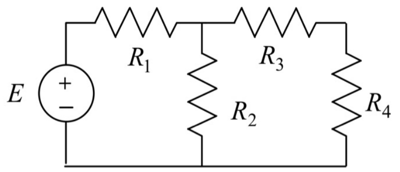
ES. 1.1 Calcolare la resistenza equivalente vista ai capi del generatore E.



$R_1 = 1\,\Omega \quad R_2 = 4\,\Omega$

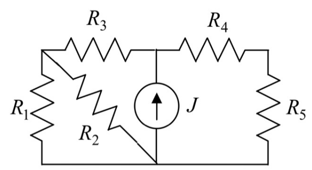
$R_3 = 3\,\Omega \quad R_4 = 2\,\Omega$

$R_{34} = R_3 + R_4$

$R_{2-34} = R_2 \parallel R_{34}$

$R_{EQ} = R_1 + R_{2-34} = R_1 + \left[\dfrac{R_2 (R_3 + R_4)}{R_2 + R_3 + R_4} \right] = 3.22\,\Omega$ Time 40"

ES. 1.2 Calcolare la resistenza equivalente vista dal generatore J.



$R_1 = R_4 = 5\,\Omega \quad R_2 = 3\,\Omega$

$R_3 = R_5 = 2\,\Omega$

$R_{45} = R_4 + R_5 = 7\,\Omega$

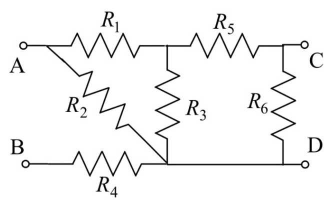
R_1 e R_2 sono in parallelo $\rightarrow$ $R_{12} = R_1 \parallel R_2 = \dfrac{R_1 R_2}{R_1 + R_2} = 1.875\,\Omega$

$R_{12+3} = R_{12} + R_3 = 3.875\,\Omega$

TIME 3'

$R_{12+3-45} = 2.49\,\Omega$

ES. 1.3 - Calcolare la R_{eq} vista ai morsetti A-B e quella vista ai morsetti C-D.



$R_1 = R_2 = 5\,\Omega \quad R_3 = 10\,\Omega$

$R_4 = 4\,\Omega \quad R_5 = 3\,\Omega$

$R_6 = 2\,\Omega$

Risultato: $R_{eqAB} = 7.125\,\Omega$, $R_{eqCD} = 1.600\,\Omega$.

- R_{AB}

$R_{56} = R_5 + R_6$

$R_{3-56} = R_3 \parallel R_{56}$

$R_{1-3-56} = R_x = R_1 + R_{3-56}$

$R_{2x} = R_2 \parallel R_x$

$R_{EQ} = R_{2x} + R_4$

$\rightarrow R_{EQ} = R_4 + \left[\dfrac{R_2 \cdot R_x}{R_2 + R_x} \right]$, $R_x = R_1 + \left[\dfrac{R_3 \cdot (R_5 + R_6)}{R_3 + R_5 + R_6} \right] = 8.\overline{3}\,\Omega$

$= 7.125\,\Omega$ Ans 1

Q_2: R_{CD}

R_4 viene eliminata

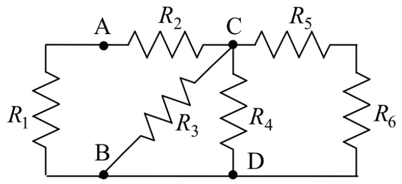
$R_{12} = R_1 + R_2$

$R_{12\text{-}3} = R_3 \parallel R_{12}$

$R_{5\text{-}12\text{-}3} = R_5 + R_{12\text{-}3}$ $\rightarrow$ $R_x = R_5 + \left[\dfrac{R_3 \cdot (R_1 + R_2)}{R_1 + R_2 + R_3} \right] = 8\,\Omega$

$R_{EQ} = \underbrace{R_{5\text{-}12\text{-}3}}_{R_x} \parallel R_6$ $\rightarrow$ $R_{EQ} = \dfrac{R_6 \cdot R_x}{R_6 + R_x} = \underline{1.600\,\Omega}$ Ans 2

ES. 1.4 - **Calcolare la R_{eq} vista ai morsetti A-B e quella vista ai morsetti C-D.**



$R_1 = R_3 = 0.2\,\Omega \quad R_2 = 0.4\,\Omega$

$R_4 = R_5 = 1\,\Omega \quad R_6 = 3\,\Omega$

Risultato: $R_{eqAB} = 0.147\,\Omega$, $R_{eqCD} = 0.126\,\Omega$.

• Q_1: R_{AB}

$R_{56} = R_5 + R_6$

$R_{56\text{-}4} = R_4 \parallel R_{56}$

$R_x = R_3 \parallel R_{56\text{-}4}$

$R_y = R_2 + R_x$

$R_{EQ} = R_y \parallel R_1 = R_1 \parallel \left\{ R_2 + R_3 \parallel \left[R_4 \parallel (R_5 + R_6) \right] \right\}$

$\rightarrow$ $\underline{R_{EQ} = 0.146\,\Omega}$ Ans 1 (Accettabile)

• Q_2: R_{CD}

• $R_{56} = R_5 + R_6$

• $R_{12} = R_1 + R_2$

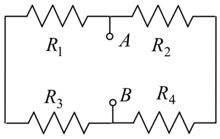
• $R_{12\text{-}3} = R_{12} \parallel R_3$

• $R_x = R_{56} \parallel R_4$

• $R_{EQ} = R_x \parallel R_{12\text{-}3} = \left[R_4 \parallel (R_5 + R_6) \right] \parallel \left[R_3 \parallel (R_1 + R_2) \right]$

$= \underline{0.126\,\Omega}$ Ans 2

ES. 1.5 - **Calcolare il valore di R_4 tale che ai morsetti A-B si abbia $R_{eq} = R$.**



$R_1 = R_2 = R \quad R_3 = R/2$

Risultato: $R_4 = 2R$.

$$\left.\begin{aligned} R_{13} &= R_1 + R_3 \\ R_{24} &= R_2 + R_4 \end{aligned}\right\} R_{EQ} = R_{13} \parallel R_{24} = \frac{(R_1+R_3)(R_2+R_4)}{R_1+R_2+R_3+R_4}$$

$$\rightarrow R_{EQ} = \frac{R_1R_2 + R_1R_4 + R_2R_3 + R_3R_4}{R_1+R_2+R_3+R_4} = \frac{R_4(R_1+R_3) + R_1R_2 + R_2R_3}{R_1+R_2+R_3+R_4}$$

$$R_{EQ}(R_1+R_2+R_3+R_4) = R_4(R_1+R_3)$$

$$\rightarrow \frac{R_{EQ}R_3 + R_{EQ}R_1 + R_{EQ}R_2}{R_1+R_3} = R_4 - R_{EQ} \cdot R_4$$

$$\rightarrow R_4(1 - R_{EQ}) = \frac{R_{EQ}(R_1+R_2+R_3)}{R_1+R_3}$$

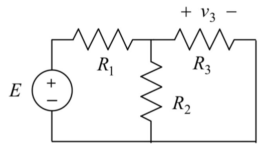
$$\Rightarrow R_4 = \frac{R_{EQ}(R_1+R_2+R_3)}{(R_1+R_3)(1-R_{EQ})}$$

$$\leadsto R_4 = \frac{R\left(R+R+\frac{1}{2}R\right)}{\left(R+\frac{1}{2}R\right)(1-R)} = \frac{\cancel{R}\left(\frac{4R+R}{2}\right)}{\frac{3}{2}\cancel{R} - \frac{3}{2}R^{\cancel{2}}}$$

$$= \frac{\frac{5}{\cancel{2}}R}{\frac{3-3R}{\cancel{2}}} =$$

BOH

ES. 1.7 - **Calcolare la tensione v_3 usando il partitore di tensione.**



$E = 220\ V$
$R_1 = 50\ \Omega$
$R_2 = R_3 = 100\ \Omega$

LKT : $v = v_1 + v_2$

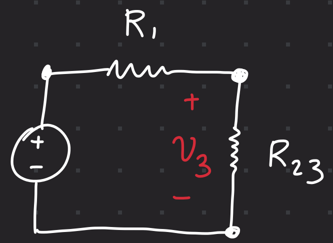
ma $\cdot$ $\underbrace{v_1 = R_1 \cdot i}_{(1)}$ (ohm)

$\Rightarrow v = (R_1 + R_2) \cdot i \Rightarrow \underbrace{i = \frac{v}{R_1 + R_2}}_{(2)}$

$\Rightarrow v_1 = \dfrac{R_1 \cdot v}{R_1 + R_2}$

Partitore di tensione

Part tens $\rightarrow$ SERIE



$$R_{23} = R_2 \parallel R_3 = \frac{R_2 \cdot R_3}{R_2 + R_3} = 50\ \Omega$$

$$\rightarrow v_3 = \frac{50\ \Omega \cdot 220\ V}{R_1 + 50} = \underline{110\ V}$$

Ans

Partitore di corrente

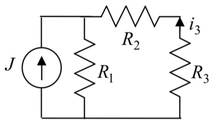
$$\begin{cases} i_1 = G_1 \cdot v \\ v = \dfrac{i}{G_1 + G_2} \end{cases}$$

$$\Rightarrow i_1 = \frac{G_1}{G_1 + G_2} \cdot i = \frac{R_2}{R_1 + R_2}\, i$$

corrente in uscita

Corrente in uscita

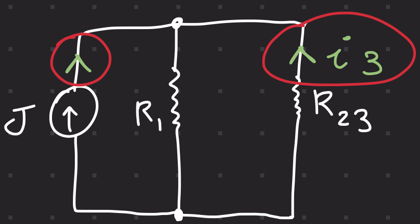
ES. 1.8 - **Calcolare la corrente i_3 usando il partitore di corrente.**



$J = 10\ mA$
$R_1 = R_3 = 5\ \mu\Omega$
$R_2 = 3\ \mu\Omega$

PART CURR. $\rightarrow$ PARALLELO

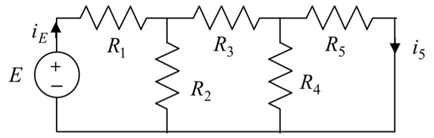
VERSO OPPOSTO $\rightarrow$ i_3 è Negativo!



$$i_3 = \frac{R_1}{R_1 + R_{23}} \cdot i = \frac{R_1}{R_1 + R_2 + R_3} (-J) = -3.84 \times 10^{-3}\ A = -3.84\ mA$$

$$\left.\begin{array}{l} J = 10\ mA = 10 \times 10^{-3}\ A = 0.01\ A \\ R_1 = R_3 = 5\ \mu\Omega = 5 \times 10^{-6}\ \Omega \\ R_2 = 3\ \mu\Omega = 3 \times 10^{-6}\ \Omega \end{array}\right\}$$

ES. 1.9 - **Calcolare la potenza erogata dal generatore E e quella assorbita dal resistore R_5**



$E = 10\ V$

$R_1 = 10\,\Omega \quad R_2 = 2\,\Omega$

$R_3 = 3\,\Omega \quad R_4 = 5\,\Omega \quad R_5 = 2\,\Omega$

$v = R \cdot i$ (1)

$P_a = v \cdot i$ (2)

Se non abbiamo v

$\hookrightarrow P_a = R\, i^2$ (3)

Potenza assorbita da un resistore

Q_1: $P_E^{erog} = E \cdot i_E$

- Devo Trovare i_E $\rightarrow$ Riduco il circuito

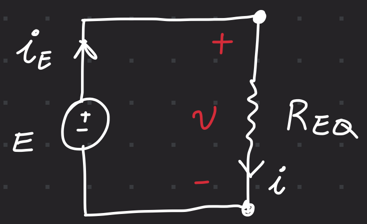
• $R_{45} = R_4 \,//\, R_5$

• $R_{3\text{-}45} = R_3 + (R_4 \,//\, R_5)$

$R_x = R_2 \,//\, R_{3\text{-}45}$

$R_{EQ} = R_1 + R_x = R_1 + \left[R_2 \,//\left(R_3 + \dfrac{R_4 R_5}{R_4 + R_5} \right) \right]$

$= 11.38\ \Omega$



• $v = R \cdot i \Rightarrow i_E = \dfrac{v}{R} = \dfrac{10\,V}{11.38\,\Omega} = 0.878\,A$

$\Rightarrow P_E^{erog} = E \cdot i_E = 10V \cdot 0.878A = 8.78\,W$

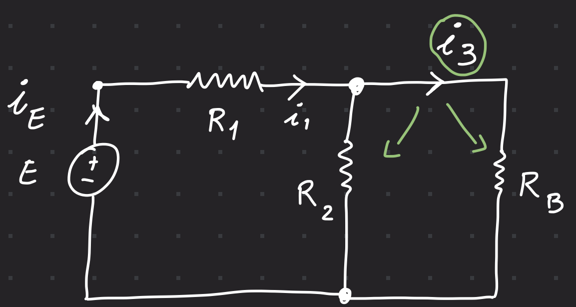
Ans 1

Q_2: $P_{R_5}^{ass} = R_5\, i_5^2$

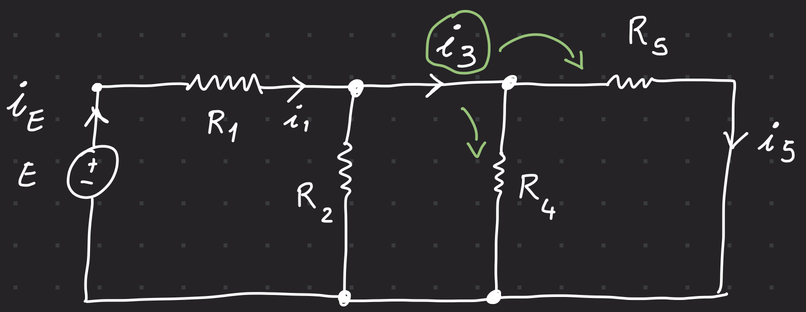
- Devo Trovare i_5: Part Corr $\rightarrow i_3$; Part Corr $\rightarrow i_5$

(A)

$R_B = R_4 \,//\, R_5 = \dfrac{R_4 R_5}{R_4 + R_5} = 1.428\ \Omega$



$\text{PART}_{2\text{-}B} \rightarrow i_3 = i_E \cdot \dfrac{R_2}{R_2 + R_B} = 0.513\ A$



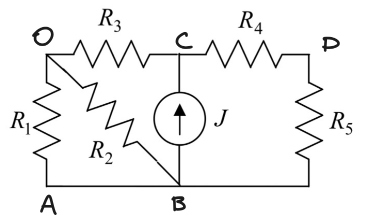
$\text{PART}_{4\text{-}5} \rightarrow i_5 = i_3 \cdot \dfrac{R_4}{R_4 + R_5}$

$\Rightarrow i_5 = 0.365\ A$

Sugli es è 0.19 A

$\Rightarrow P_{R_5}^{ASS} = R_5\, i_5^2 = 0.266\ W$???

ES. 1.10 - **Calcolare la potenza erogata dal generatore J e quella assorbita dal resistore** R_1.



$J = 5\ A$

$R_1 = R_4 = 5\,\Omega \quad R_2 = 3\,\Omega$

$R_3 = R_5 = 2\,\Omega$

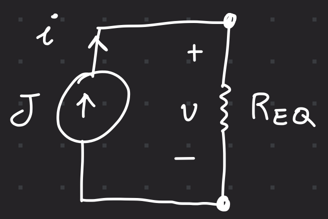
Risultato: $P_J^{erog} = 62.25\,W$, $P_{R_1} = 7.25\,W$.

$R_{25} = 2 + 5 = 7$

$R_{53} = 5 /\!/ 3 = 1.875$

$R_x = R_{53} + R_2 = 3.875$

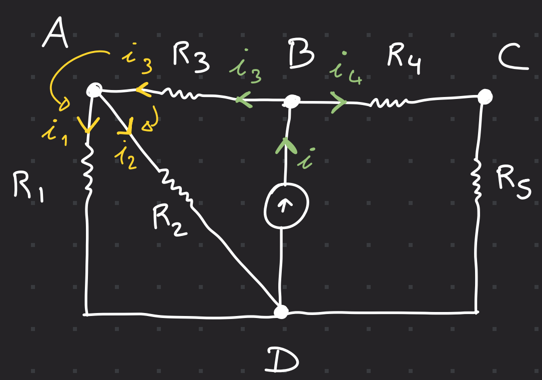
$R_{EQ} = R_x /\!/ R_{25} = 2.49\ \Omega$



$P_J^e = R \cdot i^2 = R_{EQ} \cdot J^2 = 2.49 \times 25 = \underline{62.36\ W}$

Ans 1

• Q2 : P_{R1}



• i si ripartisce in i_3 e i_4

$R_{45} = R_4 + R_5 = \underline{7\,\Omega}$

$R_{12} = R_1 /\!/ R_2 = 1.875\,\Omega$

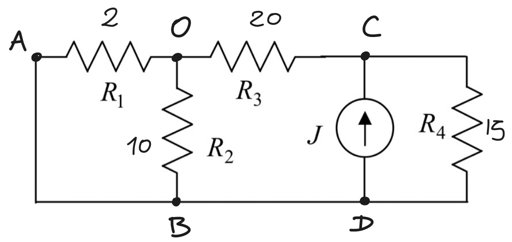
$R_{3-12} = R_3 + R_{12} = \underline{3.875\,\Omega}$

$$\Rightarrow i_3 = i \cdot \frac{R_{45}}{R_{3-12} + R_{45}} = 3.218\ A$$

$$i_1 = i_3 \cdot \frac{R_2}{R_1 + R_2} = 1.206\ A \quad \rightarrow \quad \underline{P^a_{R_1} = 7.28\ W}$$

Ans

ES. 1.11 - **Calcolare la potenza erogata dal generatore e quella assorbita da ogni resistore. Verificare la conservazione delle potenze.**

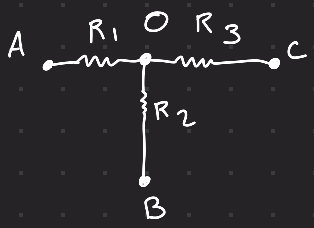


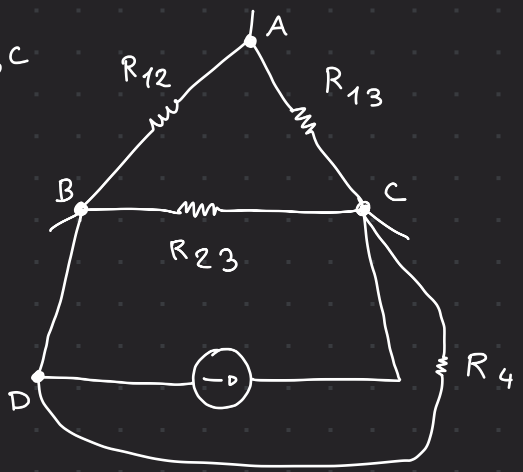
$J = 10\ A$

$R_1 = 2\ \Omega \quad R_2 = 10\ \Omega$

$R_3 = 20\ \Omega \quad R_4 = 15\ \Omega$

Risultato: $P_J^{erog} = 0.886\ \text{kW}$, $P_{R_1} = 0.023\ \text{kW}$, $P_{R_2} = 0.004\ \text{kW}$, $P_{R_3} = 0.335\ \text{kW}$, $P_{R_4} = 0.524\ \text{kW}$.



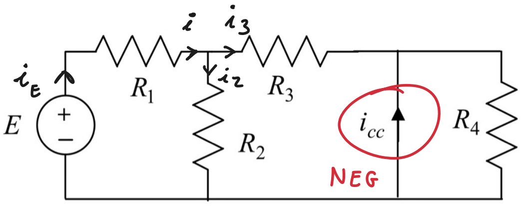


$$R_{12} = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_3} = 13$$

$$R_{13} = 26\ \Omega$$

$$R_{23} = 130\ \Omega$$

ES. 1.12 - **Calcolare la corrente i_{cc} che circola nel corto-circuito.**



$E = 220\ V$

$0.1 \times 10^3 = 100\ \Omega$

$R_1 = 10\ \Omega \quad R_2 = 0.1\ k\Omega$

$R_3 = 25\ \Omega \quad R_4 = 2\ k\Omega$

Risultato: $i_{cc} = -5.87$ A.

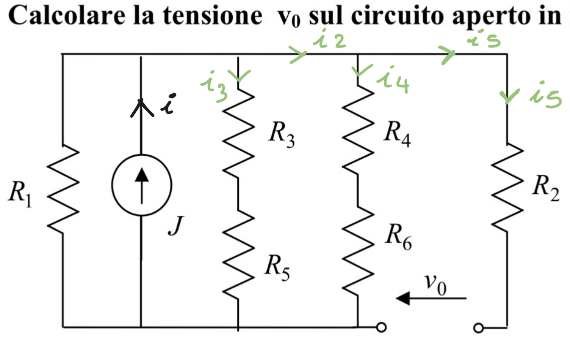
Corrente che circola nel corto-circuito

$$V = R \cdot i \Rightarrow \left.\begin{array}{l} R_{23} = R_2 // R_3 = 20\ \Omega \\ R_{EQ} = R_1 + R_{23} = 30\ \Omega \end{array}\right\} \Rightarrow i = \frac{V}{R} \rightarrow i_E = \frac{E}{R_E} = 7.\bar{3}\ A$$

$$\Rightarrow i_3 = i_E \cdot \frac{R_2}{R_2 + R_3} = 5.8\bar{6}\ A \Rightarrow i_{cc} \cong -5.87\ A$$

Ans

ES. 1.13 - **Calcolare la tensione v_0 sul circuito aperto in figura.**



$J_1 = 1\ A$

$R_1 = 10\ \Omega \quad R_2 = 10\ \Omega$

$R_3 = 15\ \Omega \quad R_4 = 5\ \Omega$

$R_5 = 30\ \Omega \quad R_6 = 25\ \Omega$

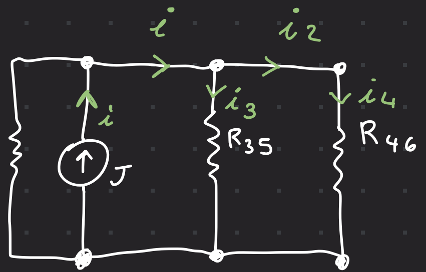
Risultato: $v_0 = -6.43$ V .

Tensione sul circuito aperto

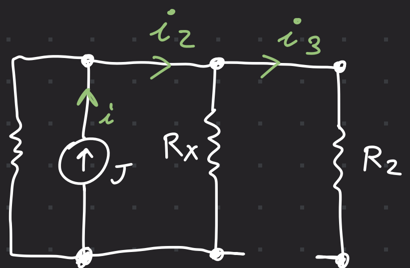
$$\left.\begin{array}{l} R_x = R_3 + R_5 \\ R_y = R_4 + R_6 \end{array}\right\} R_A = R_x // R_y = 18\ \Omega \qquad R_{EQ} = R_A // R_1 = 6.42\ \Omega$$

$$V = R \cdot i \Rightarrow V_1 = R_{EQ} \cdot J = 6.429\ V$$

BOH



$$i_2 = i \cdot \frac{R_{46}}{R_{46} + R_{35}} = 2.57\ A$$

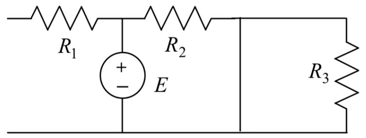


$$R_x = (R_3 + R_5) // (R_4 + R_6) = 18\ \Omega$$

$$\rightarrow i_3 = i_2 \cdot \frac{R_x}{R_x + R_2} = 1.65\ A$$

$V = R \cdot i \Rightarrow$

ES. 1.14 - **Valutare la potenza assorbita dai resistori della rete in figura.**

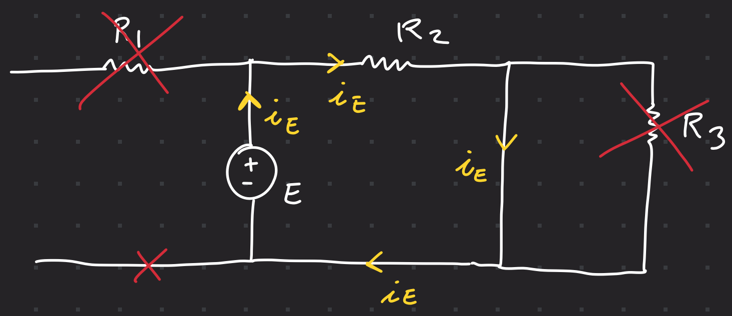


$E = 10\ V$

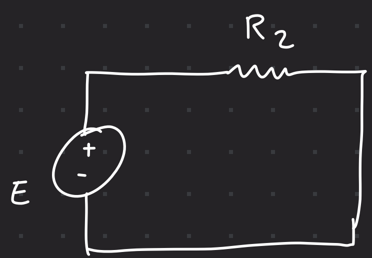
$R_1 = 10\ \Omega \quad R_2 = 1\ \Omega$

$R_3 = 100\ \Omega$

Risultato: $P_{R_1} = P_{R_3} = 0$, $P_{R_2} = 100$ W.



$\longrightarrow$



$$\Rightarrow \quad v = R \cdot i \Rightarrow i_E = \frac{E}{R_2} = \underline{10\ A}$$

$$P^a_{R_2} = R_2 \cdot i_E^2 = \underline{100\ W}$$

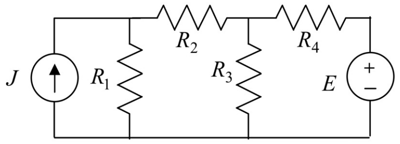
Ans 1

$$P^a_{R_1} = P^a_{R_2} = R_1 \cdot 0 = R_2 \cdot 0 = \underline{\emptyset}$$

Ans 2

2. Sovrapposizione degli effetti

ES. 2.1 - **Calcolare la potenza totale erogata dai generatori.**



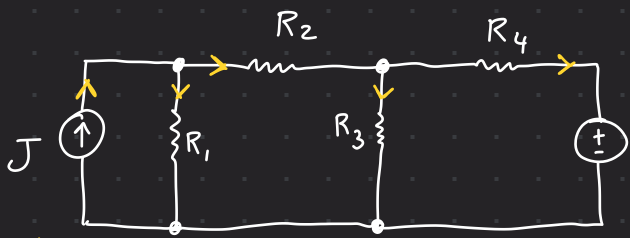
$E = 10\,V \quad J = 20\,A$

$R_1 = R_2 = 3\,\Omega$

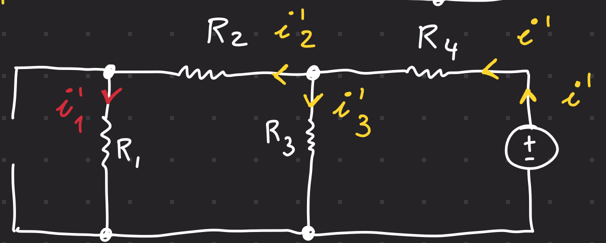
$R_3 = 2\,\Omega \quad R_4 = 5\,\Omega$

$Q_1 : P_E^e = E \cdot i_E$

$P_J^e = V_J \cdot J$



C'



• Trovo I

$R_{Eq} = R_4 + \left[(R_2 + R_1) /\!/ R_3 \right] = 6.5\ \Omega$

$V = R \cdot I \rightarrow i = \frac{E}{R_{Eq}} = 1.54\ A$

• Trovo le V

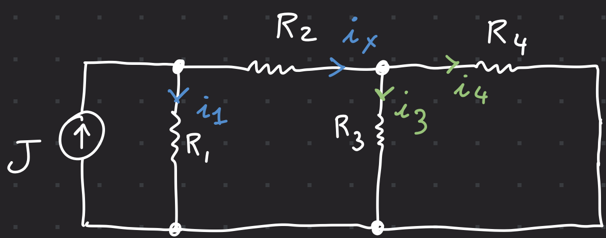
$R_x = R_1 + R_2$

Partitore di corrente

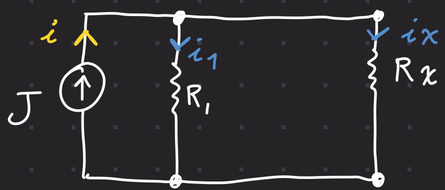
$\rightarrow i_x = i \cdot \frac{R_3}{R_x + R_3}$

$\rightarrow i_x = 0.385\ A \rightarrow$ Ohm : $V = R \cdot i \rightarrow$

$\rightarrow V_x'' = i_x \cdot R_1 = 1.155\ V$



C''



• Trovo V

$R_{Eq} = R_1 /\!/ \left[(R_3 /\!/ R_4) + R_2 \right] = 1.78\ \Omega$

$\rightarrow V = R_{Eq} \cdot J = 35.8\ V$

$R_x = \left[(R_3 /\!/ R_4) \right] + R_2 = 4.43\ \Omega$

$\rightarrow i_x = i \cdot \frac{R_1}{R_x + R_1} = 8.07\ A$

BOH!

$\rightarrow i_4 = i_x \cdot \frac{R_3}{R_3 + R_4} = -2.31\ A$

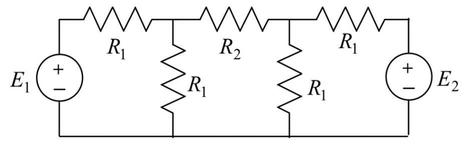
$\Rightarrow V = V' + V'' = 35.8 + 1.15 = 36.95\ V$

$I = I' + I'' = 1.54\ A - 2.31 = -0.77\ A$

$\Rightarrow P_E^e = E \cdot i_E = -7.70\ W$

$P_J^e = J \cdot V = 739\ W$

ES. 2.2 - **Calcolare la potenza totale erogata dai generatori.**

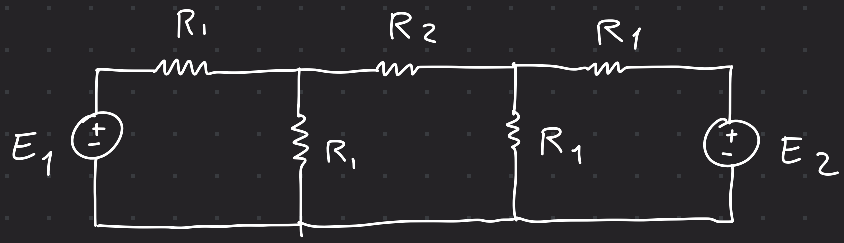


$E_1 = 10\ \text{V}$, $E_2 = 20\ \text{V}$

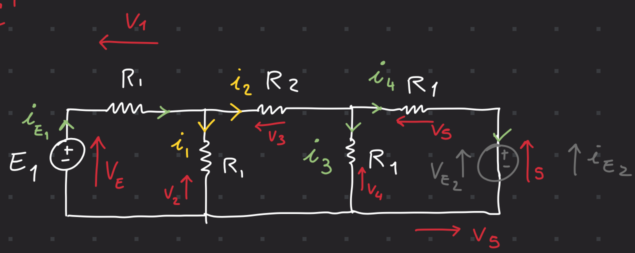
$R_1 = 2\ \Omega$, $R_2 = 1\ \Omega$

Risultato: $P_{E_1}^{erog} = 16.67\ \text{W}$, $P_{E_2}^{erog} = 0.12\ \text{kW}$.

$$\Rightarrow v_1 = \frac{R_1 \cdot v}{R_1 + R_2}$$



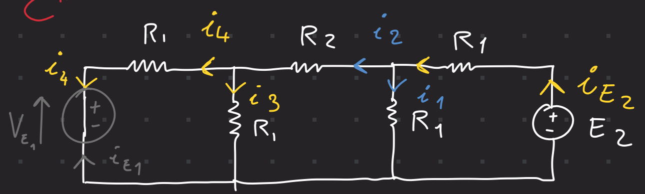
C'



$$\bullet\ I'_{E_1} = \frac{E_1}{R_{eq}} = \frac{E_1}{\{[(R_1 \parallel R_1) + R_2] \parallel R_1\} + R_1} = 3.\bar{3}\ A \quad i'_{E_1}$$

$$\bullet\ i'_4 \qquad i_2 = i_{E_1} \cdot \frac{R_1}{R_1 + R_x} = 1.\bar{6}\ A \Rightarrow i'_{E_2} = -i'_4 = i_2 \cdot \frac{R_1}{R_1 + R_1} = -0.83\ A = 833\ mA \quad i'_{E_2}$$

C''



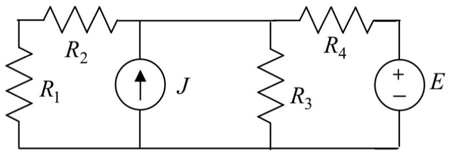
$$\bullet\ i_{E_2} = \frac{E_2}{R_{eq}} = \frac{}{\{[(R_1 \parallel R_1) + R_2] \parallel R_1\} + R_1} = 6.67\ A \quad i''_{E_2}$$

$$i_2 = i_{E_1} \cdot \frac{R_1}{R_1 + R_x} = 3.33\ A \qquad i''_{E_1} = -i''_4 = -i_2 \cdot \frac{R_1}{R_1 + R_1} = -1.66\ A \quad i''_{E_1}$$

$$\Rightarrow P^e_{E_1} = E_1 \cdot (i'_{E_1} + i''_{E_1}) = 16.67\ W \quad \text{Ans 1}$$

$$P^e_{E_2} = E_2 \cdot (i'_{E_2} + i''_{E_2}) = 116.8 = 0.12\ kW \quad \text{Ans 2}$$

ES. 2.3 - **Calcolare la potenza totale erogata dai generatori.**

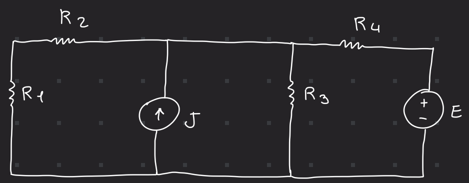


$E = 50\,V \quad J = 20\,A$

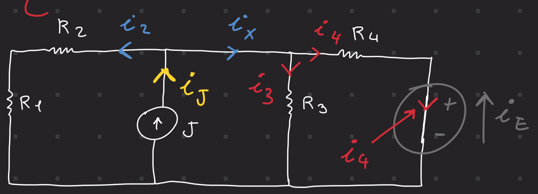
$R_1 = 1\,\Omega \quad R_2 = 5\,\Omega$

$R_3 = R_4 = 10\,\Omega$

Risultato: $P_E^{erog} = -0.09$ kW, $P_J^{erog} = 1.36$ kW.



C'



• V_J :

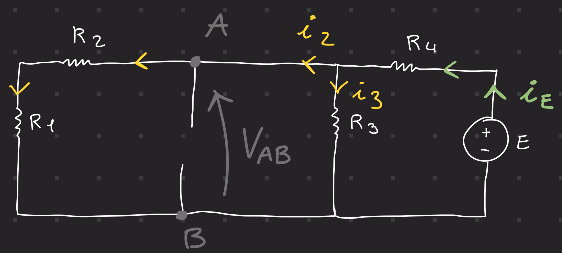
$$Req = (R_1 + R_2) \,||\, (R_3 \,||\, R_4) \overset{!}{=} 2.\overline{72}\ \Omega$$

$$\Rightarrow V_J = \frac{J}{Req} = 54.\overline{54}\ V$$

• i_4:

$$i_x = i_J \cdot \frac{R_{12}}{R_{12} + R_x} = 10.91\ A \qquad i_4 = i_x \cdot \frac{R_3}{R_3 + R_4} = 5.\overline{45}\,A = -i_E$$

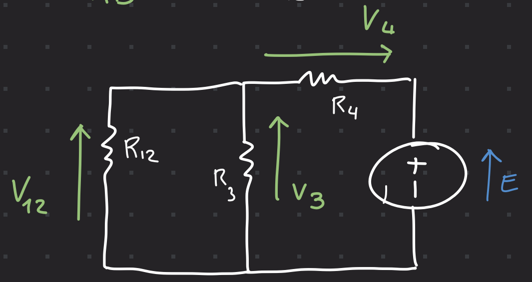
C''



• i_E'' :

$$i_E = -i_E'' = \frac{E}{Req} = \frac{E}{[(R_1+R_2) \,||\, R_3] + R_4} = 3.\overline{63}\,A$$

• $V_{AB} = V_{R_{12}} \rightarrow R_{12} = R_1 + R_2 = 6\,\Omega$



$$V_4 + V_3 = E \qquad \text{ma } V_4 = R_4 \cdot i_4 = 36.4\,V$$

$$i_4 = i_4$$

$$\Rightarrow V_3 = E - 36.4 = 13.64\ V$$

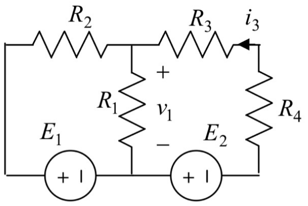
$$V_{12} - V_3 = 0 \rightarrow V_{12} = +13.64$$

$$\Rightarrow P_J^e = J \cdot (V' + V'') = 1361\ W = 1.36\ kW$$

Ans

$$\Rightarrow P_E^e = E \cdot (i' + i'') = -90.91\ W = -0.091\ kW$$

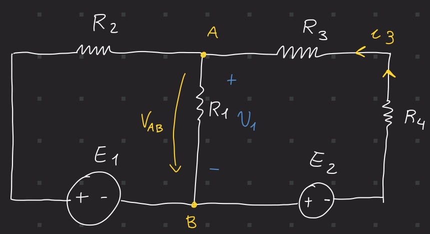
ES. 2.4 - **Calcolare la tensione v_1 e la corrente i_3.**



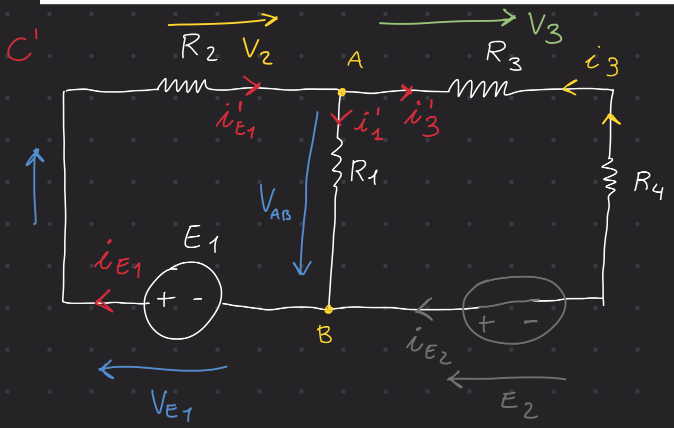
$R_1 = R_2 = R_3 = R_4 = 2\,\Omega$

$E_1 = 5\,\mathrm{V},\ E_2 = 2\,\mathrm{V}$

Risultato: $v_1 = 1.60\,\mathrm{V},\ i_3 = -0.90\,\mathrm{A}$.



C'



$$V_2 = E_1 \cdot \frac{R_2}{R_2 + R_x}$$

con $R_x = (R_3 + R_4) \parallel R_1 = 1.\bar{3}\,\Omega$

$\rightarrow V_2 = 3\ V$

V_1'

$V_2 + V_{AB} = E_1 \Rightarrow V_{AB} = E_1 - V_2 = 2\,V$

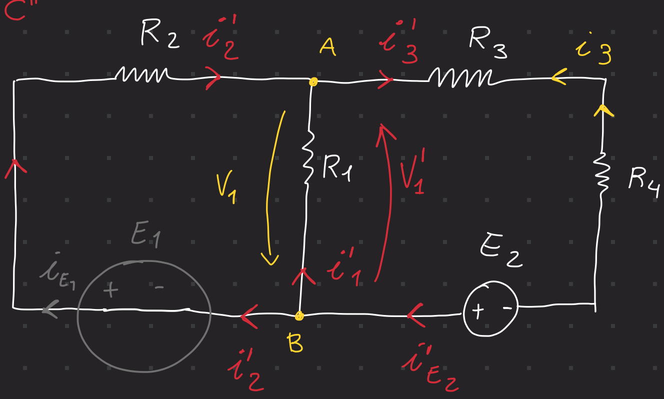
$$i_3 = -i_3' = i_{E_1} \cdot \frac{R_2}{R_2 + R_L} = -0.5\ A$$

i_3'

$$\bullet\ i_{E_1} = \frac{E_1}{Req} = \Big[\underbrace{\big((R_3+R_4) \parallel R_1\big) + R_2}_{3\,\bar{3}\,\Omega}\Big]^{-1} \cdot E_1 = 1.5\,A$$

$\bullet\ R_L = (R_3 + R_4) = 4\ \Omega$

C''



i_3''

$$\bullet\ -i_{E_2}' = \frac{E_2}{Req} = -0.4\ A = i_3$$

$$V_{12} + V_3 + V_4 = E_2$$

V_1''

$$\rightarrow V_{12} = E_2 - \left[i_{E_2} \cdot (R_3 + R_4)\right] = 0.4\ V$$

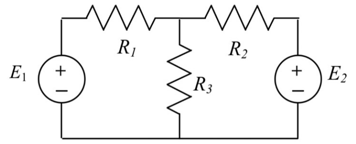
$V_1'' = V_2'' = V_{12}$

ma $V_1 = -V_1''$

$\Rightarrow\ V_1 = (V_1' - V_1'') = 1.6\ V$ Ans1

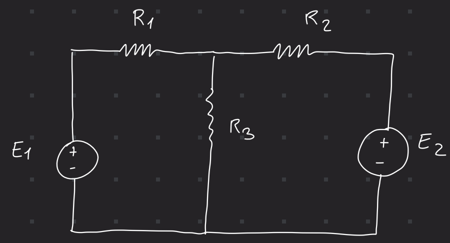
$i_3 = (-i_3' - i_3'') = -0.9\,A$ Ans2

ES. 2.6 - **Determinare la potenza erogata dal generatore E_1.**

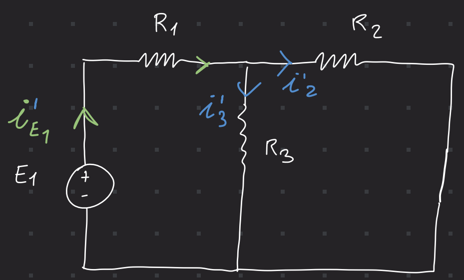


$E_1 = 5\,V$, $E_2 = 12$,
$R_1 = 3.5\,\Omega$, $R_2 = 2.3\,\Omega$, $R_3 = 3.2\,\Omega$.

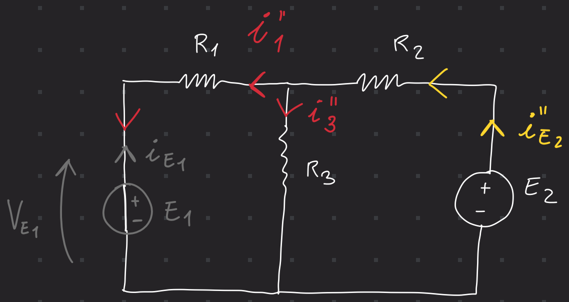
Risultato: $P_{E_1}^{erog} = -2.05$ W.



C'



$$i'_{E_1} = \frac{E_1}{R_{eq}} = 1.03\ A$$



$$i''_{E_2} = \frac{E_2}{R_{eq}} = 3.02\,A$$

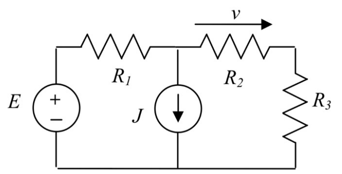
$$\Rightarrow i''_{E_1} = -i''_1 = -i''_{E_2} \cdot \frac{R_3}{R_3 + R_1} = -1.44\,A$$

$$\Rightarrow i_{E_1} = i' + i'' = 1.03 - 1.44 = -0.413\,A$$

$$\Rightarrow P^e_{E_1} = E_1 \cdot i_{E_1} = -2.065\ W$$ Ans

Time 11'

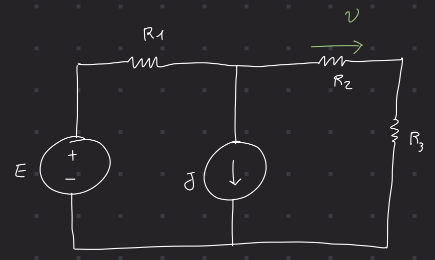
ES. 2.7 - **Utilizzando il principio di sovrapposizione degli effetti, determinare la tensione v.**

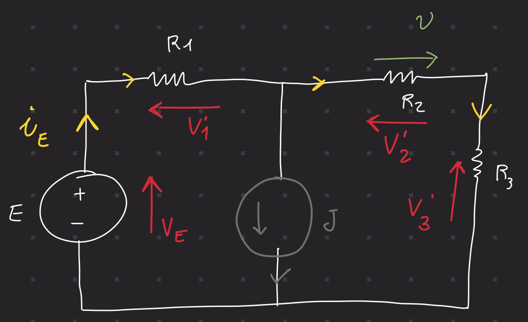


$E = 5\,V, J = 2\,mA$

$R_1 = 3\,k\Omega, R_2 = 2.4\,k\Omega, R_3 = 3.2\,k\Omega$

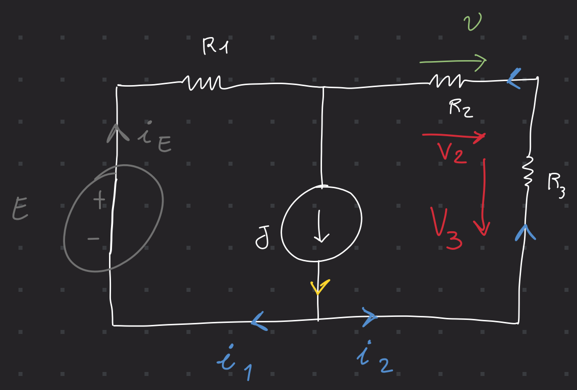
Risultato: $v = 0.28$ V.





$$i_E = \frac{E}{Req} = 0.58\ mA = 581\ \mu A$$

$$V_2 = -V_2' = -R_2 \cdot i_E' = -1.39\ V$$



$$i_2'' = J \cdot \frac{R_1}{R_1 + R_L} = 2 \times 10^{-3} \cdot \frac{3 \cancel{\times 10^3}}{(3 + 5.6) \cancel{\times 10^3}} =$$

$$= 0.697 \times 10^{-3} = 697\ \mu A$$

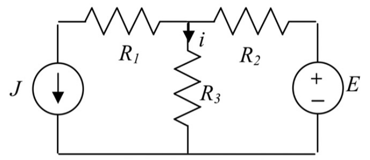
$$\Rightarrow V_2'' = R_2 \cdot i_2 = 1.67\ V$$

$$\Rightarrow V_2 = V_2' + V_2'' = 0.28\ V$$

Ans

Time 22
(ho fatto casino)

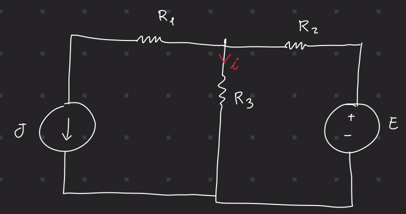
ES. 2.8 - **Utilizzando il principio di sovrapposizione degli effetti, determinare la corrente i e la potenza assorbita da R_3**



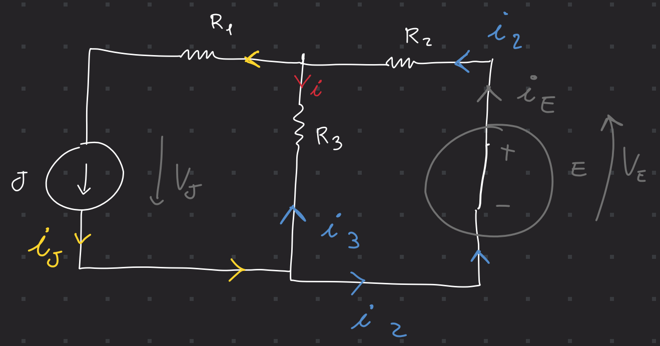
$E = 10\,V$, $J = 1\,mA$

$R_1 = 3.2\text{ k}\Omega$, $R_2 = 2.2\text{ k}\Omega$, $R_3 = 3.5\text{ k}\Omega$

Risultato: $i = 1.37\text{ mA}, P = 6.57\,\text{mW}$.



C'

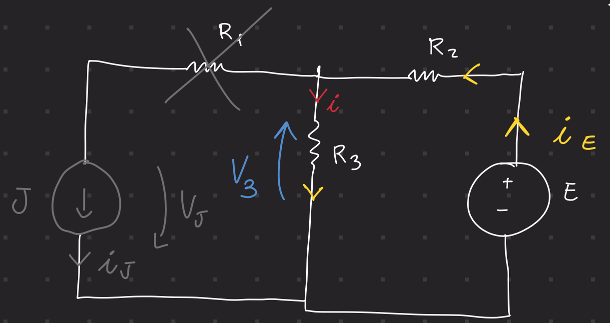


$$i_3 = -i_3' = -J \cdot \frac{R_2}{R_2 + R_3} = -0.38 \times 10^{-3}\,A$$

$$= -336\,\mu A \quad i'$$

C''

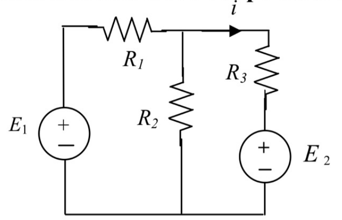
$$i_3 = i_E'' = \frac{E}{R_{eq}} = 1.75\,mA$$



$$\Rightarrow \quad i = 1.75\,mA - 0.38\,mA = \underline{1.37\,mA} \quad \text{Ans}$$

$$\Rightarrow \quad P^a_{R_3} = -P^e_{R_3} = R_3 \cdot i^2 = \underline{6.57\,mW}$$

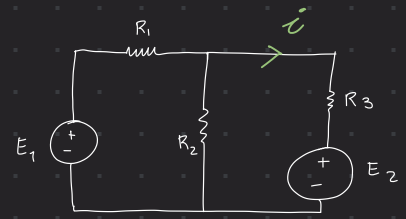
ES. 2.9 - **Valutare la corrente i e la potenza erogata dal generatore E_1.**



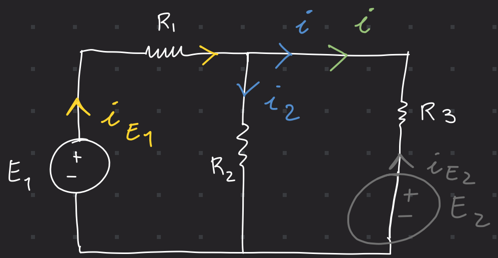
$E_1 = 10\,V$, $E_2 = 20\,V$

$R_1 = 5\,\Omega$, $R_2 = 20\,\Omega$, $R_3 = 10\,\Omega$

Risultato: $i = -0.86\,\text{A}$, $P_{E_1}^{erog} = -2.86\,\text{W}$.



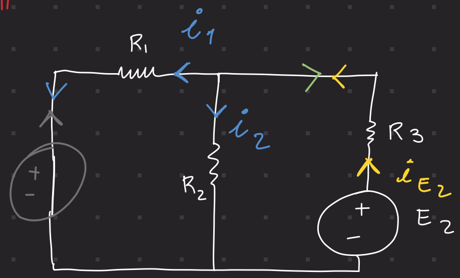
C'



$$i_{E_1} = \frac{E_1}{R_{eq}} = 0.857\,A \quad i''_{E_1}$$

$$\to i' = i'_{E_1} \cdot \frac{R_2}{R_2+R_3} = 0.57\,A \quad i'$$

C''



$$i''_{E_2} = \frac{E_2}{R_{eq}} = 1.43\,A = -i$$

$$\Rightarrow i'' = -1.43\,A \quad i''$$

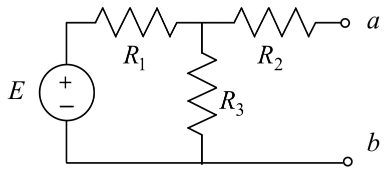
$$i_{E_1} = -i''_1 = i \cdot \frac{R_2}{R_2+R_1} = -1.144\,A \quad i''_{E_1}$$

$$\Rightarrow i = -0.86\,A$$

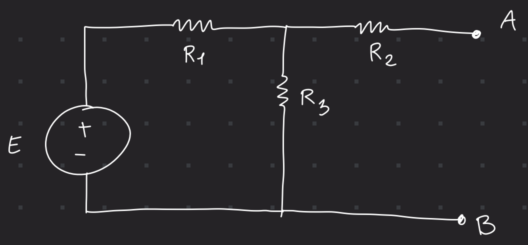
$$\Rightarrow i_{E_1} = 1.81\,A \quad \to \quad P^e_{E_1} = E_1 \cdot i_{E_1} = 0.287 \cdot 10 = -2.87\,W$$

3. Generatori equivalenti di Thevenin e norton

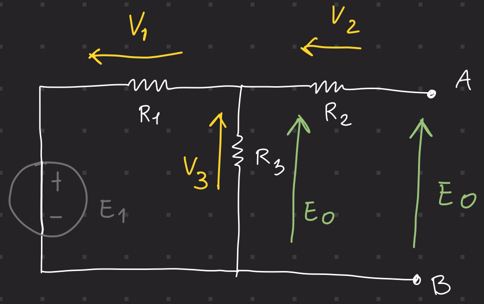
ES. 3.1 - **Calcolare l'equivalente di Thévenin visto ai capi dei morsetti a-b.**



Equivalente di Thevenin



Spengo l'unico generatore

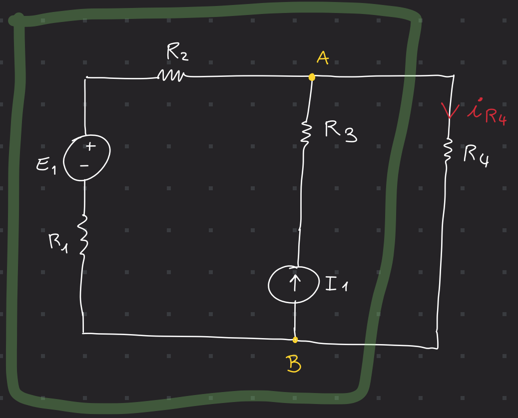


La Tensione a Vuoto E_0 si ottiene con V_{AB}, siccome non c'è corrente $V_2 = V_3 = E_0$

$\Rightarrow$ Part Tens $\rightarrow$ $E_0 = E \cdot \dfrac{R_3}{R_3 + R_1}$

Esercizio Video Elisabetta

NORTON

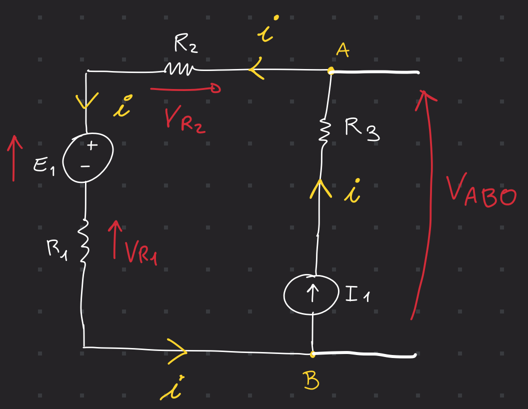


L'esercizio ci chiede di trovare Ir4, quindi lo scopo del gioco è di semplificare tutta la part4 del circuito cerchiata in verde con un **generatore ideale ed una resistenza in parallelo (Norton).**

La resistenza in parallelo si calcola andando a **spegnere tutti i generatori** e calcolando così la resistenza equivalente.

1. Isoliamo il circuito cerchiato
2. Calcoliamo la **tensione a vuoto**
3. Resistenza equivalente —> sarà la resistenza in || del nuovo gen
4. Calcolo la corrente del nuovo generatore In

1



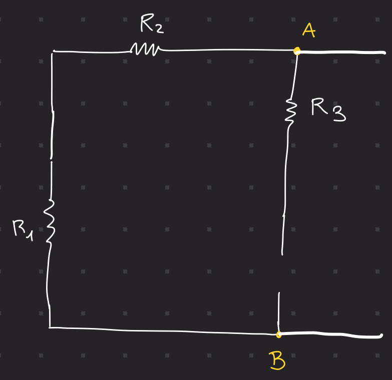
2

$$\to \quad V_{AB0} = V_{R_1} + E_1 + V_{R_2} = I_1(R_1+R_2)+E_1 = 105\,V$$

3

Resistenza in // del nuovo generatore

$$R_n = R_{eq} = R_1 + R_2 = 150\,\Omega$$

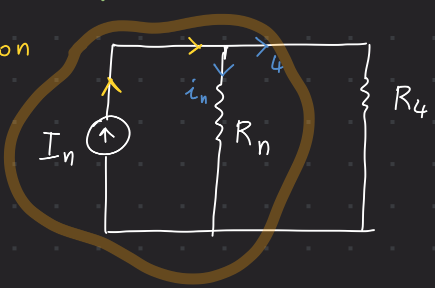


Corrente del nuovo generatore

4 $\Rightarrow I_n = \dfrac{V_{AB0}}{R_{eq}} = 0.7\,A$

NUOVO CIRCUITO

Norton $\Rightarrow$

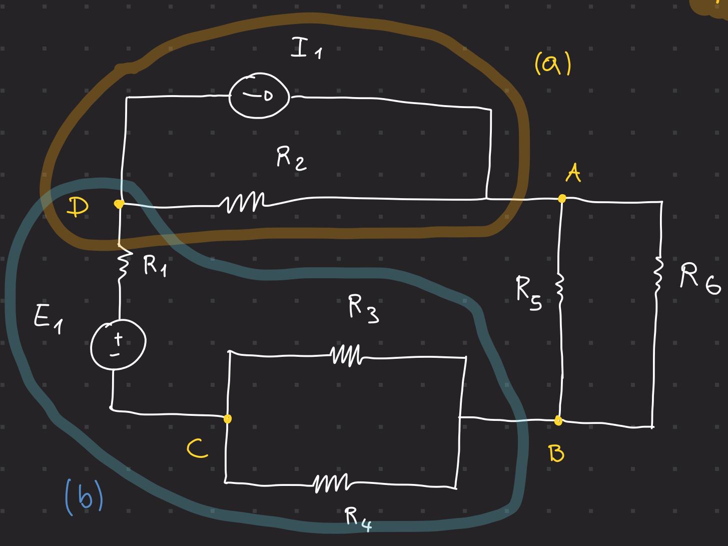


Ans

$$i_4 = I_n \cdot \frac{R_n}{R_n+R_4} = 0.62\,A$$

Esercizio Video Elisabetta

Thevenin



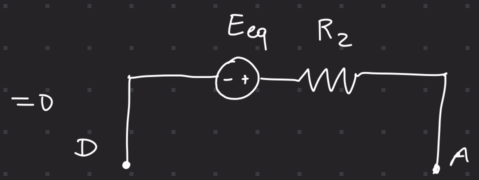
Q: I_{R6} → Serve V_{AB}

I_{R6}

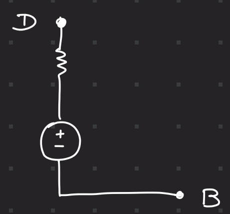
(a): gen curr → gen tens . $V = R \cdot I \Rightarrow E_{eq} = R_2 \cdot I_1 = 4.8V$

$R_{eq} = R_2$

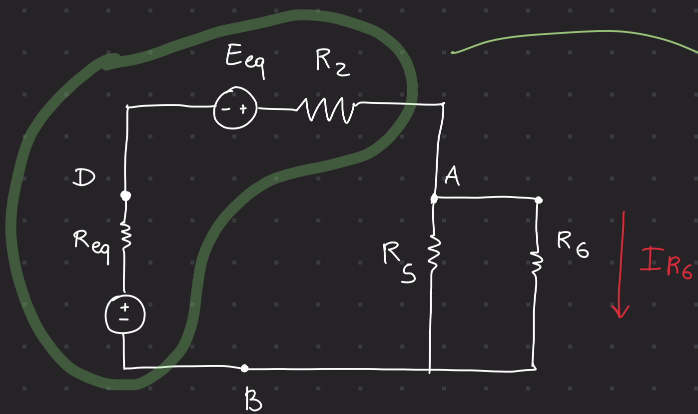
⇒



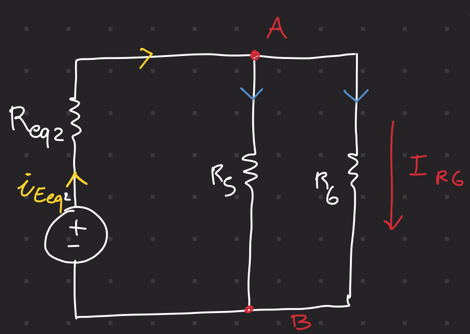
(b) $R_{eq} = (R_3 \parallel R_4) + R_1 = 40\Omega$ ⇒



⇒



Quando ho due generatori in serie questi si possono sempre sommare. Quando hanno lo stesso "verso" allora li sommiamo, quando invece sono discordi uno dei due verrà sottratto.
Le due resistenze vengono messe in serie e ne viene calcolata la somma.



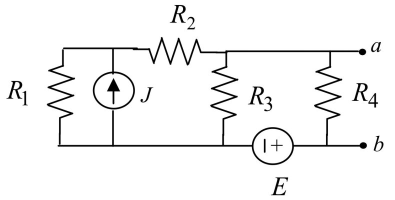
(x) $i_{Eeq} = \frac{E_{eq2}}{R_{eq}} = \frac{\overbrace{E_1 + E_{eq}}^{28.8V}}{\underbrace{R_{eq2} + (R_5 \parallel R_6)}_{77.14\Omega}} = 0.373A$

$\Rightarrow i_6 = i_{Eeq} \cdot \frac{R_5}{R_5 + R_6} = 0.16\ A$ Ans

Processo Alternativo: Diverso dal punto (x) in poi

$V_{AB} = E_{eq2} \cdot \frac{R_{56}}{R_{56} + R_{eq2}} = 6.4V$ → $I_6 = \frac{V_{AB}}{R_6} = 0.16\ A$ Ans

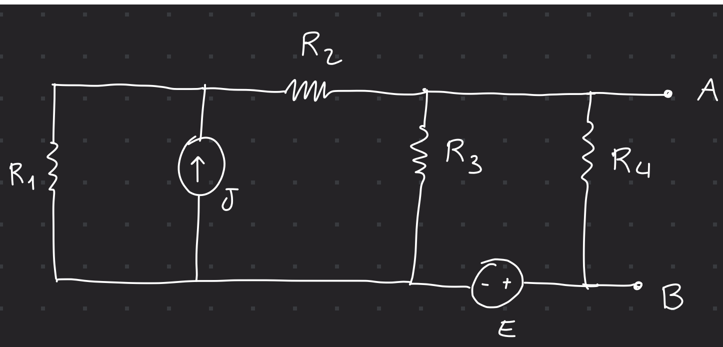
ES. 3.2 - **Calcolare l'equivalente di Norton visto ai capi dei morsetti a-b.**

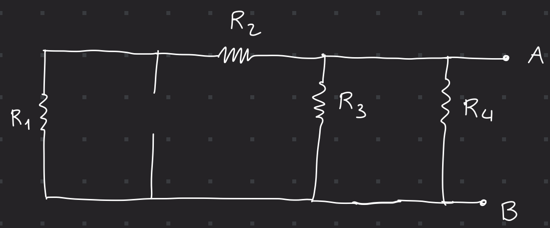


$J = 20\ A \qquad E = 10\ V$

$R_1 = R_2 = 2\ \Omega$

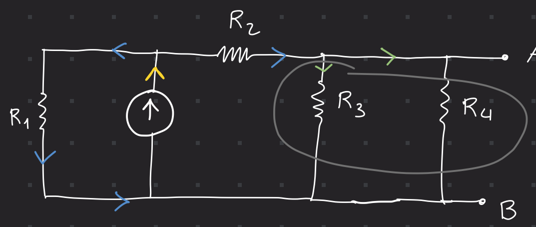
$R_3 = R_4 = 4\ \Omega$





- $R_{eq} = \left[(R_1+R_2) \,//\, R_3\right] \,//\, R_4 = 1.\bar{3}\,\Omega$

C'

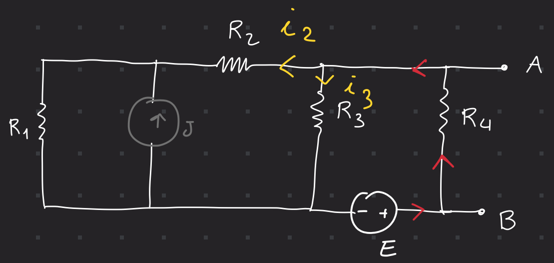


Passo fare il // per avere la stessa i di R_2

$\Rightarrow i_{R_3} + i_{R_4} = i_{R_2} = I_{cc}$

I'_{cc}

$$\rightarrow I'_{cc} = J \cdot \frac{R_1}{R_1+R_2} = 10\,A$$



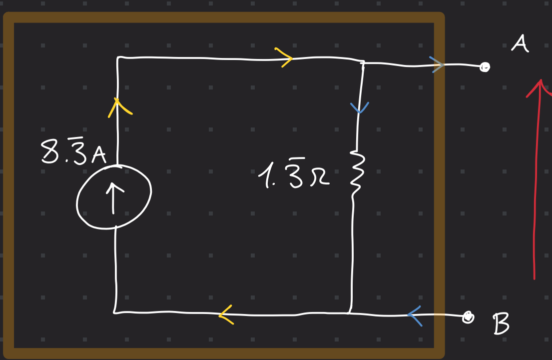
I''_{cc}

$$I''_{cc} = -i_E = \frac{E}{R_{eq}} = \frac{E}{\underbrace{(R_1+R_2)\,//\,R_3}} = -5\ A$$

R_4 in serie <u>NON</u> viene inclusa

$$\Rightarrow I_{cc} = I'_{cc} + I''_{cc} = 5\ A$$

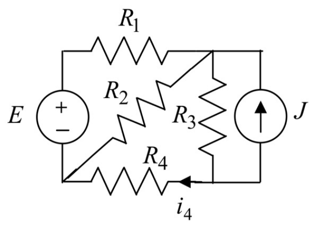
Ans



Circuito equivalente di norton

$\Rightarrow V_{AB} = 5A \cdot 1.\bar{3}\Omega = 6.\bar{6}\ V$

ES. 3.3 - **Utilizzando l'equivalente di Norton calcolare la corrente che circola in R_4.**

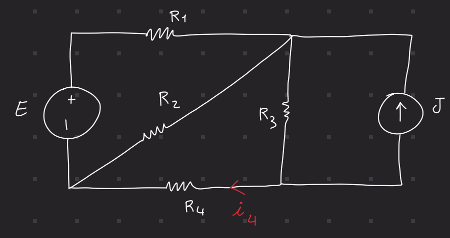


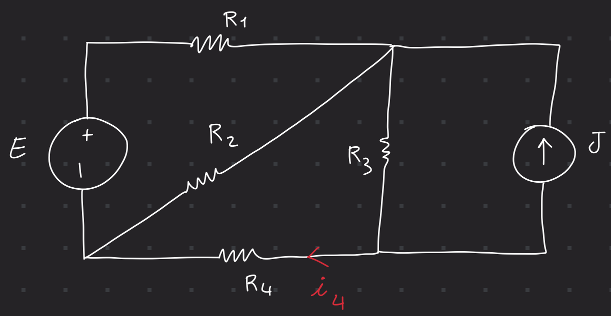
$E = 54\ V$

$J = 10\ A$

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

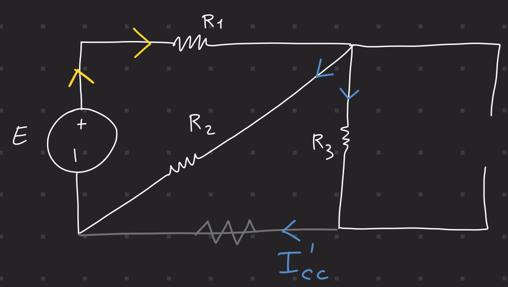
$R_4 = 12\,\Omega$





(1) $R_{eq} : (R_1 \parallel R_2) + R_3 = 6.4\ \Omega$

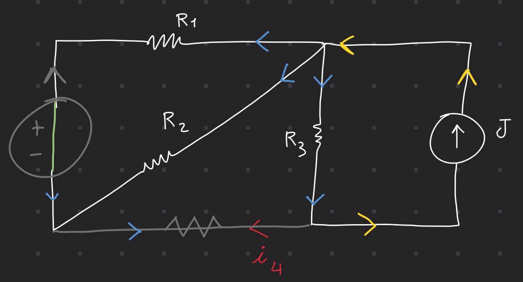
C'



$$i_E = \frac{E}{R_{eq}} = 6.75$$

$$\Rightarrow I'_{cc} = i_E \cdot \frac{R_2}{R_2 + R_3} = 3.375\ A$$

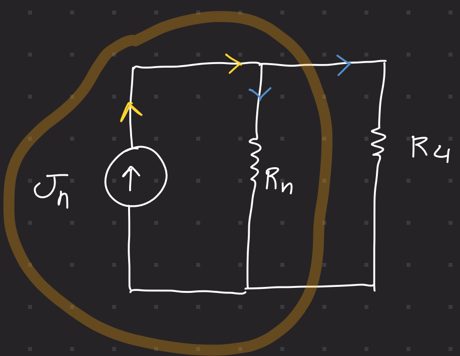
I'_{cc}



I''_{cc}

$$I''_{cc} = -i_{12} = J \cdot \frac{R_3}{R_3 + R_{12}} = -6.25\ A$$

$$\Rightarrow I_N = I' + I'' = -2.875\ A \qquad R_N = 6.4\ \Omega$$

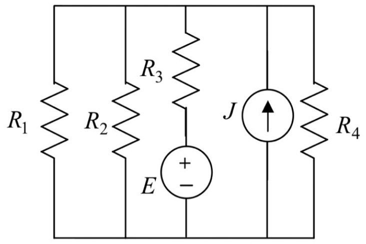


NORTON

$$i_4 = J_n \cdot \frac{R_n}{R_n + R_4} = -1\ A$$

Ans

ES. 3.4 - **Utilizzando il teorema di Thévenin calcolare la potenza assorbita dal resistore R_2.**

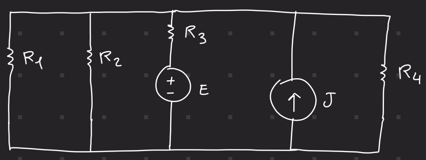


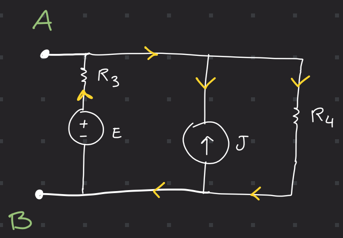
$E = 1\,V \quad J = 2\,mA$

$R_1 = R_2 = 1\,k\Omega \quad R_3 = 2\,k\Omega$

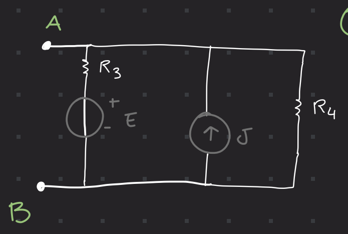
$R_4 = 5\,k\Omega$

Risultato: $P_{R_2} = 0.85\,mW$.





• R_t

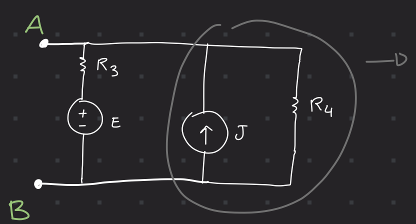


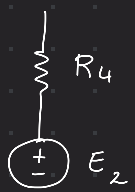
1

$R_{th} = R_{AB} = R_3 // R_4 = 1428.57\,\Omega$

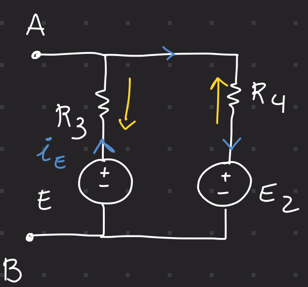
R_{th}

2





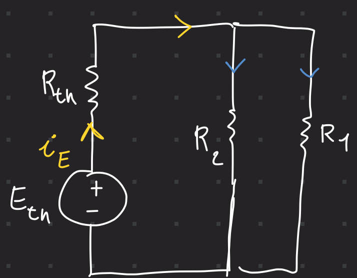
$\to \quad E_2 = R_4 \cdot J = 10V$



$\to \; -E + V_3 + V_4 + E_2 = 0 \; \to \; i_E (R_3 + R_4) = E - E_2$

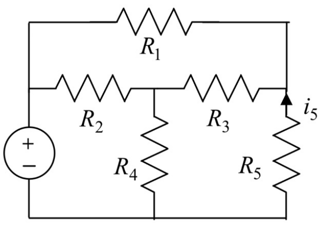
$$\to \; i_E = \frac{E - E_2}{R_3 + R_4} = -1.28\ mA$$

$V_{AB} = 3.6\,V \quad \to$



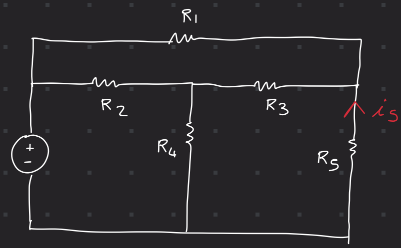
$$\to \; i_2 = i_E \cdot \frac{R_1}{R_1 + R_2} = -1.28 \cdot \frac{1K}{1K + 1K} = \frac{1.28}{2} = 0.64\ mW$$

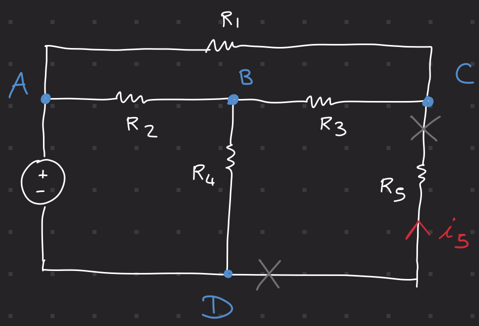
ES. 3.5 - **Utilizzando il teorema di Thévenin calcolare la corrente i_5.**

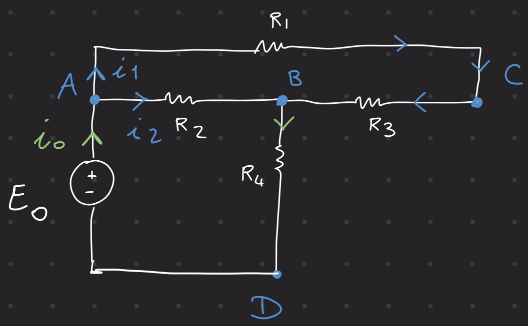


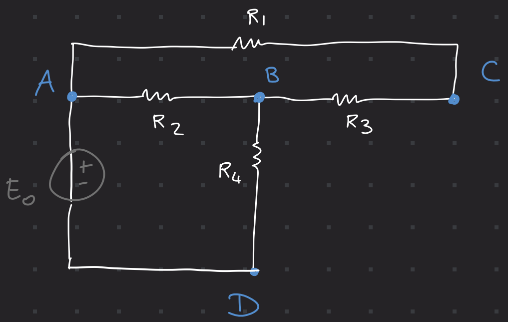
$E = 12\,V$
$R_1 = R_3 = 0.2\,k\Omega$
$R_2 = 0.6\,k\Omega$
$R_4 = R_5 = 0.4\,k\Omega$

Risultato: $i_5 = -18\,mA$.





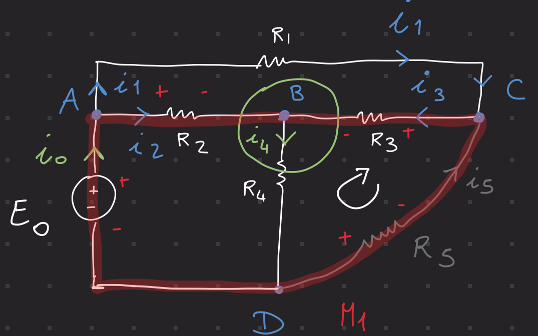




R_{tn}

$$R_{thDC} = \left[(R_2 \| R_4) + R_3 \right] \| R_1 = 137.5\,\Omega$$

$A \equiv D$



$$R_{eq} = \left[(R_1 + R_3) \| R_2 \right] + R_4 = 640\,\Omega$$

$$\to i_0 = \frac{E_0}{R_{eq}} = 0.0187\,A = 18.75\,mA$$

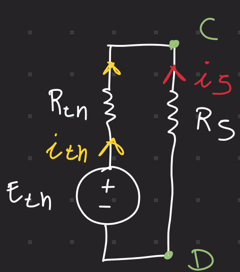
$$LKC_A: \quad -i_0 + i_2 + i_1 = 0 \to i_2 = i_0 - i_1 = 7.5\,mA$$

$$i_1 = i_0 \cdot \frac{R_2}{R_2 + (R_1 + R_3)} = 11.25\,mA$$

$$LKC_B: \quad -i_2 + i_4 - \underset{i_3 = i_1}{i_3} = 0 \to i_4 = i_1 + i_2 = 18.75\,mA$$

$$\Rightarrow LKT_{M_1}: \quad -E_0 + V_2 - V_3 - V_5 = 0 \to V_5 = V_2 - V_3 - E_0$$

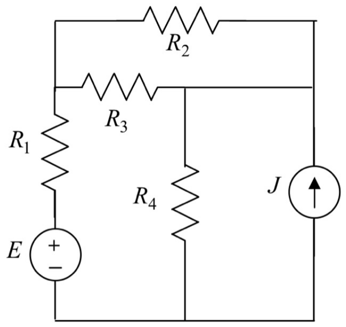
$$\hookrightarrow V_5 = (i_2 R_2) - (i_1 R_3) - E_0 = -9.75\,V \quad E_{thDC}$$



$$\Rightarrow i_{th} \overset{i_5}{=} \frac{E_{th}}{R_{th} + R_5} = -0.018 = -18.34\,mA$$

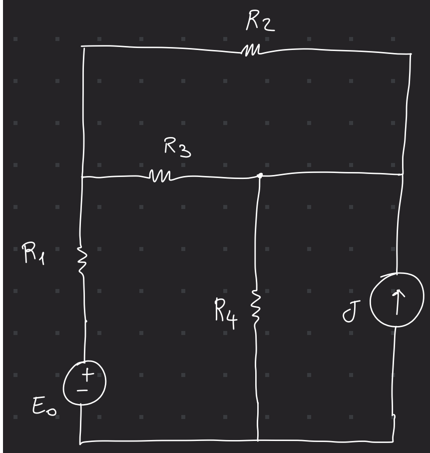
Ans

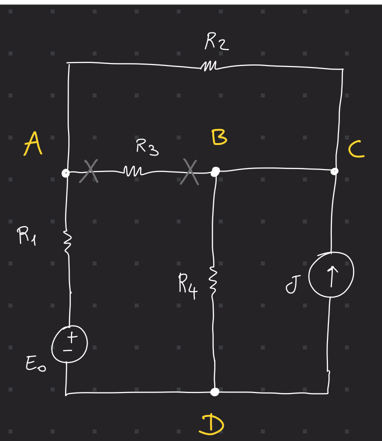
ES. 3.6 - **Utilizzando il teorema di Norton calcolare la potenza assorbita dal resistore R_3.**

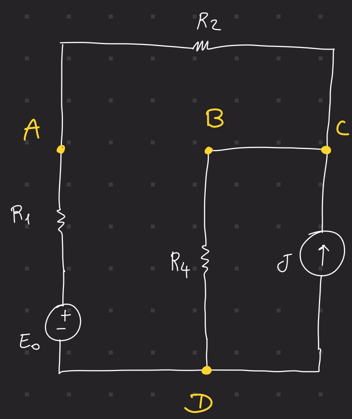


$E = 5\,V$
$J = 1\,\mu A$
$R_1 = R_3 = 2\,M\Omega$
$R_2 = 800\,k\Omega$
$R_4 = 300\,k\Omega$

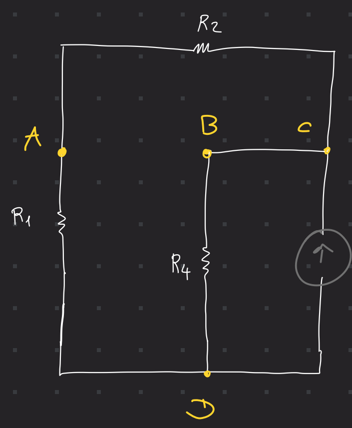
Risultato: $P_{R_3} = 0.43\,\mu W$.







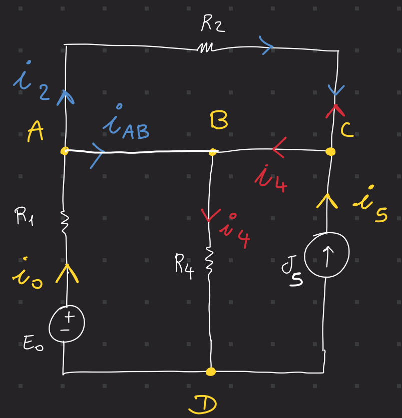
C'

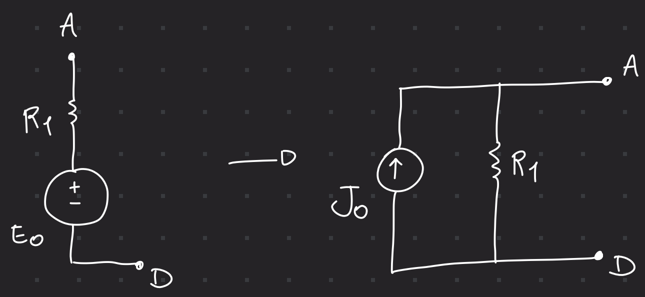


$R_{N\,AB} = (R1+R_4) \parallel R_2 = 593.54\ k\Omega$

R_{NAB}

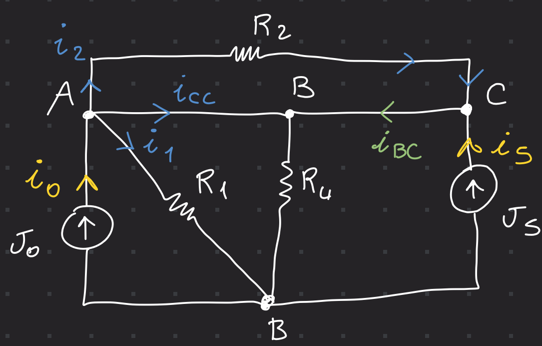
C''



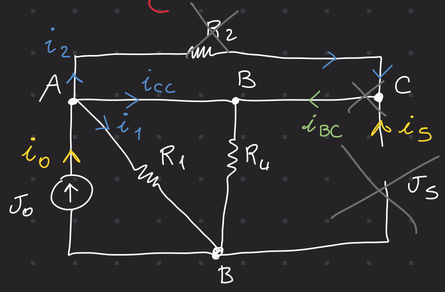


Con $J_o = \dfrac{E_o}{R_1} - i_o = 2.5\,\mu A$

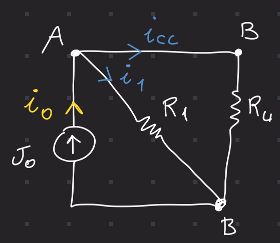
J_o



C'

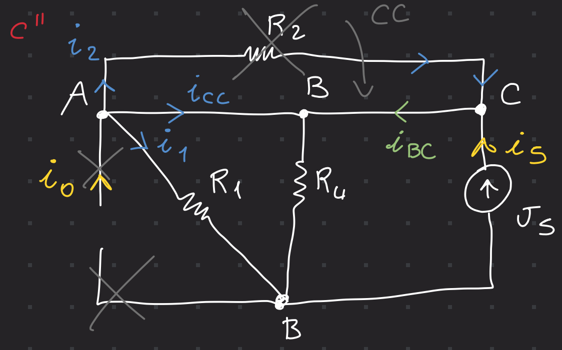


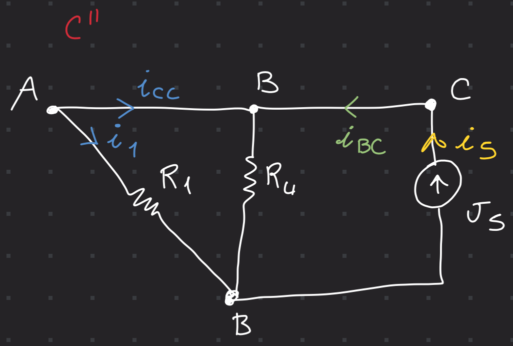
C'



i'_{cc}

$\rightarrow \quad i'_{cc} = J_o \cdot \dfrac{R_1}{R_1 + R_4} = 2.174\ \mu A$



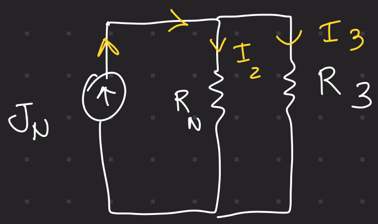


$$i_{cc}'' = -i_{cc} = -J_S \cdot \frac{R_4}{R_4 + R_1} = -0.130\,\mu A$$

i_{cc}''

J_N

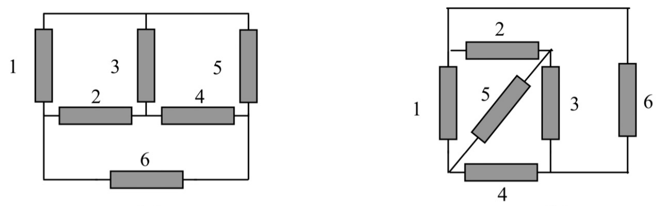
$$\Rightarrow i_{cc} = 2.043\,\mu A$$



$$\rightarrow \quad I_3 = J_N \cdot \frac{R_N}{R_N + R_3} = 0.467\,\mu A$$

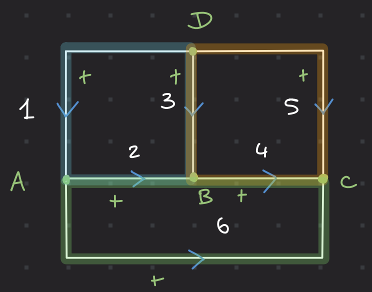
$$\rightarrow \quad P_{R_3}^a = R_3 \cdot I_3^2 = 0.43\,\mu W$$

ES. 4.1 - **Date le seguenti reti di bipoli, scrivere un sistema completo di equazioni di Kirchhoff indipendenti.**



(a) **(b)**

(a)



LKC:

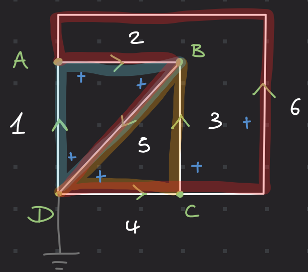
$$\begin{cases} -i_1 + i_2 + i_6 = 0 \\ -i_2 - i_3 + i_4 = 0 \\ -i_4 - i_5 - i_6 = 0 \end{cases}$$

LKT

$$\begin{cases} -V_1 + V_3 - V_2 = 0 \\ -V_3 + V_5 - V_4 = 0 \\ +V_2 + V_4 - V_6 = 0 \end{cases}$$

(b)

C.U. - Orario



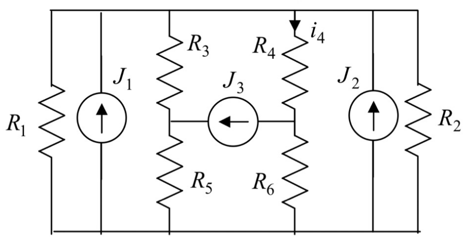
LKC

$$\begin{cases} -i_1 + i_2 - i_6 = 0 & A \\ -i_2 - i_3 + i_5 = 0 & B \\ -i_4 + i_3 + i_6 = 0 & C \end{cases}$$

LKT

$$\begin{cases} M_1 \quad V_1 + V_2 + V_5 = 0 \\ M_2 \quad -V_5 - V_3 - V_4 = 0 \\ M_3 \quad -V_6 - V_4 - V_5 - V_2 = 0 \end{cases}$$

ES. 4.2 - **Utilizzando il metodo dei potenziali nodali calcolare la corrente nel resistore R_4.**



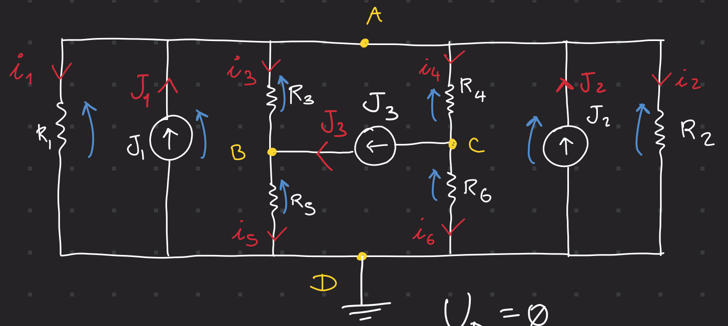
$J_1 = J_2 = 1\,A \quad J_3 = 3\,A$

$R_1 = 30\,\Omega \quad R_2 = 10\,\Omega$

$R_3 = 25\,\Omega \quad R_4 = 5\,\Omega$

$R_5 = 35\,\Omega \quad R_6 = 15\,\Omega$

(1) Potenziale a zero



$U_D = 0$

(2) LKC:

A: $i_3 + i_4 + i_1 + i_2 = J_1 + J_2$

B: $-i_3 + i_5 = J_3$

C: $-i_4 + i_6 = -J_3$

(3) Correnti di lato

$V_1 = U_A - U_D = U_A$

$V_2 = U_A$

$V_3 = U_A - U_B$

$V_4 = U_A - U_C$

$V_5 = U_B$

$V_6 = U_C$

$$\Rightarrow \quad i_1 = \frac{U_A}{R_1} \qquad i_4 = \frac{U_A - U_C}{R_4}$$

$$i_2 = \frac{U_A}{R_2} \qquad i_5 = \frac{U_B}{R_5}$$

$$i_3 = \frac{U_A - U_B}{R_3} \qquad i_6 = \frac{U_C}{R_6}$$

(4) Unisco

$$\begin{cases} \dfrac{U_A - U_B}{R_3} + \dfrac{U_A - U_C}{R_4} + \dfrac{U_A}{R_1} + \dfrac{U_A}{R_2} = J_1 + J_2 \\ \dfrac{U_B - U_A}{R_3} + \dfrac{U_B}{R_5} = J_3 \\ \dfrac{U_C - U_A}{R_4} + \dfrac{U_C}{R_6} = -J_3 \end{cases}$$

$$\Rightarrow \begin{cases} G_3 (U_A - U_B) + G_4 (U_A - U_C) + G_1 U_A + G_2 U_A = J_1 + J_2 \\ G_3 (U_B - U_A) + G_5 U_B = J_3 \\ G_4 (U_C - U_A) + G_6 U_C = -J_3 \end{cases}$$

$$\Rightarrow \begin{cases} U_A (G_3 + G_4 + G_1 + G_2) + U_B (-G_3) + U_C (-G_4) = J_1 + J_2 \\ U_A (-G_3) + U_B (G_3 + G_5) = J_3 \\ U_A (-G_4) + U_C (G_6 + G_4) = -J_3 \end{cases}$$

$$\begin{pmatrix} (G_3+G_4+G_1+G_2) & (-G_3) & (-G_4) \\ (-G_3) & (G_3+G_5) & 0 \\ (-G_4) & 0 & (G_6+G_4) \end{pmatrix} \begin{pmatrix} U_A \\ U_B \\ U_C \end{pmatrix} = \begin{pmatrix} J_1+J_2 \\ J_3 \\ -J_3 \end{pmatrix}$$

$\Rightarrow$ $U_A = 7.5\ V$

$U_B = 48.125\ V$

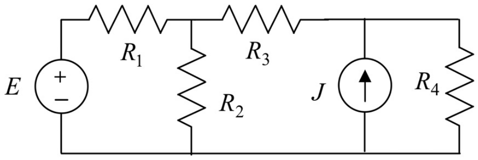
$U_C = -5.625\ V$

Q: i_4

Ans

$$\Rightarrow i_4 = \frac{U_A - U_C}{R_4} = 2.625\ A$$

ES. 4.3 - **Utilizzando il metodo dei potenziali nodali modificato calcolare la potenza erogata dai due generatori e la potenza assorbita dai resistori (verificare la conservazione delle potenze).**

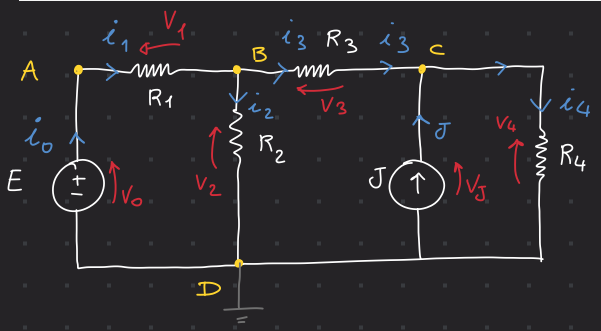


$E = 50\,V \quad J = 60\,A$

$R_1 = 5\,\Omega \quad R_2 = 40\,\Omega$

$R_3 = 80\,\Omega \quad R_4 = 120\,\Omega$

La differenza con il metodo "base" è che in questo caso i generatori di tensione vengono considerati **direttamente** nei calcoli (non si convertono in corrente)



(1) LKC:

$$\begin{cases} B: & -i_1 + i_3 + i_2 = 0 \\ C: & -i_3 + i_4 = J \end{cases}$$

Siccome $\quad U_A = E$

(2) Potenziali

$V_1 = U_A - U_B = E - U_B \quad \Rightarrow \quad i_1 = G_1(E - U_B)$

$V_2 = U_B \;,\; V_3 = U_B - U_C \qquad i_2 = G_2 U_B \quad i_3 = G_3(U_B - U_C)$

$\qquad\qquad\qquad\qquad\qquad\qquad i_4 = G_4 U_C$

$V_4 = U_C$

$$\Rightarrow \begin{cases} G_1 U_B - G_1 E + G_3 U_B - G_3 U_C + G_2 U_B = 0 \\ G_3 U_C - G_3 U_B + G_4 U_C = J \end{cases} \Rightarrow \begin{cases} U_B(G_1 + G_3 + G_2)\ U_C(-G_3) = G_1 E \\ U_B(-G_3) + U_C(G_3 + G_4) = J \end{cases}$$

$$\begin{bmatrix} (G_1 + G_2 + G_3) & (-G_3) \\ (-G_3) & (G_3 + G_4) \end{bmatrix} \begin{bmatrix} U_B \\ U_C \end{bmatrix} = \begin{bmatrix} G_1 E \\ J \end{bmatrix}$$

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} U_B \\ U_C \end{pmatrix} = \begin{pmatrix} E \\ F \end{pmatrix} \Rightarrow \begin{array}{l} U_B = 200V = 0.2kV \\ U_C = 3kV \end{array}$$

$\Rightarrow i_1 = -30\ A \qquad i_3 = -35A$

$\quad i_2 = 5\ A \qquad i_4 = 25A$

Ans

$\Rightarrow P_E^e = E \cdot i_0 = E \cdot i_1 = -1.5\,kV \qquad P_{R_1} = R_1 \cdot i_1^2 = 4.5\,kW$

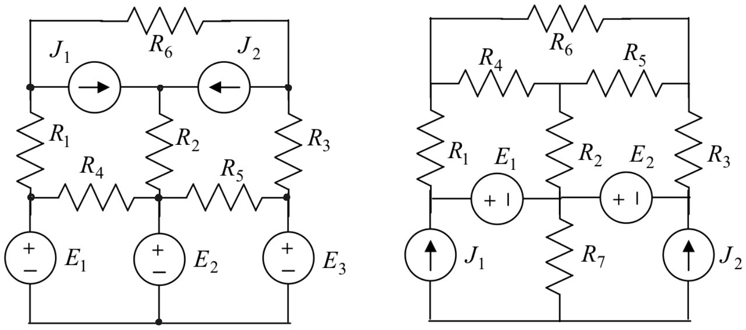
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad P_{R_2} = 1\,kW$

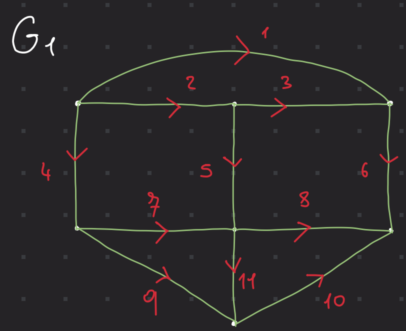
$P_J^e = J \cdot V_{CD} = J \cdot V_4 = 180\,kW \qquad P_{R_3} = 98\,kW \;,\; P_{R_4} = 75\,kW$

ES. 4.4 - Con riferimento alla seguenti reti:

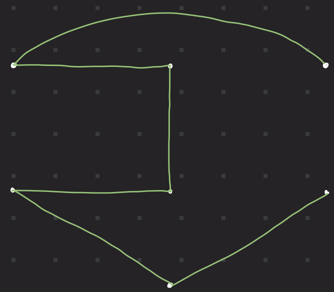
a) scrivere il sistema completo delle equazioni di Kirchhoff e delle equazioni caratteristiche (utilizzare grafo, albero e co-albero).

b) scrivere il suddetto sistema in forma matriciale, individuando le matrici di incidenza ridotta e di maglia fondamentale.

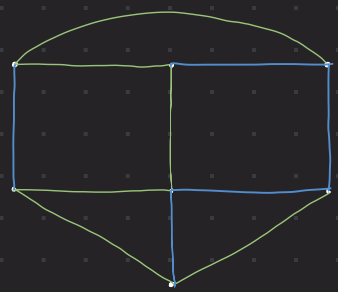


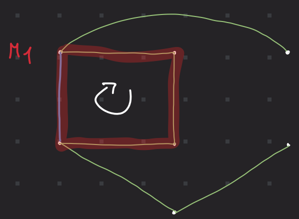


Albero



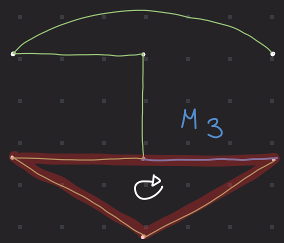
Albero + Coalbero





LKT Alle Maglie fondamentali

(Albero + 1 lato di coalbero)



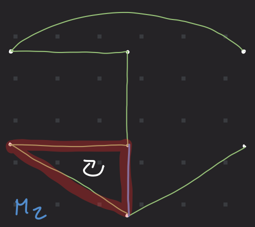
$M_1: V_2 + V_5 - V_7 - V_4 = 0$

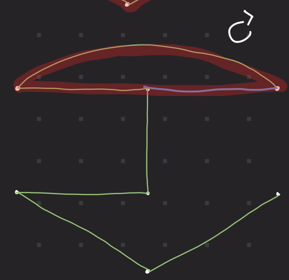
$M_2: V_7 + V_{11} - V_9 = 0$

$M_3: V_7 + V_8 - V_{10} - V_9 = 0$

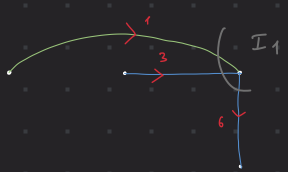
$M_4: V_1 + V_6 - V_{10} - V_9 + V_7 - V_5 - V_2 = 0$

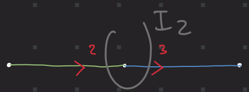
$M_5: V_1 - V_3 - V_2 = 0$

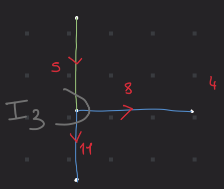


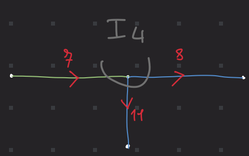


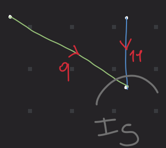
LKC agli Idt fondamentali (1 lato Albero + n del coalbero)

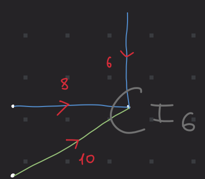








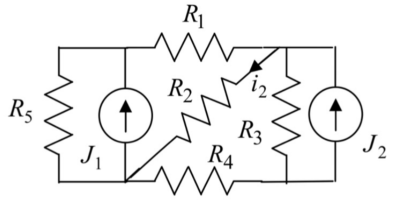




LKC Idt:

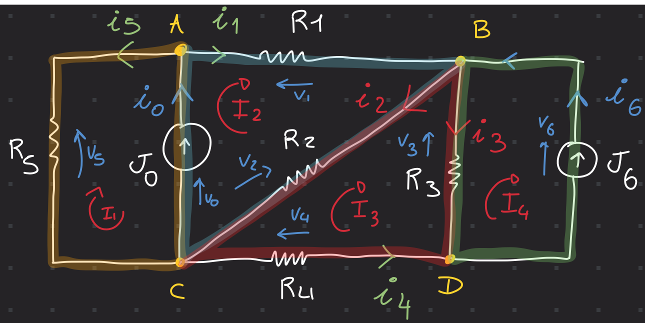
$$\begin{cases} -i_1 - i_3 + i_6 = 0 \\ -i_2 + i_3 = 0 \\ -i_5 + i_8 + i_{11} = 0 \\ -i_7 + i_8 + i_{11} = 0 \\ -i_9 - i_{11} = 0 \\ -i_8 - i_{10} - i_6 = 0 \end{cases}$$

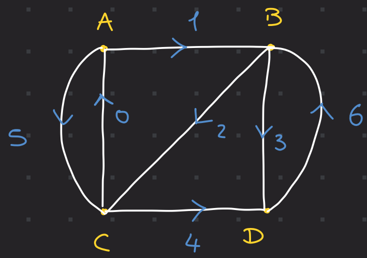
ES. 4.5 - Utilizzando il metodo delle correnti di maglia calcolare la corrente in R_2.



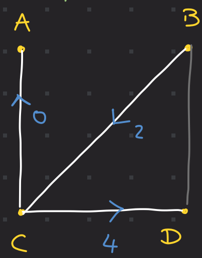
$J_1 = 10\ A$
$J_2 = 5\ A$
$R_1 = 2\,\Omega \quad R_2 = R_3 = 3\,\Omega$
$R_4 = R_5 = 5\,\Omega$

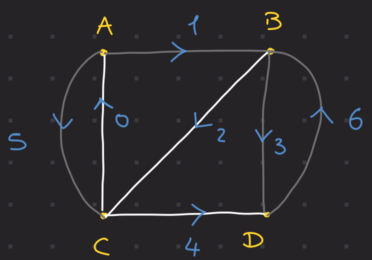
Risultato: $i_2 = 5\ A$..

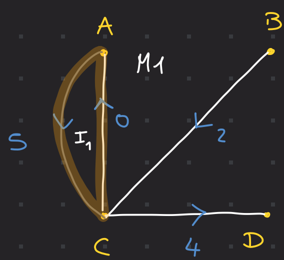


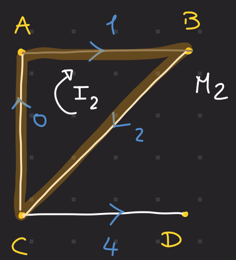


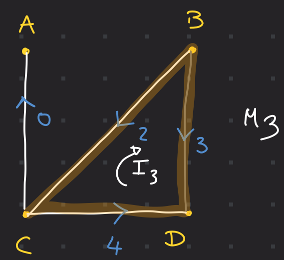
Albero

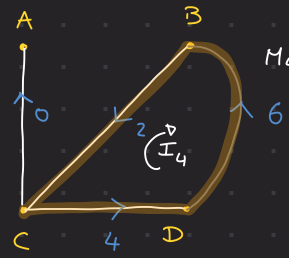












LKT Maglie orario - C.M.

$$\begin{cases} M_1: & -V_5 - V_0 = 0 \\ M_2: & V_0 + V_1 + V_2 = 0 \\ M_3: & -V_2 + V_3 - V_4 = 0 \\ M_4: & -V_2 - V_6 - V_4 = 0 \end{cases}$$

$$Req_{AC} = \left\{\left[(R_3+R_4) \parallel R_2\right] + R_1\right\} \parallel R_5 = 2.277\,\Omega$$

$$Req_{BD} = \left\{\left[(R_5+R_1) \parallel R_2\right] + R_4\right\} \parallel R_3 = 2.11\,\Omega$$

Correnti di Maglia

$i_0 = -I_1 + I_2$
$i_1 = I_2$
$i_2 = I_2$
$i_3 = I_3$
$i_4 = -I_3$
$i_5 = -I_1$
$i_6 = -I_4$

Rel caratteristiche

$$\begin{cases} V_0 = i_0 \cdot Req_{AC} \\ V_1 = R_1 i_1 = R_1 \cdot I_2 \\ V_2 = R_2 i_2 = R_2 \cdot I_2 \\ V_3 = R_3 i_3 = R_3 I_3 \\ V_4 = R_4 i_4 = -R_4 I_4 \\ V_5 = R_5 i_5 = -R_5 I_1 \\ V_6 = i_6 \cdot Req_{BD} \end{cases}$$

$\Rightarrow$ Sostituisco

$$\begin{cases} R_5 I_1 = i_0 Req_{AC} \\ R_1 I_2 + R_2 I_2 = -i_0 Req_{AC} \\ -R_2 I_2 + R_3 I_3 + R_4 I_4 = 0 \\ -R_2 I_2 + R_4 I_4 = i_6 Req_{BD} \end{cases} \Rightarrow \begin{bmatrix} (R_5) & 0 & 0 & 0 \\ 0 & (R_1+R_2) & 0 & 0 \\ 0 & (-R_2) & (R_3) & (R_4) \\ 0 & (-R_2) & 0 & (R_4) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} i_0 Req_{AC} \\ -i_0 Req_{AC} \\ \emptyset \\ i_6 Req_{BD} \end{bmatrix}$$

$$\begin{cases} I_1 = 4.55\ A \\ I_2 = -4.55\ A \\ I_3 = -3.51\ A \\ I_4 = 3.33\ A \\ I_5 = -0.62\ A \end{cases}$$

$$i_2 = I_2 = -4.55\ A \ldots$$

Boh