}{50}} = 200\,V$$

$V_{TH} = 200\,V$



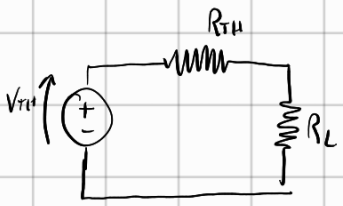
$$V_C G_2 = g V_C + I_0 - \alpha G_2 V_C$$

$$V_C (G_2 - g + \alpha G_2) = I_0$$

$$V_C = \frac{I_0}{G_2 - g + \alpha G_2} \rightarrow \neq 0$$ circuito non è con

$$R_{TH} = \frac{1}{G_2 - g + \alpha G_2} = \frac{1}{\frac{1}{100} - \frac{1}{50} + 3 \cdot \frac{1}{100}} = 50\,\Omega$$

⇒ EQUIVALENTE:

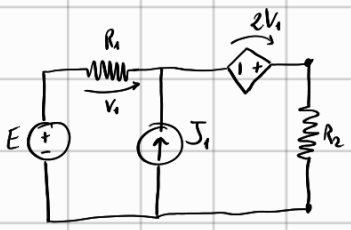


$$I = \frac{V_{TH}}{R_{TH}+R_L} = \frac{200}{250} = \frac{4}{5}\,A$$

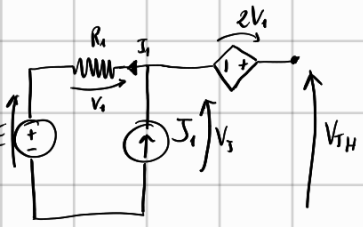
$$P = V_{TH}\,I = 200 \cdot \frac{4}{5} = 160\,W$$

Good Job!

5.41)



Applico Thevenin!



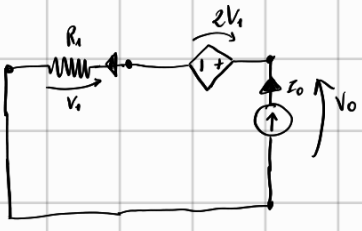
$V_{TH} = V_J + 2V_1$

$V_1 = R_1 I_1 = R_1 J_1 = 3V$

$E + V_1 - V_J = 0 \Rightarrow V_J = V_1 + E$

$\Rightarrow V_J = 3 + 18 = 21\,V$

$\Rightarrow V_{TH} = 21 + 6 = 27V$

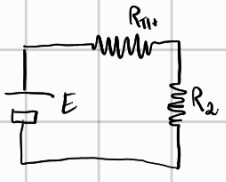


$V_1 = R_1 I_0$

$\Rightarrow V_0 - 2V_1 - V_1 = 0$

$V_0 = 3V_1 = 3R_1 I_0$

$\Rightarrow R_{TH} = 3R_1$



$I_2 = \frac{E}{R_{TH}+R_2} = \frac{27}{9} =$

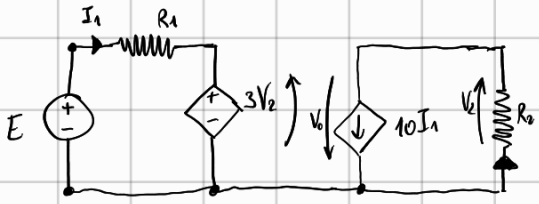
$3A$

5.41)

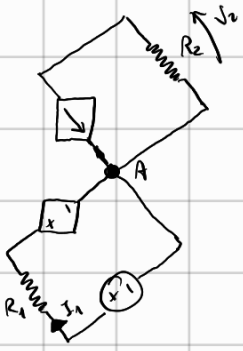
THÉVENIN $R_1 = 1000\ \Omega$

$R_2 = 12\ \Omega$ $R_3 = 24\ \Omega$

$E = 48\ V$



$V_2 = V_{TH}$

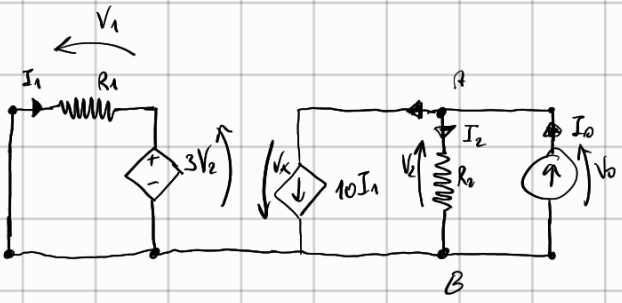


$E - V_1 - 3V_2 = 0 \rightarrow E - R_1 I_1 + 3R_2(10I_1) = 0 \rightarrow E = R_1 I_1 - 30 R_2 I_1$

$V_2 + V_0 = 0 \qquad 10 R_2 I_1 + V_0 = 0$

$\Rightarrow I_1 = \frac{E}{R_1 - 30R_2} = \frac{48}{1000 - 360} = \frac{48}{640} = \frac{3}{40}\ A$

$V_2 = 10 R_2 I_1 = \frac{103}{40} \cdot 12 = 9\ V$



$3V_2 + V_1 = 0 \qquad 3R_2 I_2 + I_1 R_1 = 0$

$V_x + V_2 = 0 \Rightarrow V_x + I_2 R_2 = 0$

$V_x + V_0 = 0$

$I_2 = V_0 G_2$

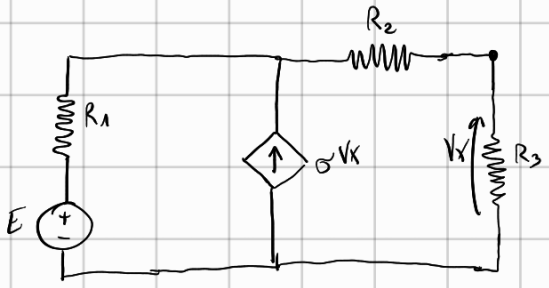
$\Rightarrow I_1 = -\frac{3R_2}{R_1} I_2 = -\frac{3R_2}{R_1} V_0 G_2$

$$I_o = I_2 + 10 I_1 = V_o G_2 \left(1 - \frac{30 R_2}{R_1}\right)$$

$$\Rightarrow R_{TH} = \frac{V_o}{I_o} = \frac{1}{G_2\left(1 - \frac{30R_2}{R_1}\right)} = \frac{1}{\frac{1}{12}\left(1 - \frac{30 \cdot 12}{1000}\right)} = \frac{1}{\frac{1}{12}\left(\frac{16}{25}\right)} = \frac{25}{16} \cdot 12 = \frac{75}{4}\,\Omega$$

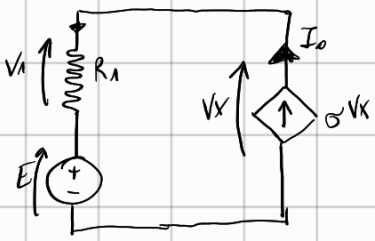
$$\Rightarrow I_3 = \frac{E_{TH}}{R_{TH} + R_3} = \frac{9}{\frac{75}{4} + 24} = 0{,}21\,A$$

5.44)



$E=10V \quad \sigma=0,1S \quad R_1=5\Omega \quad R_2=8\Omega \quad R_3=14\Omega$

THÉVENIN



$V_x = V_{TH}$

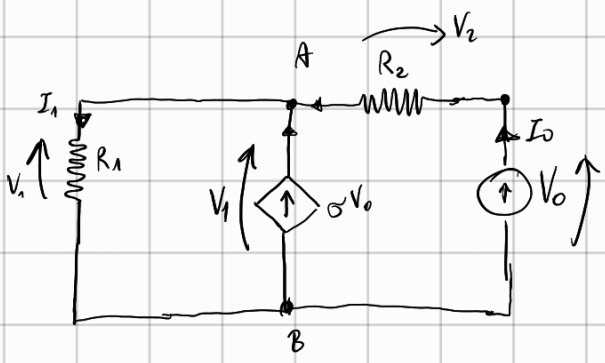
$E + V_1 - V_x = 0$

Se $R_1\sigma - 1 = 0$ collegamento proib.

$E + R_1\sigma V_x - V_x = 0$

$V_x(R_1\sigma - 1) = -E$

$V_x = \frac{E}{1-R_1\sigma} = \frac{10}{1-\frac{5}{10}} = \frac{10}{\frac{1}{2}} = 20V = V_{TH}$



$V_1 + V_2 - V_o = 0 \quad \Rightarrow R_1 I_1 + R_2 I_o - V_o = 0$

$I_o + \sigma V_o - I_1 = 0 \quad I_1 = I_o + \sigma V_o$

$\Rightarrow \quad R_1 I_o + R_1\sigma V_o + R_2 I_o - V_o = 0$

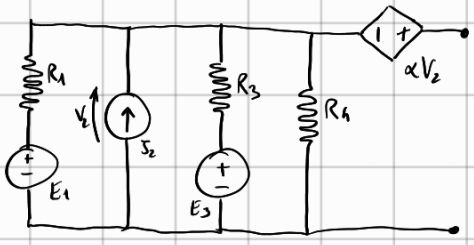
$V_o(1 - R_1\sigma) = R_1 I_o + R_2 I_o$

$V_o = \frac{I_o(R_1+R_2)}{1-R_1\sigma} \rightarrow R_{TH} = \frac{R_1+R_2}{1-R_1\sigma} = \frac{13}{1-\frac{1}{2}} = 26\Omega$

$I_3 = \frac{E_{TH}}{R_{TH}+R_3} = \frac{20}{26+14} = 0,5A$

Good Sob!

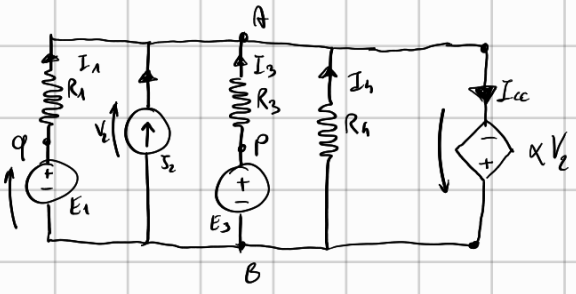
Quesito 1)



$R_1 = 1K\Omega \quad R_3 = 1K\Omega \quad R_4 = 1K\Omega$

$\alpha = -\frac{1}{2} \quad E_1 = 20V \quad E_3 = 20V \quad J_2 = 10mA$

Posso applicare Norton: Non ho maglie.



$U_A = V_2$

$-U_A = \alpha V_2 \Rightarrow U_A = 0$

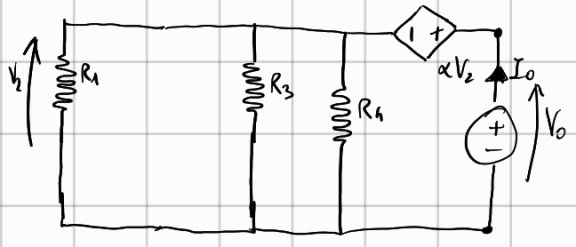
$\Downarrow$

$U_q = 20V \quad U_P = 20V$

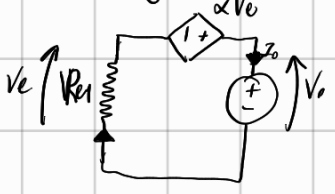
$I_{cc} = I_1 + J_2 + I_3 + \overset{0}{I_4}$

$I_{cc} = \frac{U_q}{R_1} + J_2 + \frac{U_P}{R_3} = 0{,}05A$

G.EQ?



$\Downarrow \rightarrow \alpha V_e$

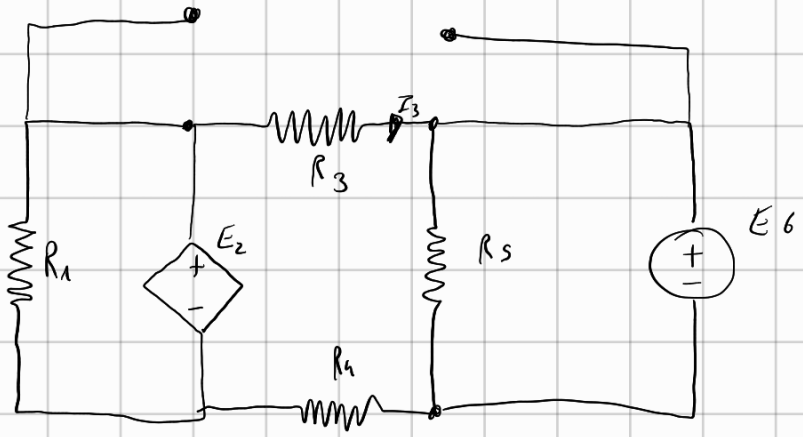


$R_e = \left(\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_4}\right)^{-1} = \frac{1000}{3}$

$-R_e I_o + \alpha(-R_e I_o) - V_o = 0$

$V_o = 1V \Rightarrow R_e I_o (-1-\alpha) = 1 \rightarrow I_o = \frac{1}{R_e(-1-\alpha)} = \frac{1}{R_e(-\frac{1}{2})} = -\frac{2}{R_e} = \frac{-6}{1000} = -6mS$

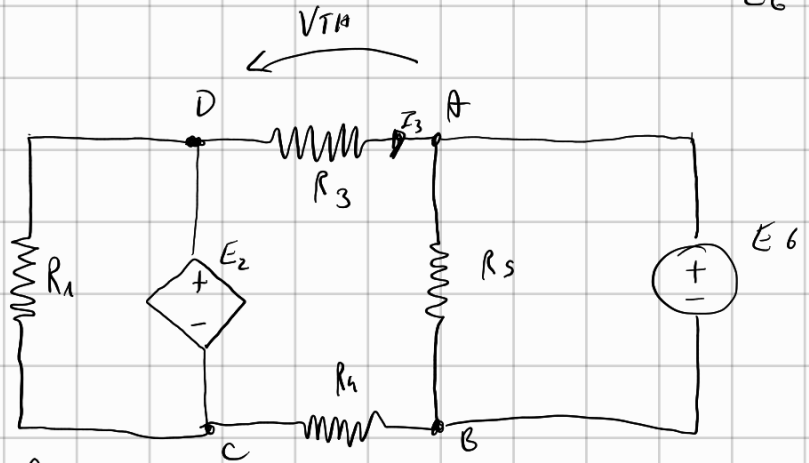
1)



THEVENIN:

$R_1 = 3\Omega$ $R_3 = 3\Omega$ $R_4 = 2\Omega$ $R_5 = 1\Omega$ $E_2 = \alpha I_3$ $\alpha = 2\Omega$

$E_6 = 2V$



Lascio circuito aperto. $V_{TH} = V_3$.

$U_B = 0$ $U_A = 2V$

$U_D - U_C = \alpha I_3 \Rightarrow U_D - U_C = \alpha (U_D - 2) G_3$

$U_D (G_3 + G_1) - U_A G_3 - U_C G_1 = 0$

$U_C (G_1 + G_4) - U_D G_1 = -N$

$\downarrow$

$U_D G_3 + U_D G_1 - U_A G_3 - U_C G_1$

$+ U_C G_1 + U_C G_4 - U_D G_1 = 0$

$U_D G_3 + U_C G_4 = \frac{2}{3}$

$\frac{U_D}{3} + \frac{U_C}{2} = \frac{2}{3}$

$2U_D + 3U_C = 4$

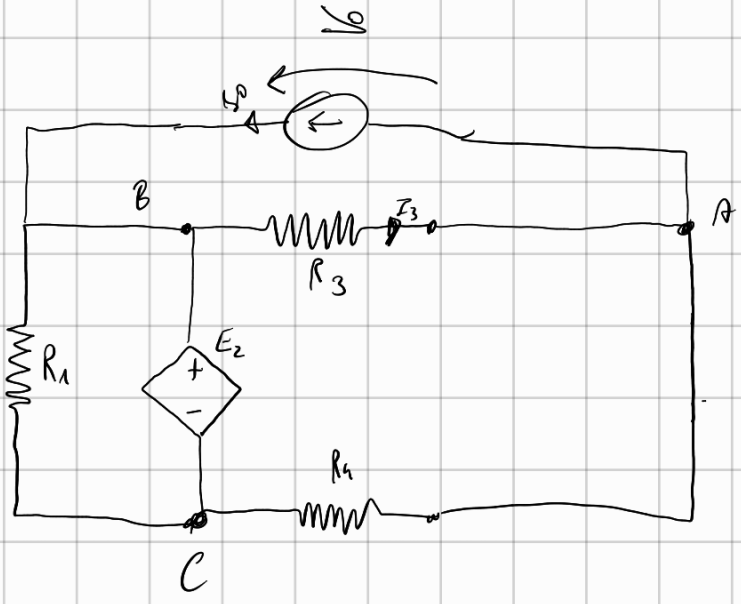
$$\begin{cases} U_D(1-\alpha G_3) - U_C = -2\alpha G_3 \end{cases}$$

$$\begin{cases} \frac{U_D}{3} - U_C = -\frac{4}{3} \end{cases} \Rightarrow \begin{cases} U_D - 3U_C = -4 \\ 2U_D + 3U_C = 4 \end{cases}$$

$U_D = 0$

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

$V_{TH} = -2V$



$U_C = 0$ $\qquad U_B = \alpha I_3 = \alpha (U_B - U_A) G_3$

$U_A (G_3 + G_4) - U_B G_3 = -J_0$

$$\Rightarrow \begin{cases} U_B(1-\alpha G_3) + U_A \alpha G_3 = 0 \\ U_B G_3 - U_A(G_3+G_4) = J_0 \end{cases}$$

$R_1 = 3\Omega$ $\quad R_3 = 3\Omega$ $\quad R_4 = 2\Omega$ $\quad R_S = 1\Omega$ $\quad E_2 = \alpha I_3$ $\quad \alpha = 2\Omega$

$E_G = 2V$

$$\begin{cases} \frac{U_B}{3} + U_A \frac{2}{3} = 0 \\ \frac{U_B}{3} - \frac{5U_A}{6} = 1 \end{cases}$$

$I_0 = 1A$

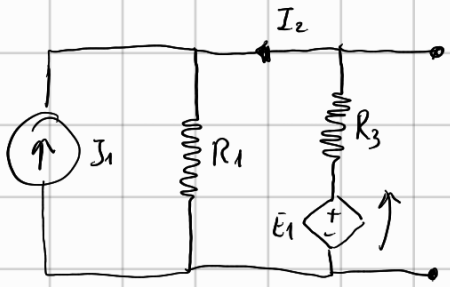
$$\begin{cases} U_B + 2U_A = 0 \\ 2U_B - 5U_A = 6 \end{cases}$$

$U_B = \frac{4}{3} \quad U_A = -\frac{2}{3}$

$V_0 = U_B - U_A = 2V \Rightarrow R_{TH} = 2\Omega$

$V = V_{TH} - R_{TH} I = -2 - 2I$

1)

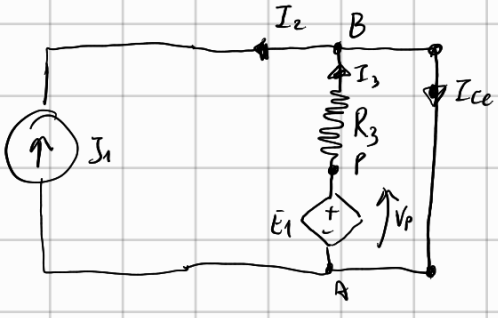


$E_1 = r_{32} I_2$ $\quad R_1 = 10K\Omega$ $\quad R_3 = 2K\Omega$ $\quad J_1 = 10mA$

$r_{32} = 15K\Omega$

THEVENIN

Calcolo morlan e convento in Thevenin

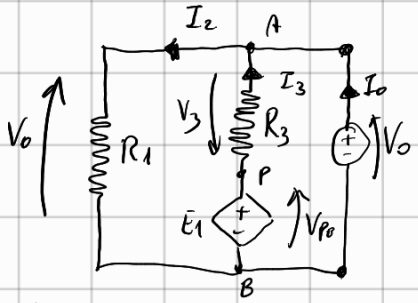


$V_P = r_{32} I_2 = r_{32} (-J) = -10mA \cdot 15K\Omega = -150V$

$V_{BA} = 0 \Rightarrow V_{PB} = V_{PA} = -150V$

$I_3 = V_{PB} G_3 = -7,5mA$

$I_{cc} = J_1 + I_3 = 10mA - 7,5mA = 2,5mA$



$R_1 = 10K\Omega \quad R_3 = 20K\Omega \quad J_1 = 10mA$

$R_{23} = 15K\Omega$

$V_0 = 1V$

$I_2 = V_0 G_1 = \frac{1}{10K\Omega} = 0,1mA$

$V_{PB} = I_2 R_{23} = 0,1mA \cdot 15K\Omega = 1,5V$

$V_0 + V_3 - V_{PB} = 0 \Rightarrow V_3 = V_{PB} - V_0 = 0,5V$

$I_3 = V_3 G_3 = \frac{0,5V}{20000\Omega} = 2,5 \cdot 10^{-5} A = 25\mu A \qquad I_0 = I_2 - I_3 = 7,5 \cdot 10^{-5} A$

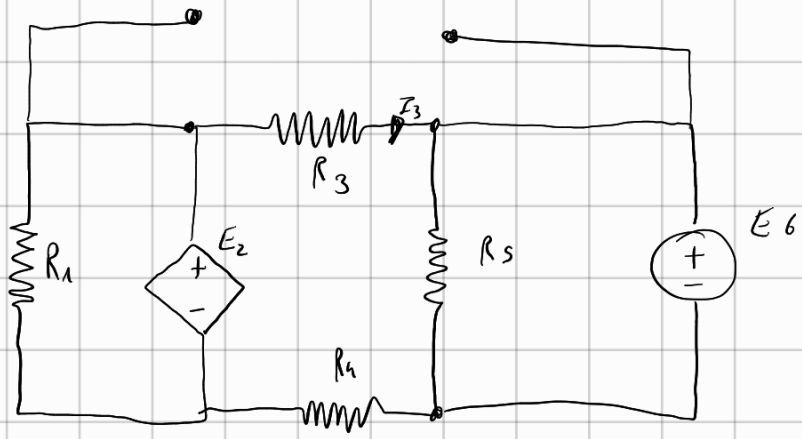
$\Rightarrow G_N = 75\mu S \qquad R_{TH} = \frac{1}{G_N} = \frac{40000}{3}\Omega$

$I = I_{cc} - G_N V \Rightarrow I = 2,5mA - 25\mu S \cdot V$

$V = \frac{I_{cc}}{G_N} - \frac{I}{G_N} \Rightarrow V_{TH} = \frac{I_{cc}}{G_N} = \frac{2,5 \cdot 10^{-3}}{75 \cdot 10^{-6}} = \frac{100}{3} V$

RIFACCIO 1)

1)

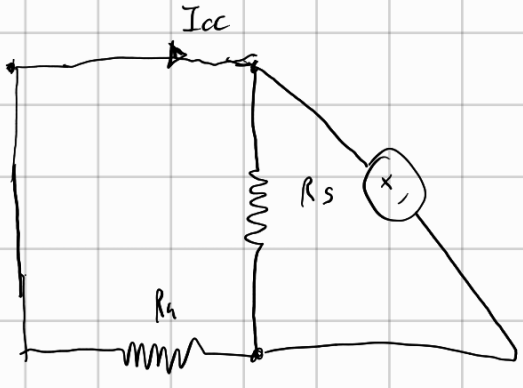


THEVENIN:

$R_1 = 3\Omega$ $R_3 = 3\Omega$ $R_4 = 2\Omega$ $R_5 = 1\Omega$ $E_2 = \alpha I_3$ $\alpha = 2\Omega$

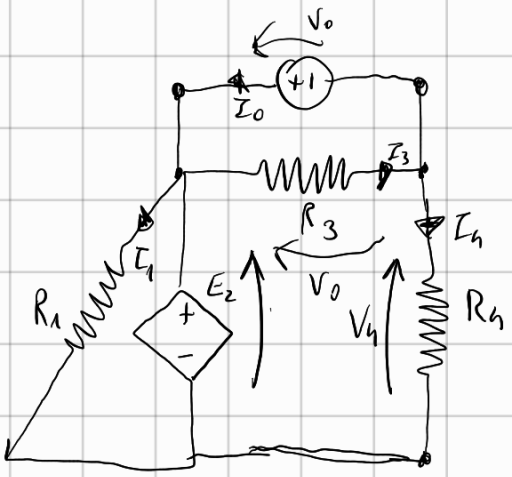
$E_6 = 2V$

NORTON:



E_6

$I_{cc} = -E_6 G_4 = -1A$



$V_0 = 1\,V$

$I_3 = V_0 G_3 = \frac{1}{3}\,A$

$E_2 = \alpha I_3 = \frac{2}{3}\,V$

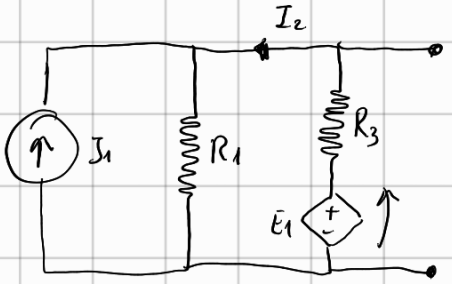
$I_1 = E_2 G_1 = \frac{2}{3} \cdot \frac{1}{3} = \frac{2}{9}\,A$

$E_2 - V_0 - V_4 = 0 \Rightarrow V_4 = \frac{2}{3} - 1 = -\frac{1}{3}\,V \qquad I_4 = G_4 \cdot V_4 = -\frac{1}{6}\,A$

$I_0 + I_4 - I_3 = 0 \Rightarrow I_0 = I_3 - I_4 = \frac{1}{3} + \frac{1}{6} = \frac{1}{2} = G_N$

$V_{TH} = \frac{I_{cc}}{G_N} = -2\,V$ Good.

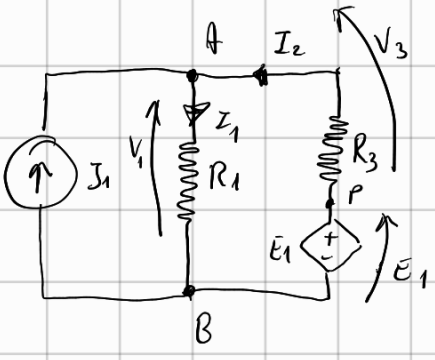
Rifacco 2)



$E_1 = r_{32} I_2$ $\quad R_1 = 10K\Omega$ $\quad R_3 = 2K\Omega$ $\quad J_1 = 10mA$

$r_{32} = 1.5K\Omega$

THEVENIN



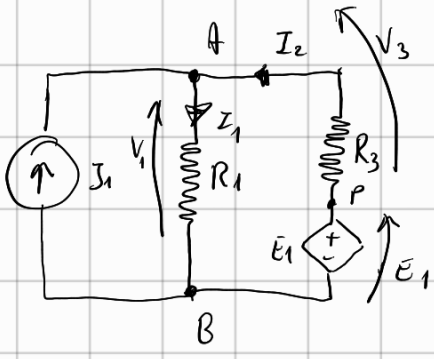
E_1 si comporta come un resistore a resistenza negativa.

$R_0 = -r_{32}$

$R_{03} = R_3 + R_0 = 3K\Omega$

$$I_1 = J_1 \frac{R_{03}}{R_{03}+R_1} = \frac{10 \cdot 10^{-3} \cdot 3 \cdot 10^3}{\frac{15 \cdot 10^3}{3}} = \frac{10}{3000} = \frac{1}{300} A$$

$$V_1 = I_1 R_1 = \frac{100}{3} V$$



$E_1 = r_{32} I_2$ $\quad R_1 = 10k\Omega$ $\quad R_3 = 20k\Omega$ $\quad J_1 = 10mA$

$r_{32} = 15k\Omega$

$$J_1 + I_2 - I_1 = 0$$
$$V_1 = V_3 + E_1$$
$$E_1 = I_2 \alpha$$

$$\Rightarrow \begin{cases} J_1 + I_2 - I_1 = 0 \\ R_1 I_1 = R_3 I_2 + I_2 \alpha \end{cases}$$

$$I_1 = J_1 + I_2$$

$$R_1 J_1 + R_1 I_2 = -R_3 I_2 + \alpha I_2$$

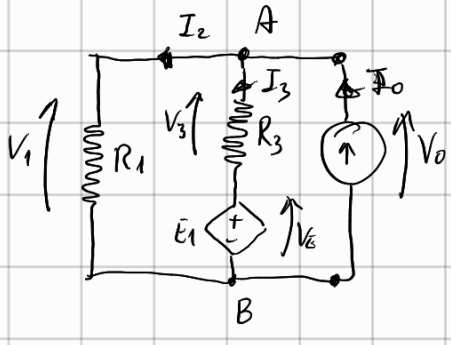
$$I_2 (-R_3 + \alpha - R_1) = R_1 J_1$$

$$I_2 = \frac{R_1 J_1}{-R_3 + \alpha - R_1} = \frac{100}{-15 \cdot 10^3} = -\frac{1}{150} \text{ A}$$

$$I_1 = J_1 + I_2 = -\frac{1}{150} + \frac{1}{100} = \frac{1}{300} \text{ A}$$

$$V_1 = R_1 I_1 = 10 \cdot 10^3 \cdot \frac{1}{300} = \frac{100}{3} \text{ V}$$

R_{TH}:



$$I_0 + I_3 = I_2$$
$$V_1 - V_3 - V_E = 0 \Rightarrow R_1 I_2 = -R_3 I_3 + \alpha I_2$$

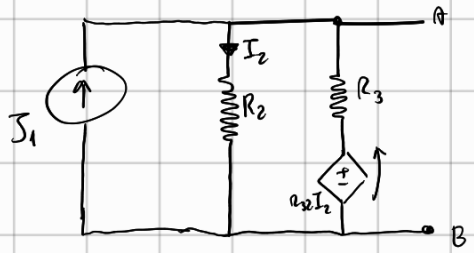
$$I_3 = I_2 - I_0$$

$$R_1 I_2 = -R_3 I_2 + R_3 I_0 + \alpha I_2$$

$$I_2 (R_1 + R_3 - \alpha) = R_3 I_0 \Rightarrow I_2 = \frac{4}{3} \text{ A}$$

$\Rightarrow V_0 = R_1 I_2 = \frac{40000}{3} V \Rightarrow R_{TH} = \frac{40000}{3} \Omega$

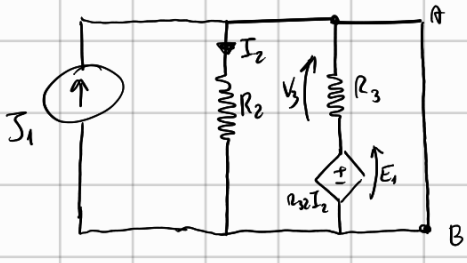
ES.1)



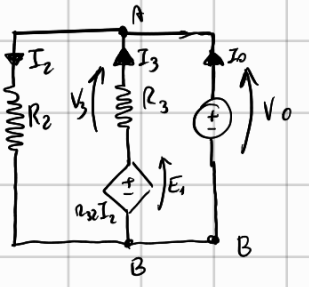
$R_3 = 10K\Omega$

$R_2 = 20K\Omega \quad \alpha_{32} = -5K\Omega \quad J_1 = 10mA$

Norton:



$I_2 = 0 \Rightarrow E_1 = 0 \Rightarrow V_3 = 0 \Rightarrow I_{cc} = J_1 = 10mA$



$V_0 = 1V$

$I_2 = V_0 G_2 = \frac{1}{20 \cdot 10^3} = 5 \cdot 10^{-5} A$

$E_1 = I_2 \alpha = 5 \cdot 10^{-5} \cdot (-5 \cdot 10^3) = -0{,}25\ V$

$V_0 - V_3 - E_1 = 0 \Rightarrow V_3 = V_0 - E_1 = 1{,}25\ V$

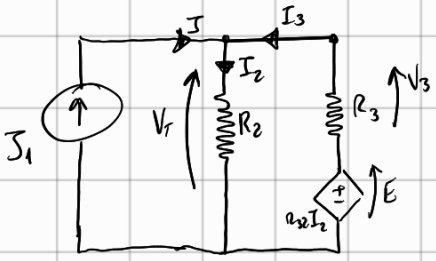
$I_3 = \frac{-V_3}{G_3} = -1{,}25 \cdot 10^{-4} A$

$I_0 = I_2 - I_3 = 5 \cdot 10^{-5} + 1{,}25 \cdot 10^{-4} = 1{,}75 \cdot 10^{-4} A$

$G_N = 1{,}75 \cdot 10^{-4} S$

$\frac{J_1}{G_N} = V_T = \frac{400}{7} V$

CALCOLO TH.



$R_3 = 10K\Omega$

$R_2 = 20K\Omega \quad \alpha_{32} = -5K\Omega \quad J_1 = 10mA$

$I_3 + J = I_2 \qquad I_3 = I_2 - J$

$V_T - V_3 - E = 0$

$E = I_2\alpha \Rightarrow R_2 I_2 = -R_3 I_3 + I_2\alpha$

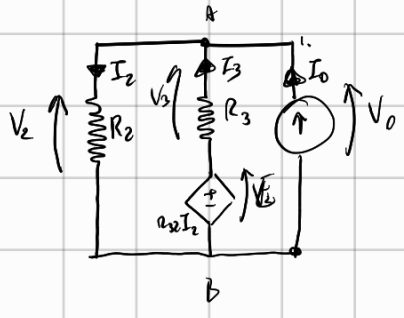
$R_2 I_2 = -R_3 I_2 + R_3 J + I_2\alpha$

$I_2(R_2 + R_3 - \alpha) = R_3 J$

$I_2 = \frac{R_3 J}{R_2 + R_3 - \alpha} = \frac{100}{35 \cdot 10^3} = \frac{1}{350} A$

$V_T = I_2 R_2 = \frac{400}{7} V$

R_{TH}:



$I_0 + I_3 = I_2 \qquad I_3 = I_2 - I_0$

$V_2 - V_3 - E = 0 \qquad R_2 I_2 + R_3 I_3 - \alpha I_2 = 0$

$E = \alpha I_2 \qquad R_2 I_2 + R_3 I_2 - R_3 I_0 - \alpha I_2 = 0$

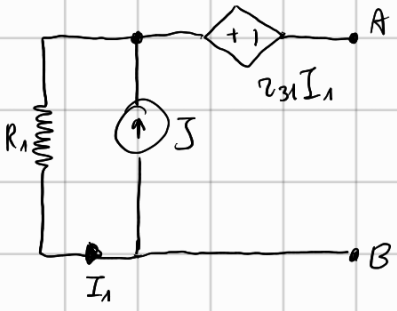
$I_2(R_2 + R_3 - \alpha) = R_3 I_0$

$I_2 = \frac{R_3 I_0}{R_2 + R_3 - \alpha} = \frac{2}{7} A$

$V_2 = R_2 I_2 = \frac{40000}{7} V$

$R_{TH} = \frac{40000}{7} \Omega$

Compito 2)

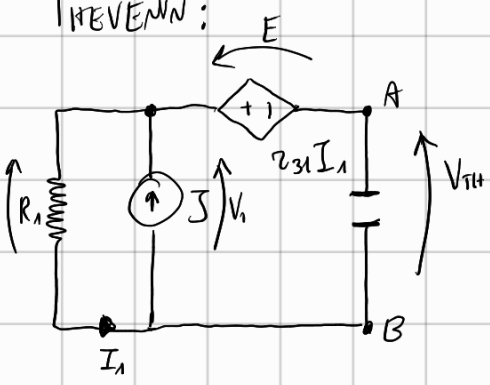


$R_1 = 2k\Omega$

$J = 1A$

$r_{31} = 1k\Omega$

THEVENIN:

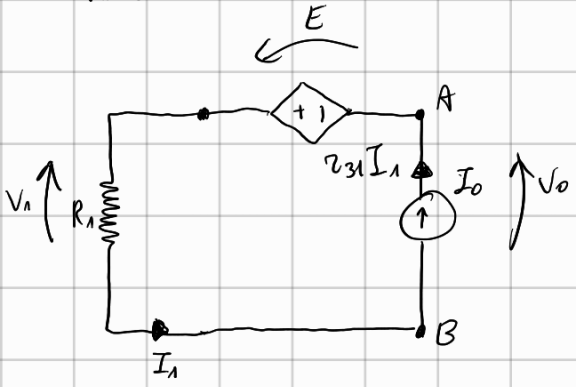


$V_{TH} + E - V_1 = 0 \Rightarrow V_{TH} = V_1 - E$

$I_1 = J$

$E = r_{31}I_1 = 1kV$ $\qquad V_1 = R_1 J = 2kV$

$V_{TH} = 1kV$



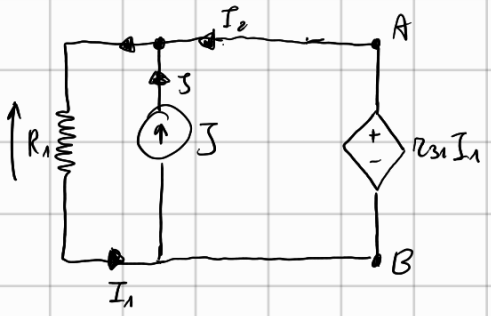
$I_1 = I_0 = 1V$

$E = r_{31}I_1 = 1kV$ $\qquad V_1 = 2kV$

$V_0 = V_1 - E = 1kV$

$R_{TH} = 1000\Omega$

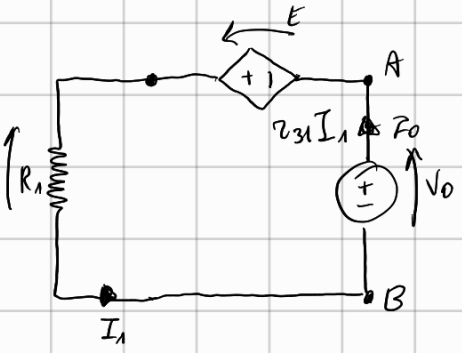
PROVA NORTON



$J + I_2 - I_1 = 0$

$r_{31} I_1 = R_1 I_1 \Rightarrow I_1 = 0$

$I_{cc} = -I_2 = J = 1\,A$



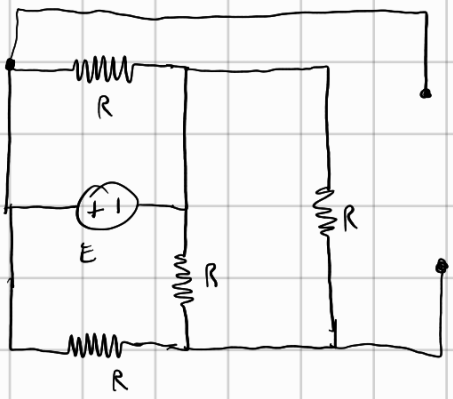
$V_0 + E - V_1 = 0 \Rightarrow V_0 = R_1 I_1 - r_{31} I_1$ $\quad V_0 = 1\,V$

$r_{31} I_1 = E$

$I_1 = \frac{V_0}{R_1 - r_{31}} = \frac{1}{1000}\,A$

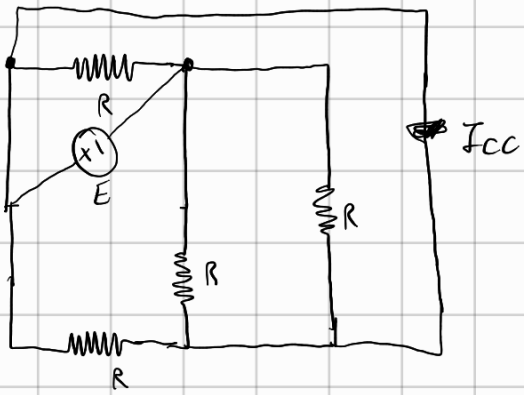
$G_N = \frac{1}{1000}\,S$

PROBLEMA 1)

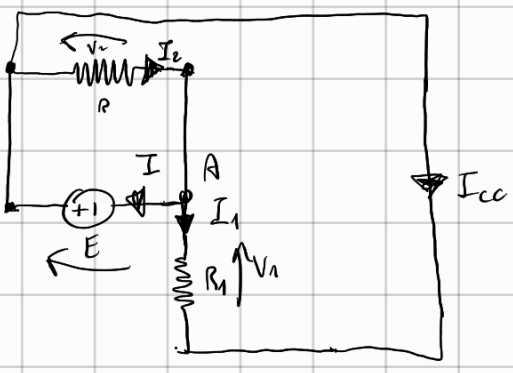


$R = 2\Omega \qquad E = 2V$

NORTON:



$R_1 = \left(\frac{1}{R} + \frac{1}{R}\right)^{-1} = 1\Omega$



$V_1 + V_2 = 0 \Rightarrow I_2 R = I_1 R_1$

$I_3 = 0$

$E + V_1 = 0 \Rightarrow V_1 = -E = -2\,V \qquad I_1 = V_1 G_1 = -2\,A$

$V_2 = 2V \qquad I_2 = V_2 G = 1A$

$I + I_1 - I_2 = 0$

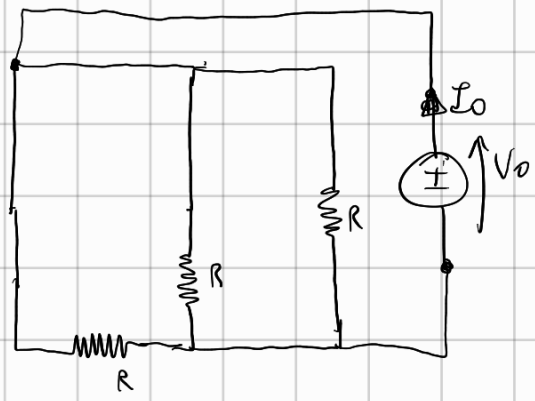
$I = I_2 - I_1 = 3A$

$I_{cc} = -I_1 = 2A$

$\underline{I} = I_{cc} - G_N V$

$V = \frac{I_{cc}}{G_N} - \frac{I}{G_N}$

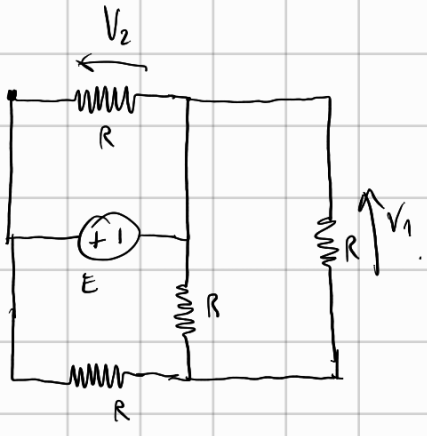
G_N:



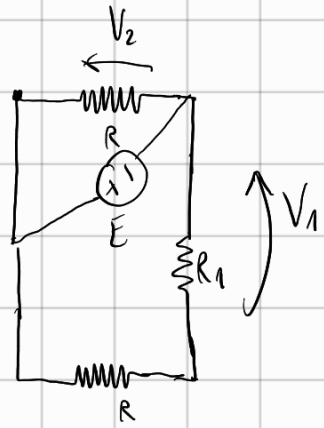
$R_1 = \left(\frac{1}{R} + \frac{1}{R}\right)^{-1} = 1\Omega \qquad R_{eq} = \left(1 + \frac{1}{2}\right)^{-1} = \frac{2}{3}\Omega$

$G_N = \frac{3}{2} S$

Vado con THEVENIN



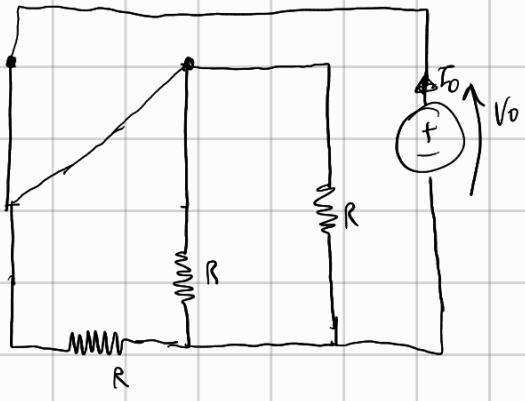
$V_{TH} = V_2 + V_1$

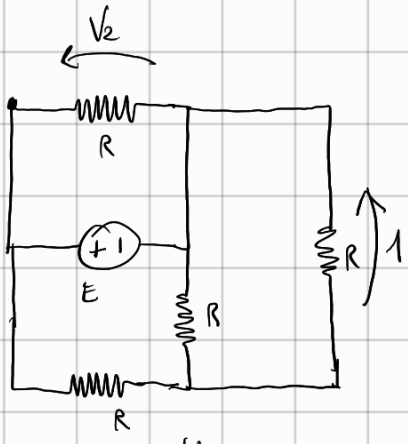


$R_1 = 1\,\Omega$ $\quad$ $R_2 = 3\,\Omega$

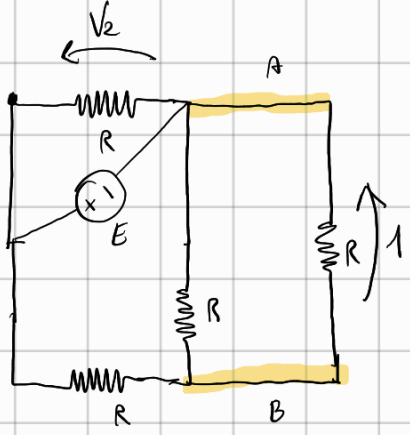
$$V_1 = -\frac{E R_1}{R + R_1} = \frac{-2 \cdot 1}{3} = -\frac{2}{3} V \qquad V_2 = E$$

$$\Rightarrow V_{TH} = 2 - \frac{2}{3} = \frac{4}{3} V$$

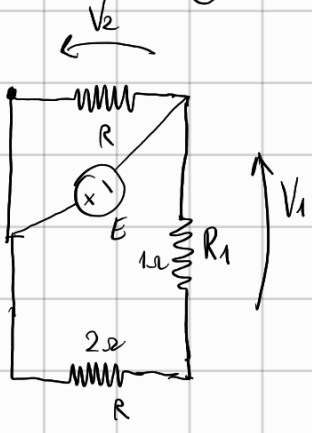




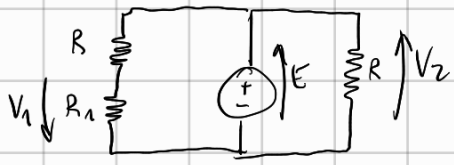
$V_T = V_2 + V_1$



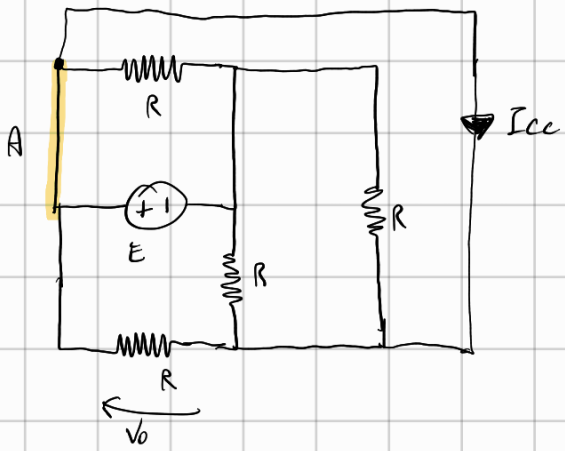
$V_2 = E$



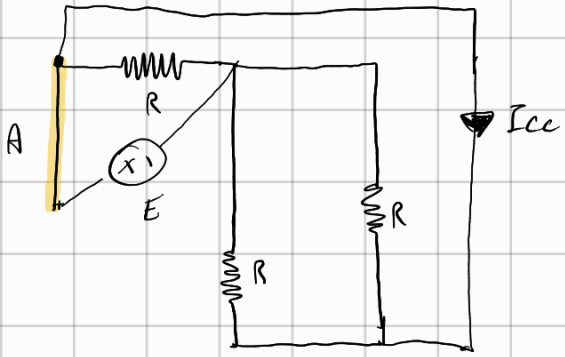
$R_1 = \left(\frac{1}{R} + \frac{1}{R}\right)^{-1} = 1\,\Omega$

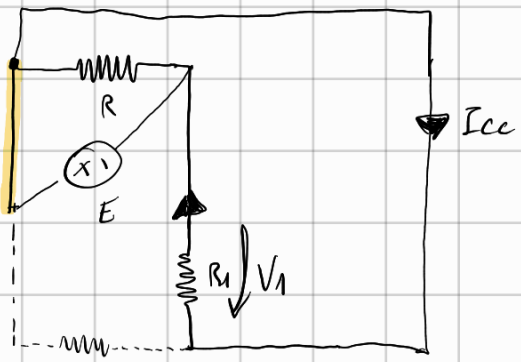


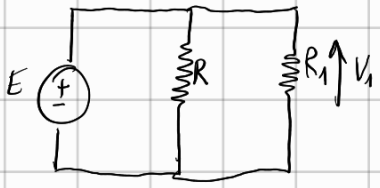
$V_1 = \frac{-ER_1}{R+R_1} = -\frac{2}{3}\,V$ $\qquad V_2 = 2 - \frac{2}{3} = \frac{4}{3}\,V$



$V_0 = 0$

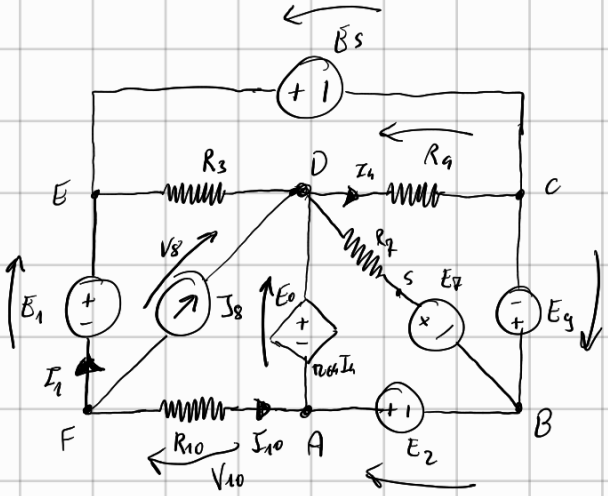






$$I_1 = \frac{E}{R_1} = 2A$$

1)



$R_3 = 1k\Omega$ $R_4 = 4k\Omega$

$R_7 = 3k\Omega$ $R_{10} = 1k\Omega$

$E_1 = 4V$ $E_2 = 1V$ $E_g = 4V$

$E_5 = 10V$ $E_7 = 1V$ $J_8 = 1mA$

$r_{64} = 1,5k\Omega$

$$V_{10} + E_1 - E_5 + E_g + E_2 = 0$$

$$V_{10} = E_5 - E_1 - E_g - E_2 = 10 - 4 - 4 - 1 = 1V$$

$$I_{10} = V_{10} G_{10} = 10^{-3} A = 1mA$$

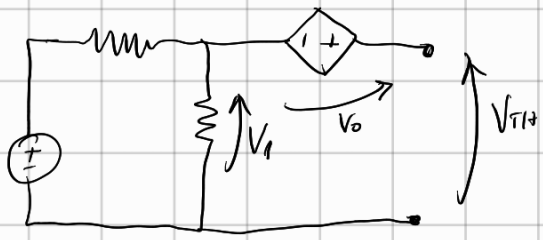
$$I_1 = -I_{10} - J_8 = -2mA$$

$$E_g + E_2 + r_{64} I_4 - R_4 I_4 = 0$$

$$I_4 = \frac{E_2 + E_g}{+r_{64} - R_4} = \frac{5}{+2,5k\Omega} = \frac{+1}{500} A = +2mA$$

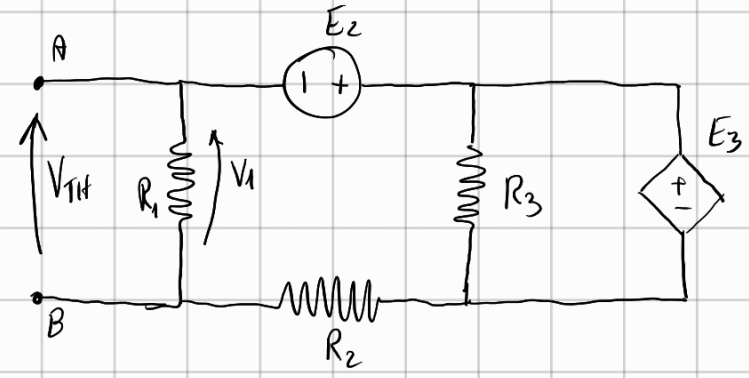
$$E_0 = \sum_4 r_{64} = +3V$$

$$V_{10} + V_8 - E_0 = 0 \Rightarrow V_8 = E_0 - V_{10} = +3 - 1 = 2V$$



$$V_{TH} = V_0 + V_1$$

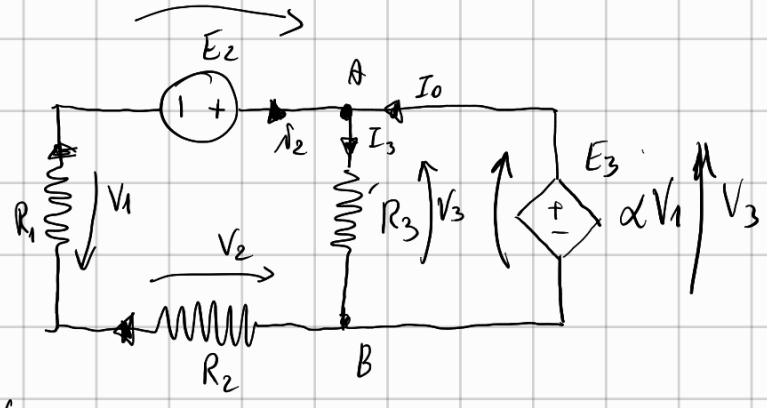
1)



$E_3 = \alpha V_1 \qquad \alpha = 2$

$E_2 = 1\,V$

$R_1 = 2\,\Omega \qquad R_2 = 1{,}2\,\Omega \qquad R_3 = 1\,\Omega$



$V_{TH} = V_1$

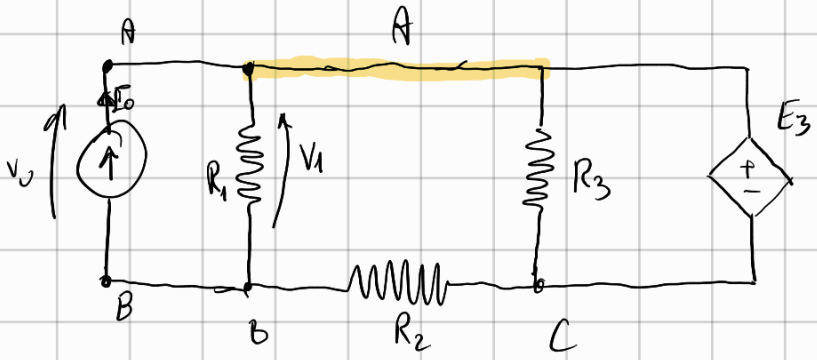
$$\begin{cases} E_2 - \alpha V_1 - V_2 - V_1 = 0 \\ I_3 - I_0 - I_2 = 0 \end{cases}$$

$$E_2 - \alpha R_1 I_1 - R_2 I_1 - R_1 I_1 = 0$$

$$E = I_1 (R_2 + R_1 + \alpha R_1)$$

$$I_1 = \frac{5}{36}$$

$$V_1 = R_1 I_1 =$$



$U_C = 0$

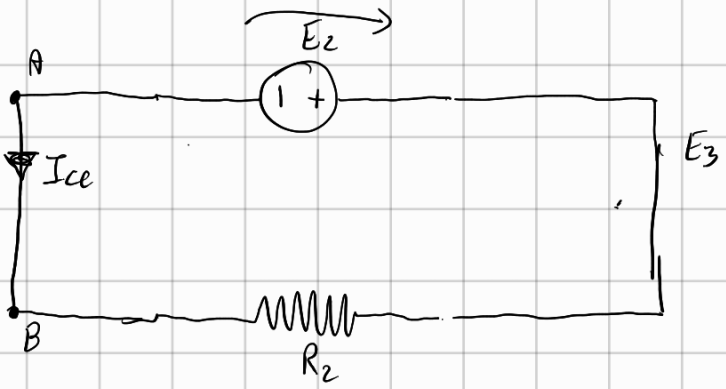
$$\begin{cases} U_B (G_1 + G_2) - U_A G_1 = -I_0 \\ U_A = \alpha (U_A - U_B) \end{cases}$$

$$\begin{cases} U_B \left(\frac{1}{2} + \frac{1}{12} \right) - \frac{U_A}{2} = -I_0 \\ U_A = 2 U_A - 2 U_B \end{cases}$$

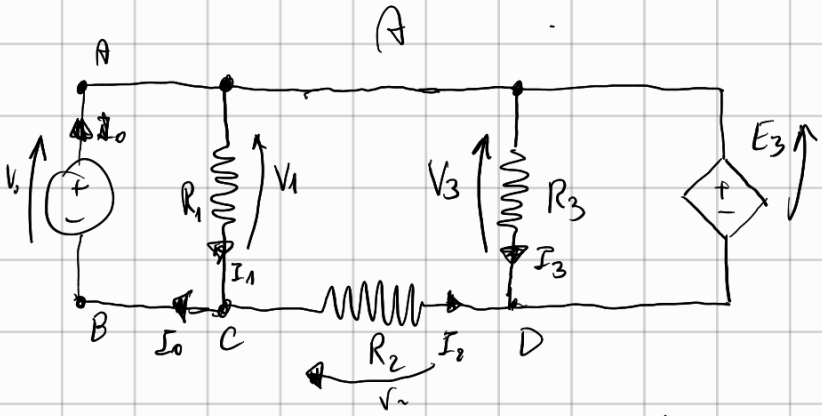
$$\begin{cases} \frac{4}{3} U_B - \frac{U_A}{2} = -1 \\ 2 U_B - U_A = 0 \end{cases}$$

$U_B = -3\,V \qquad U_A = -6\,V$

$U_A - U_B = -3\,V \quad \Rightarrow \quad R_{eq} = -3\,\Omega$



$$I_{cc} = -\frac{E_2}{R_2} = -\frac{5}{6}\,A$$



$$V_0 = V_1 = 1\,V \qquad E_2 = \alpha V_0 = 2\,V$$

$$U_D = 0 \Rightarrow U_A = 2\,V$$

$$U_C = 1\,V$$

$$I_1 = (U_A - U_C)\,G_1 = G_1 = 0{,}5\,A$$

$$I_3 = (U_A - U_D)\,G_3 = 2\,A$$

$$I_2 = (U_C - U_D)\,G_2 = \frac{5}{6}\,A$$

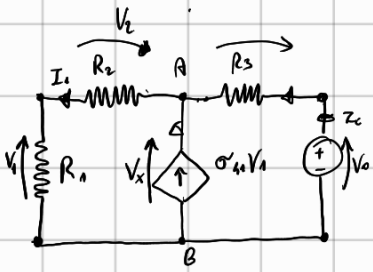
$$I_0 - I_1 + I_2 = 0$$

$$I_0 = I_1 - I_2 = -\frac{1}{3}\,A$$

$$V_{TH} = \frac{I_{cc}}{G_N} = \frac{-\frac{5}{6}}{-\frac{1}{3}} = \frac{5}{2}\,V$$

$$I = I_{cc} - G_N V \Rightarrow V G_N = I_{cc} - I \Rightarrow V = \frac{I_{cc}}{G_N} - \frac{I}{G_N}$$

1)



$R_1 = 15\,\Omega$ $\quad I = 2\,A$

$R_2 = R_3 = 5\,\Omega$ $\quad \sigma_{11} = \frac{1}{15}\,S$

$$\begin{cases} V_1 + V_2 - V_x = 0 \\ V_x + V_3 - V_o = 0 \\ I_o - I_1 + \sigma_{11} V_1 = 0 \end{cases}$$

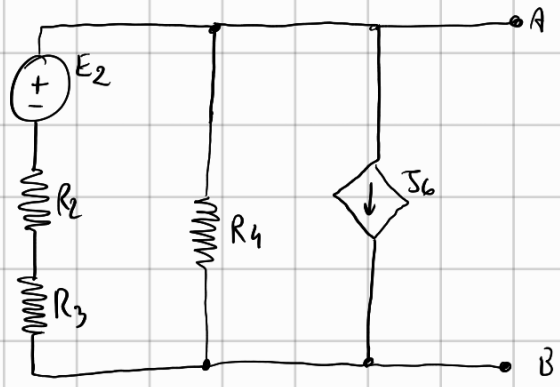
$$R_1 I_1 + R_2 I_1 - V_x = 0$$

$$V_x + R_3 I_o - V_o = 0$$

$$I_o - I_1 + \sigma_{11} R_1 I_1 = 0$$

$$I_1 = \frac{I_o}{+1 - \sigma_{11} R_1}$$

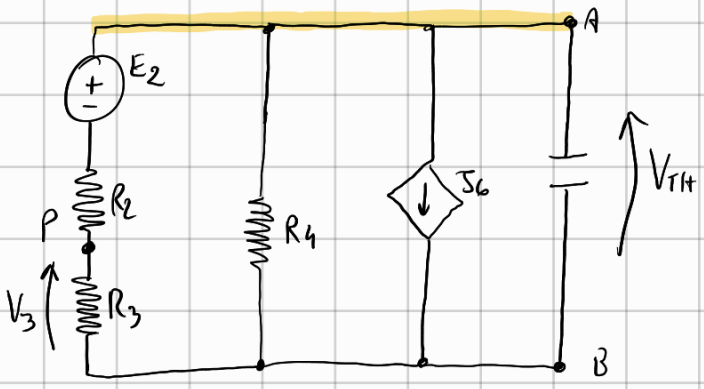
1)



THEVENIN:

$E_1 = 3V \quad J_5 = \alpha V_3 \quad \alpha = -1 S$

$R_2 = R_3 = 2\Omega \quad R_4 = 2/3\ \Omega$



$J_6 = \alpha V_3 = \alpha U_P$

$U_B = 0$

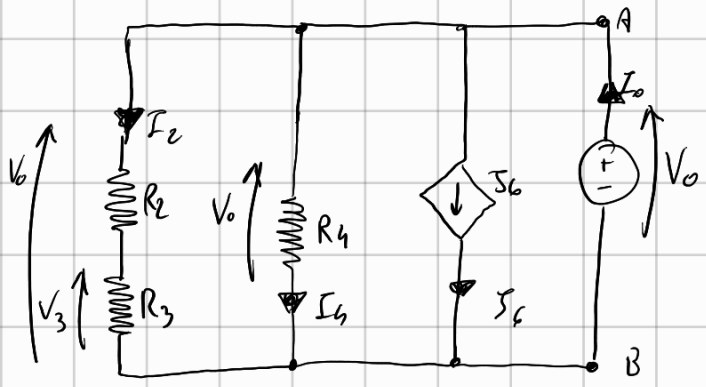
$$\begin{cases} U_A (G_2 + G_4) - U_P G_2 = E_2 G_2 - J_6 \\ U_P (G_2 + G_3) - U_A G_2 = -E_2 G_2 \end{cases}$$

$$\begin{cases} 2U_A - \frac{U_P}{2} = \frac{3}{2} + U_P \\ U_P - \frac{U_A}{2} = -\frac{3}{2} \end{cases}$$

$$\begin{cases} 2U_A - \frac{3}{2}U_P = \frac{3}{2} \\ U_P - \frac{U_A}{2} = -\frac{3}{2} \end{cases}$$

$$V_{TH} = -\frac{3}{5}V$$

$$\Rightarrow \begin{cases} 4U_A - 3U_P = 3 \\ U_A - 2U_P = 3 \end{cases} \Rightarrow \quad U_A = -\frac{3}{5}V \qquad U_P = -\frac{9}{5}V$$



$$V_0 = 1\,V$$

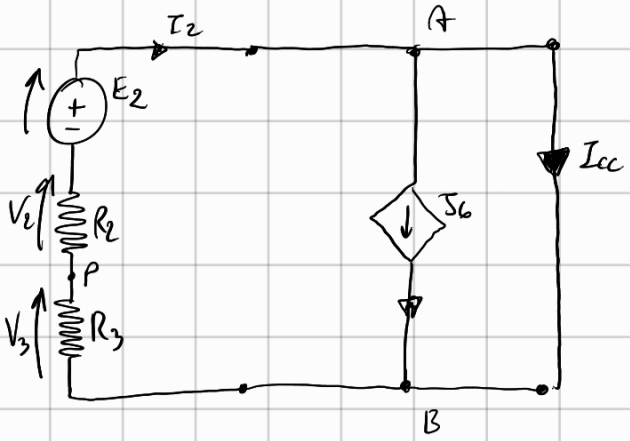
$$V_3 = \frac{V_0 \cdot R_3}{R_2 + R_3} = \frac{V_0}{2} = \frac{1}{2}V$$

$$J_6 = \alpha V_3 = -\frac{1}{2}A$$

$$I_4 = V_0 G_4 = \frac{3}{2}A$$

$$I_2 = V_3 G_3 = \frac{1}{4}A \qquad I_0 = J_6 + I_4 + I_2 = \frac{5}{4}A$$

$$\Rightarrow \qquad G_N = \frac{5}{4}S$$



$$E + V_2 + V_3 = 0$$

$$\Rightarrow E - R_2 I_2 - R_3 I_2 = 0$$

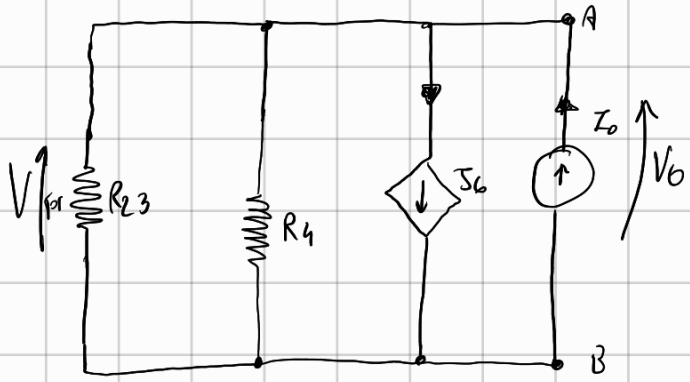
$$I_2 = \frac{E}{R_2 + R_3} = \frac{3}{4} A$$

$$V_3 = -R_3 I_2 = -\frac{3}{2} V$$

$$J_6 = \alpha V_3 = \frac{3}{2} A$$

$$I_{cc} + J_6 - I_2 = 0$$

$$I_{cc} = I_2 - J_6 = \frac{3}{4} - \frac{3}{2} = -\frac{3}{4} A$$



$R_{23} = 4\,\Omega$

$$V_3 = \frac{V_T \cdot R_2}{R_2 + R_3} = \frac{V_{tot}}{2}$$

$$U_A \left(G_{23} + G_4 \right) = I_0 - \alpha \frac{U_A}{2}$$

$$U_A(G_{23}+G_4) - \frac{U_A}{2} = I_0$$

$$2U_A(G_{23}+G_4) - U_A = 2$$

$$U_A(2G_{23}+2G_4-1) = 2$$

$$U_A = \frac{2}{2G_{23}+2G_4-1} = \frac{4}{5}V$$

$\uparrow \frac{1}{4}$ $\uparrow \frac{3}{2}$ $\quad \frac{1}{2}+3-1 = \frac{5}{2}$

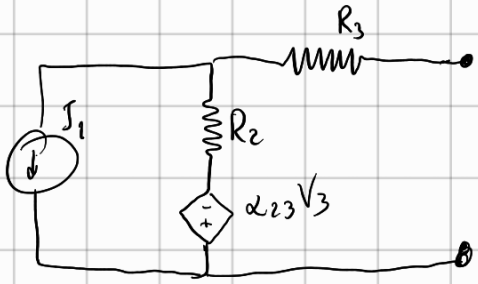
$$R_{TH} = \frac{4}{5}V$$

$$I = I_{CC} - G_N V \qquad V = \frac{I_{CC}}{G_N} - \frac{1}{G_N}V$$

$$I = -\frac{3}{4} - \frac{5}{4}V$$

$$V_{TH} = \frac{I_{CC}}{G_N} = -\frac{3}{4}\cdot\frac{4}{5} = -\frac{3}{5}V$$

THEVENIN

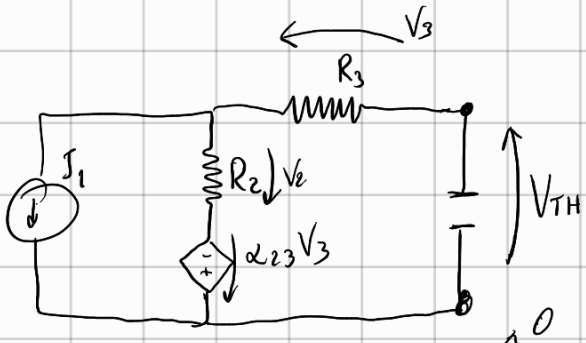


$R_2 = R_3 = 1k\Omega$

$\alpha_{23} = 0,1$

$J_1 = 1mA$

Na ho prob. di controllabilità.

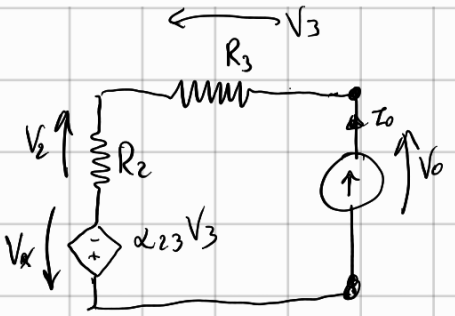


$V_3 = 0$ $\qquad V_{TH} + V_2 + \alpha_{23} V_3 = 0$ (0)

$V_{TH} = -V_2$

$V_2 = J_1 R_2 = 1k \cdot 1m = 1V$

$V_{TH} = -1V$



$I_0 = 1$

$V_3 = -R_3 I_0 = -1kV$

$V_2 = R_2 I_0 = 1kV$

$V_x = \alpha_{23} V_3 = -100V$

$V_0 + V_3 - V_2 + V_x = 0$

$V_0 = V_2 - V_3 - V_x = 1000 + 1000 + 100 = 2100\ V$

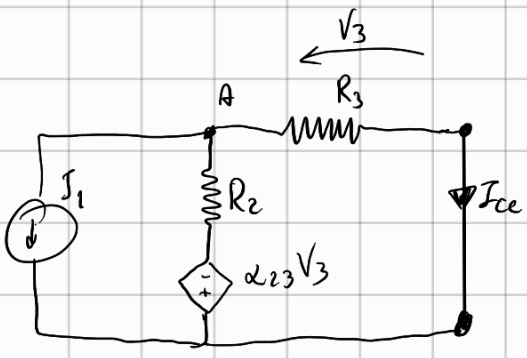
$\Rightarrow R_{TH} = 2100\ \Omega$

$V_0 - R_3 I - R_2 I + V_x = 0$

$V_0 - R_3 I - R_2 I + \alpha_{23}(-R_3 I) = 0$

$V_0 = I_0 (R_3 + R_2 + \alpha_{23} R_3)$

$I_0 = \frac{1}{2100} A$



$R_2 = R_3 = 1k\Omega$

$\alpha_{23} = 0{,}1$

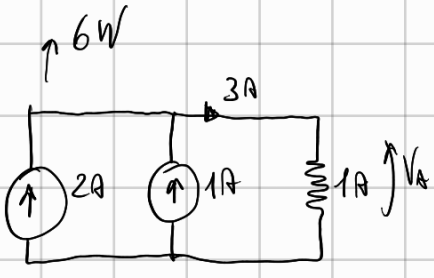
$J_1 = 1mA$

$U_A (G_3 + G_2) = -J_1 - \alpha_{23} U_A G_3$

$U_A (G_3 + G_2 + \alpha_{23} G_3) = -J_1$

$U_A = \frac{-J_1}{G_3 + G_2 + \alpha_{23} G_3} = -\frac{10}{21} V$

$I_{cc} = \frac{U_A}{R_3} = -\frac{1}{2100} A$

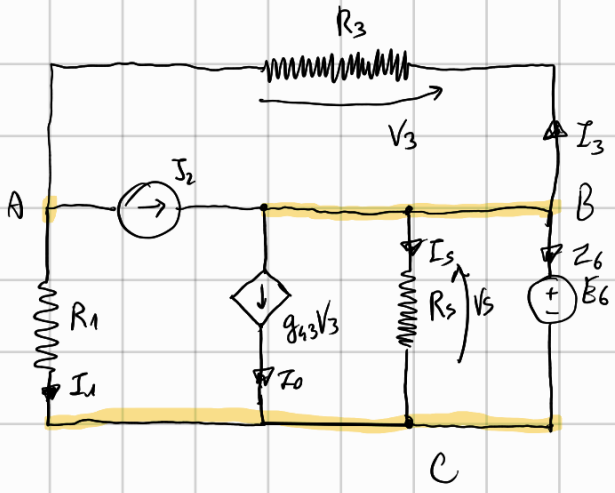


$V = 3\ Volt$

$P_{ass} = 3W$

$3W$

1)



$J_2 = 1A \quad E_6 = 1V \quad g_{43} = 2S$

$R_1 = 3\Omega \quad R_3 = R_5 = 1\Omega$

$U_C = 0 \quad U_B = 1V$

$U_A(G_3 + G_1) - U_B G_3 = -J_2$

$U_A(1 + \frac{1}{3}) - \cancel{U_B} = -\cancel{1}$

$U_A = 0$

$I_3 = U_B G_3 = 1A$

$I_1 = 0 \qquad (U_B - U_A) G_3 = 1A$

$I_5 = G_5 U_B = 1A$

$I_0 = g_{43} V_3 = U_B \, g_{43} = 2A$

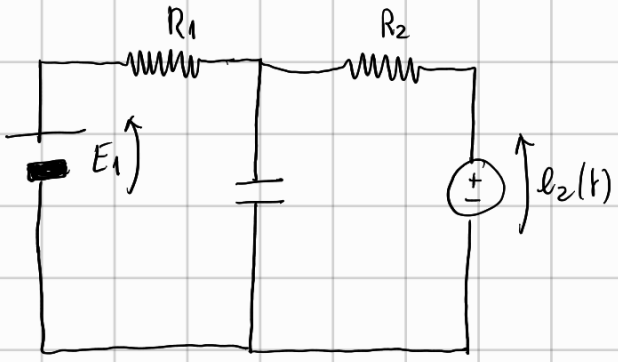
$I_6 + I_3 + I_5 + I_0 - J_2 = 0$

$I_6 = J_2 - I_3 - I_5 - I_0 =$

$= 1 - 1 - 1 - 2 = -3A$

$P = -3W$

2)

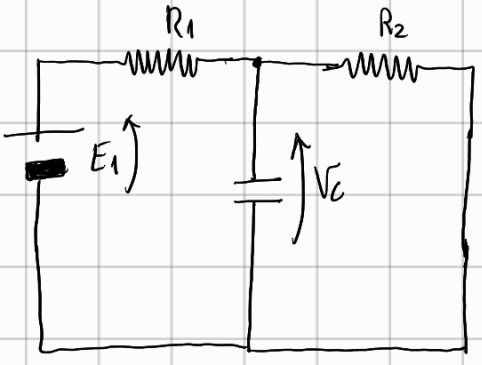


$E_1 = 10V \quad e_2(t) = 5u(t)\ V$

$R_1 = 100\,\Omega \quad R_2 = 50\,\Omega$

$C = 0{,}1\,\mu F \quad L = 10\,\mu H$

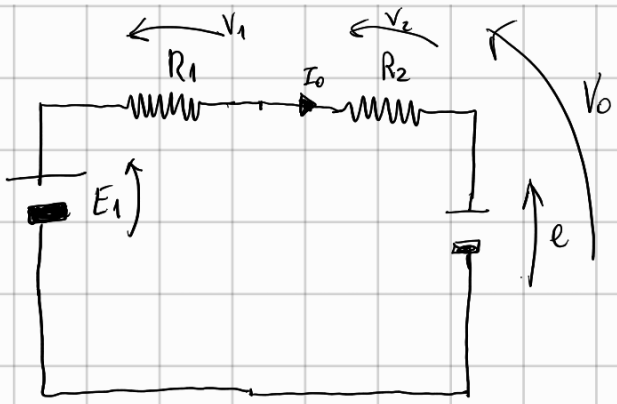
$t<0$:



La corrente in regime è 0.

$V_C = V_2 \Rightarrow V_2 = \frac{E_1 R_2}{R_1 + R_2} = \frac{10 \cdot 50}{150} = \frac{10}{3}\,V$

$V_C(0^+) = \frac{10}{3}V$



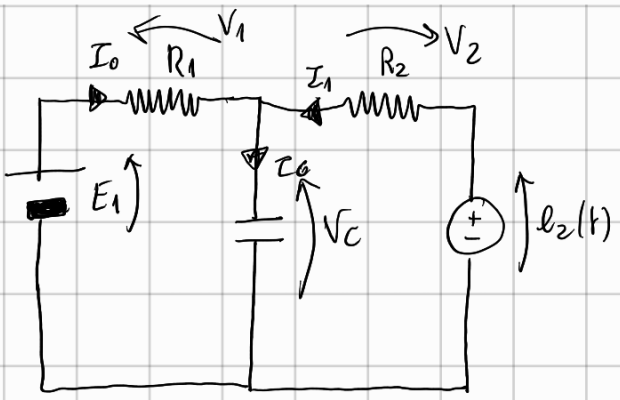
$t>0$, regime stazionario

$e + V_2 = V_0$

$\Rightarrow E_1 - R_1 I_1 - R_2 I_1 - e = 0$

$I_1 = \frac{E-e}{R_1+R_2} = \frac{5}{150} = \frac{1}{30}\ A$

$V_2 = R_2 I_1 = \frac{5}{3} V$ $\qquad$ $V_0 = \frac{20}{3} V$



$$\begin{cases} E_1 - V_1 - V_C = 0 \\ E_2 - V_2 - V_C = 0 \\ I_0 + I_1 - I_C = 0 \end{cases}$$

$$E_1 - I_0 R_1 - V_C = 0$$

$$E_2 - I_1 R_2 - V_C = 0$$

$$I_1 = I_C - I_0 \qquad I_0 = \frac{E_1}{R_1} - \frac{V_C}{R_1}$$

$$\Rightarrow \quad E_2 - (I_C - I_0) R_2 - V_C = 0$$

$$E_2 - I_C R_2 + \frac{R_2 E_1}{R_1} - \frac{V_C R_2}{R_1} - V_C = 0$$

$$V_C \left(1 + \frac{R_2}{R_1}\right) + I_C R_2 = E_2 + \frac{R_2 E_1}{R_1}$$

$$C R_2 \frac{dV_C}{dt} + V_C \left(1 + \frac{R_2}{R_1}\right) = E_2 + \frac{R_2 E_1}{R_1}$$

$$\begin{cases} \dfrac{dV_C}{dt} + \dfrac{V_C}{C R_2} \left(1 + \dfrac{R_2}{R_1}\right) = E_2 + \dfrac{R_2 E_1}{R_1} \\ V(0^+) = \dfrac{10}{3} V \end{cases}$$

$$V_C(t) = A e^{-\frac{t}{RC}} + \frac{20}{3} V$$

$$V_C(t) = -\frac{10}{3} e^{-\frac{t}{RC}} + \frac{20}{3} V \qquad \Rightarrow I_1 = \frac{E_2}{R_2} - \frac{V_C}{R_2}$$

$$i_1(t) = \frac{1}{10} - \frac{1}{15} e^{-\frac{t}{RC}} - \frac{2}{15} \ A$$

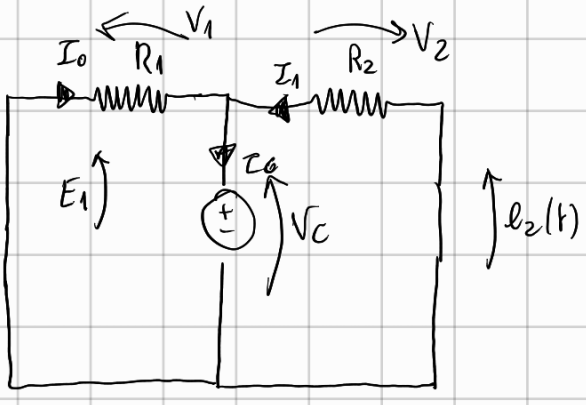
$$i_1(t) = -\frac{1}{30} - \frac{1}{15} e^{-\frac{t}{RC}} \ A$$

$$\Rightarrow P_{ass\,2}(t) = -i_1(t) \cdot i_2(t) = \frac{1}{6} + \frac{1}{3} e^{-\frac{t}{RC}} \ W$$

$$i_C(t) = C \frac{dv_C}{dt} = +10^6 e^{-\frac{t}{RC}}$$

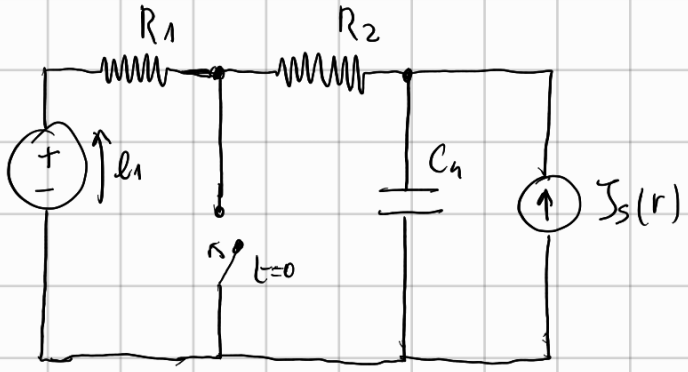
$$P_{gen\,C}(t) = i_C(t) \cdot (-v(t)) = -10^6 e^{-\frac{t}{RC}} \cdot \left(-\frac{10}{3} e^{-\frac{t}{RC}} + \frac{20}{3} \right) \qquad t \geq 0$$

Se $t < 0$ $P_{gen} = 0$ perché $i_2 = 0$.



$$\left(\frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} = \left(\frac{3}{100} \right)^{-1} = \frac{100}{3} \Omega$$

1)



$e_1(t) = 20\sqrt{2}\,\sin(\omega_1 t)$

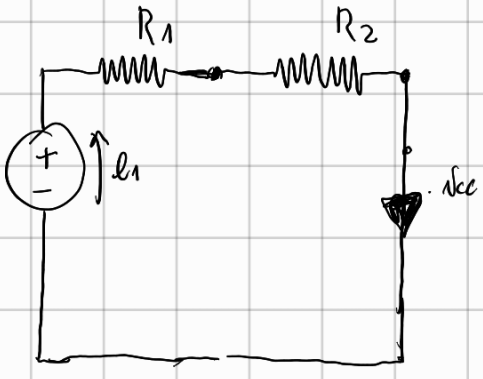
$\omega_1 = 10\,krad/s$

$J_s(t) = 4\,mA$

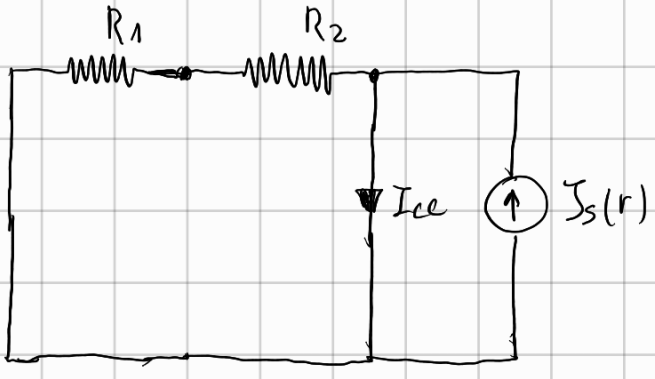
$L = 100\,\mu H \quad C = 1\,\mu F$

$R_1 = R_2 = 20\,\Omega$

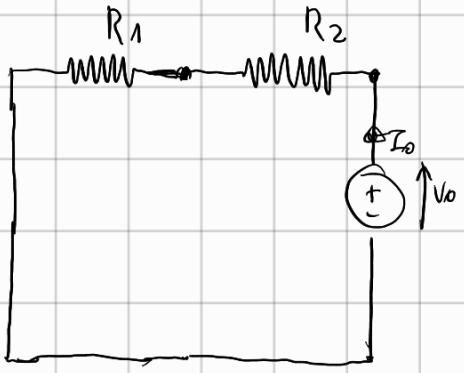
Trovo equivalente di Norton:



$$I_{cc}(t) = \frac{e_1(t)}{R_1+R_2} = \frac{\sqrt{2}}{2}\sin(\omega_1 t)\ A$$

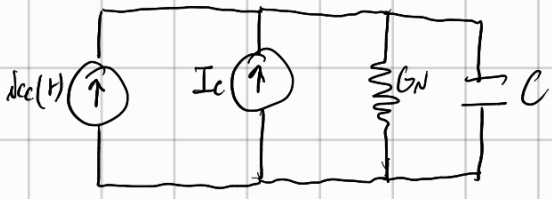


$I_{cc} = J_s$

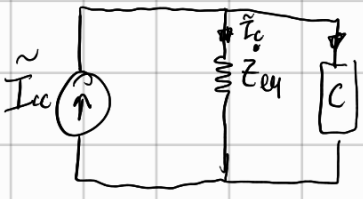


$$G_N = (R_1+R_2)^{-1} = \frac{1}{40}\,S$$

$\Rightarrow$ $t<0$:



Sovrapposizione effetti: fasori:



$$\dot{z}_C = \frac{1}{j\omega C} = -100\,j$$

$$\dot{z}_{eq} = 40\,\Omega$$

$$\tilde{\dot{I}}_C = \frac{\tilde{\dot{I}}_{cc}\cdot \dot{z}_{eq}}{\dot{z}_{eq}+\dot{z}_C} = 0{,}43 - 0{,}17\,j \;A$$

$$\tilde{V} = \dot{z}_{eq}\,\tilde{\dot{I}}_C = 17{,}2 - 6{,}9\,j \;V$$

$$v(t) = 26{,}26\,\sin(\omega_1 t - 0{,}38)$$

Se ho I_C il condensatore si comporta da aperto

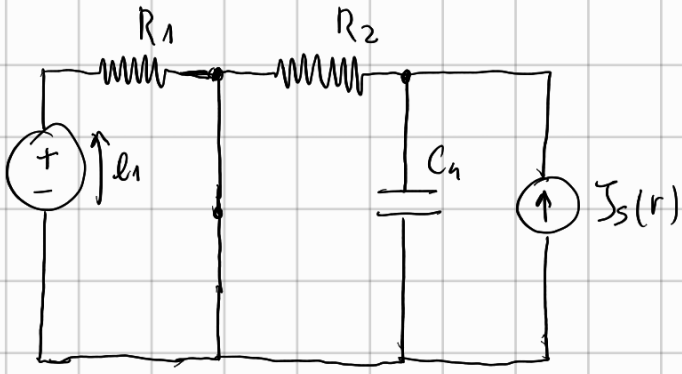
$\Rightarrow$

$$v(t) = I_C R_{eq} = 4mA \cdot 40 = 0{,}16\;V$$

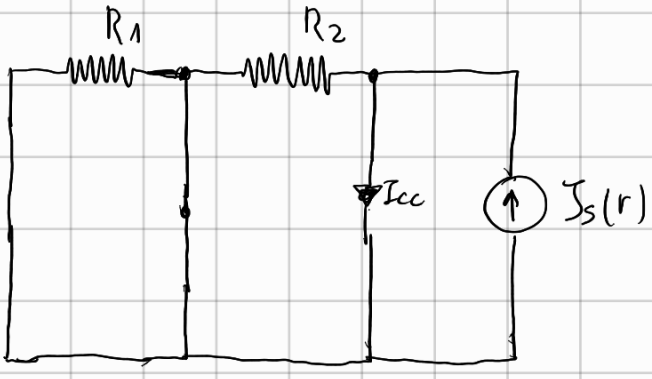
$$v_L(t) = 26{,}26\,\sin\left(\omega_1 t - 0{,}1\right) + \frac{4}{25}\;V$$

$$v_L(0^+) = -2{,}46\,V$$

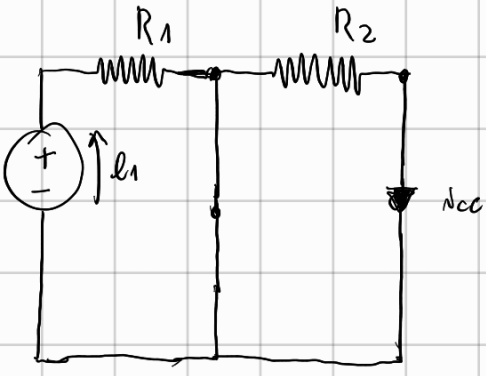
$t>0$:



Equivalente:

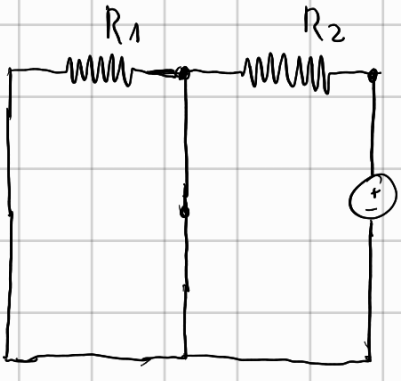


$I_{cc} = J_S$

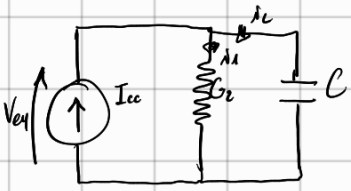


$V_{cc}(t) = 0$ perché corto circuito.

Geq: G_2



$t>0$:



$G_2 = \frac{1}{80}\,S \qquad I_{cc} = 4\,mA$

A regime: C tende a essere circuito aperto.

$V_C = I_{cc} R_2 = 80\,mV$

$$I_{cc} - i_1 - i_C = 0$$

$$\Rightarrow I_{cc} = \frac{V_C}{R_2} + i_C$$

$$I_{cc} = C\frac{dV_C}{dt} + \frac{V_C}{R_2}$$

$$\begin{cases} \dfrac{dV_C}{dt} + \dfrac{V_C}{R_2 C} = \dfrac{I_{cc}}{C} \\ V_C(0^+) = -2{,}46\,V \end{cases}$$

$$V_C(t) = A\,e^{-\frac{t}{R_2 C}} + 0{,}08$$

$$V_C(0^+) = A + 0{,}08 = -2{,}46 \Rightarrow A = -3{,}2\ V$$

$$\Rightarrow V_C(t) = -3{,}2\,e^{-\frac{t}{R_2 C}} + 0{,}08\ V$$

$$V_C(t) = -3{,}2\,e^{-50000t} + 0{,}08 \Rightarrow$$

$\mathcal{E}(1) = ?$ $\qquad V_C(1) = 0{,}08\,V$

$$\mathcal{E} = \frac{1}{2} C V^2 = 3{,}2 \cdot 10^{-9}\,J$$