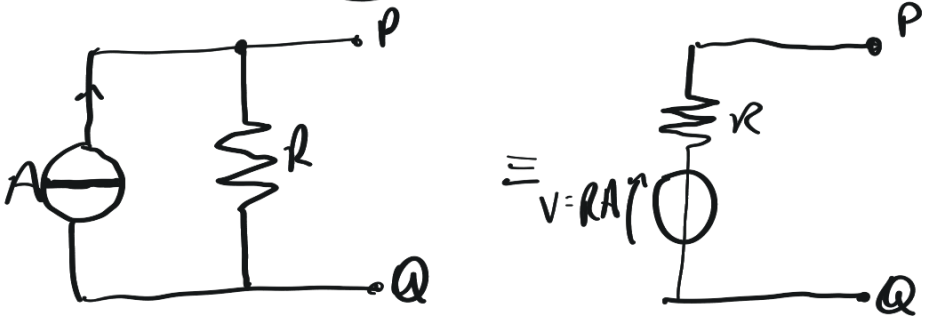
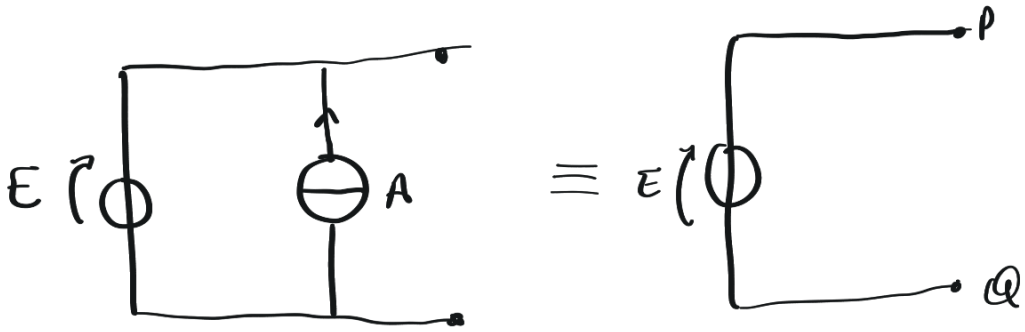
Esercitazione 3

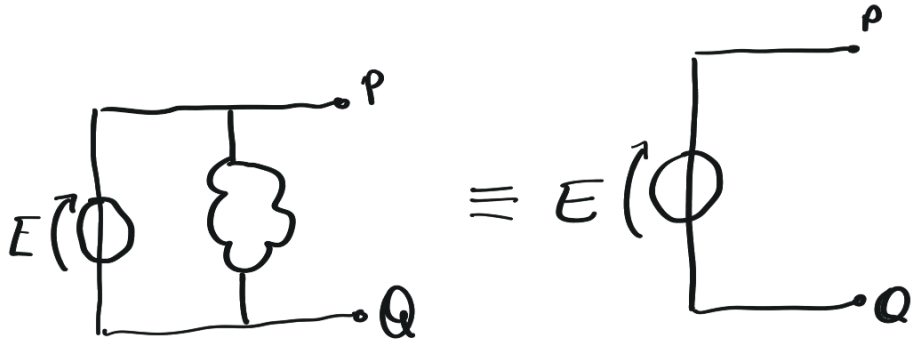
Nuovo metodo (Thevenin e Norton) — Equivalenti di

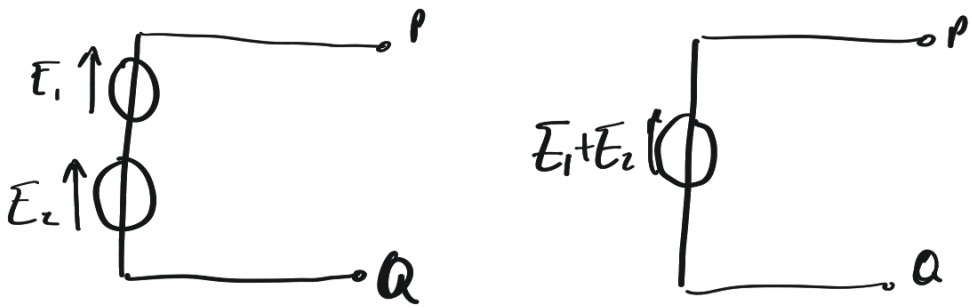
Thevenin





Solo ai morsetti, internamente non può esser scambiato





Regole

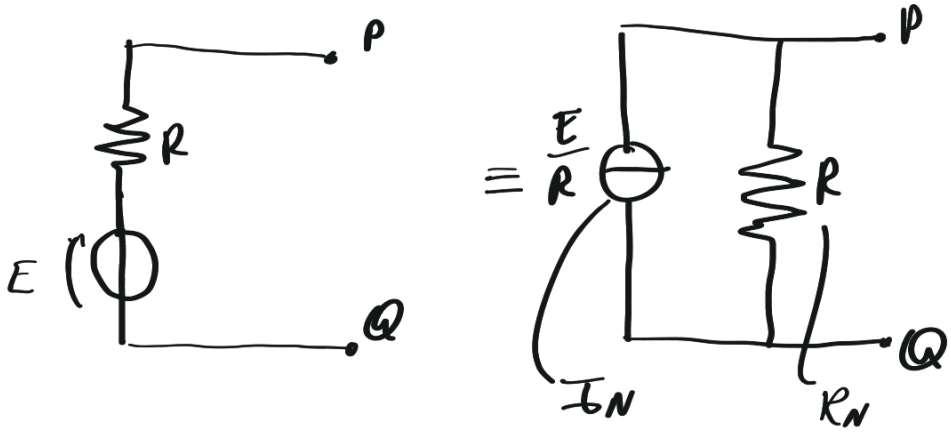
1) Calcolare la tensione a vuoto ai morsetti

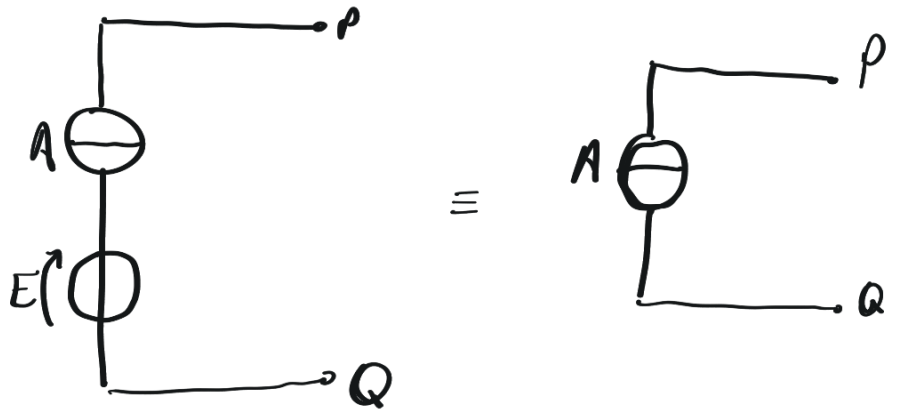
$PQ \rightarrow E_{th}$

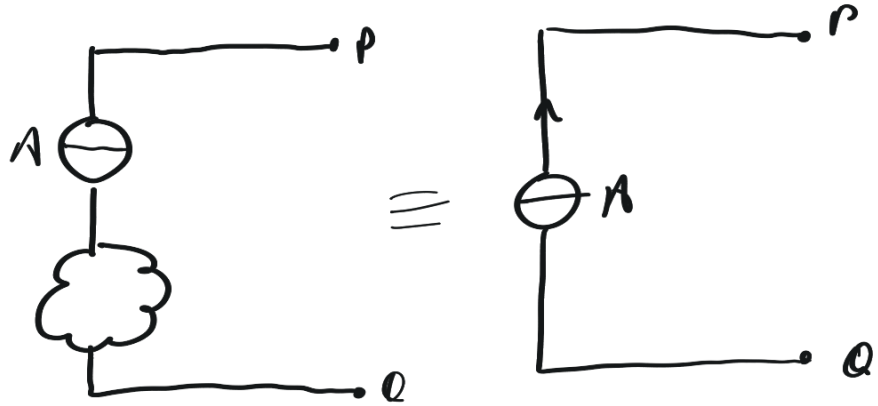
2) Spegnere i generatori

3) Calcolare la resistenza equivalente R_{th}

Norton - Stesse regole







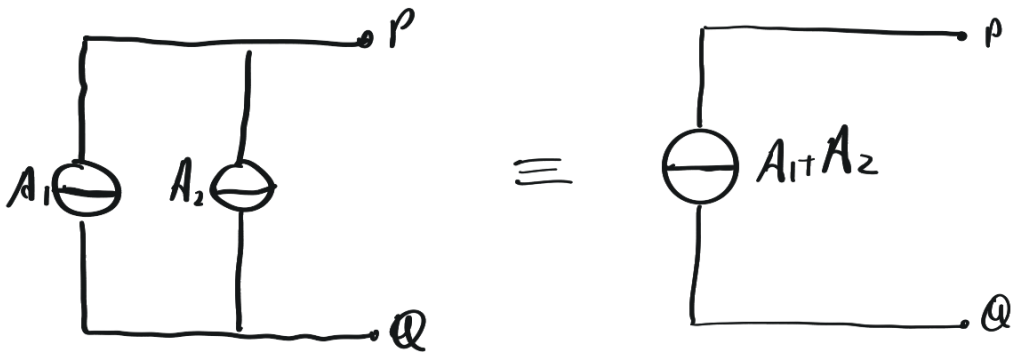
Regole

1) Calcolare la corrente di circuito ai morsetti

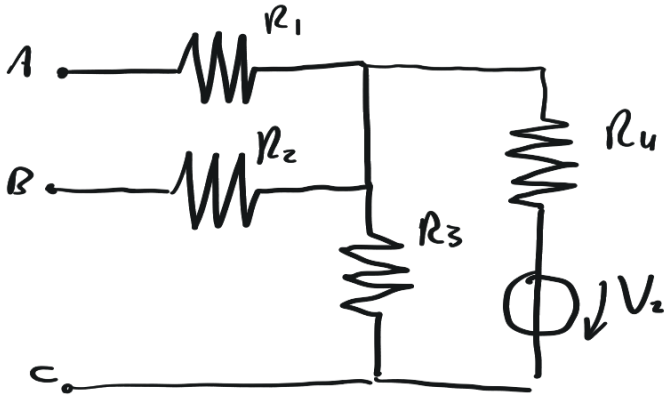
$PQ \rightarrow I_N$

2) Spegnere i generatori

3) Calcolare la resistenza equivalente R_N

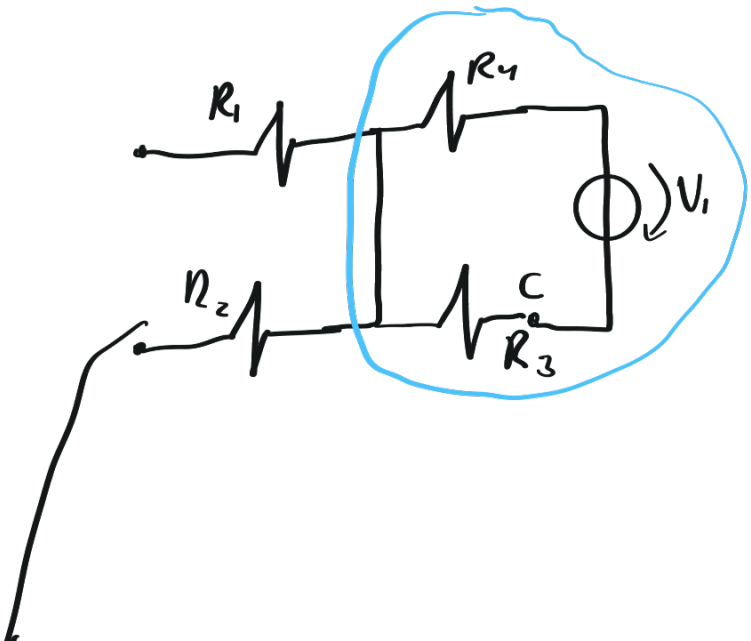


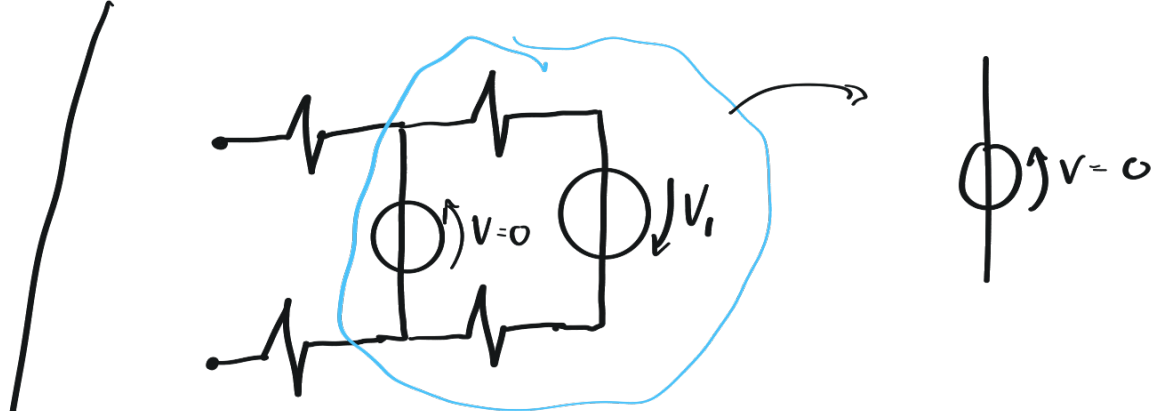
Esercizio 1

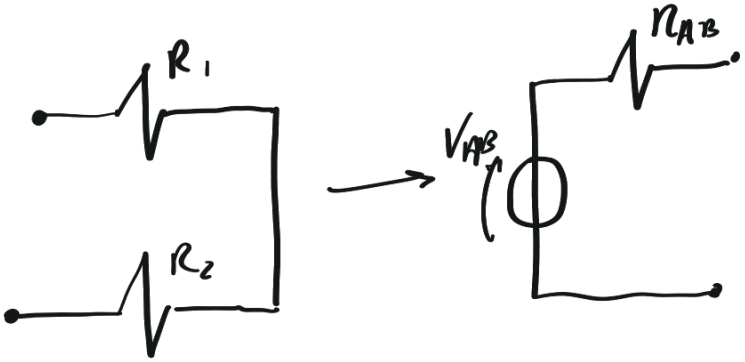


$R_1 = 5\Omega$
$R_2 = 10\Omega$
$R_3 = 20\Omega$
$R_4 = 30\Omega$
$V_1 = 10V$

Equivalente Thevenin AB e BC



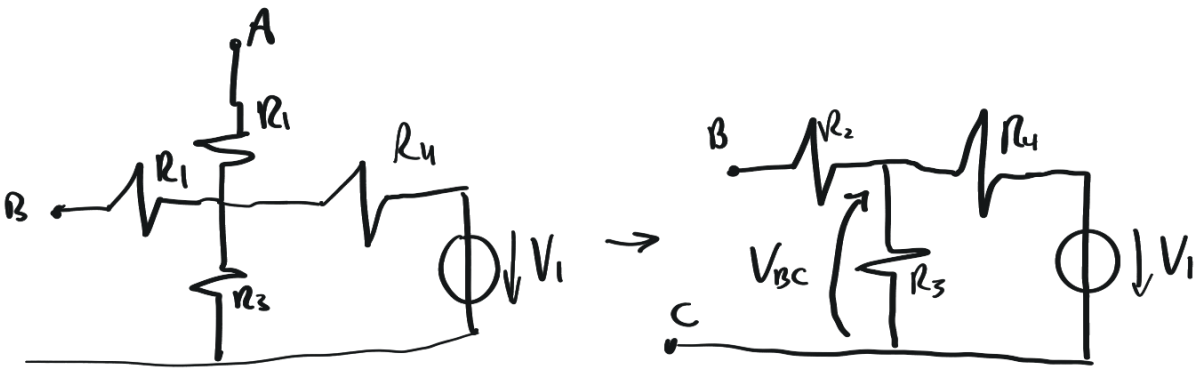




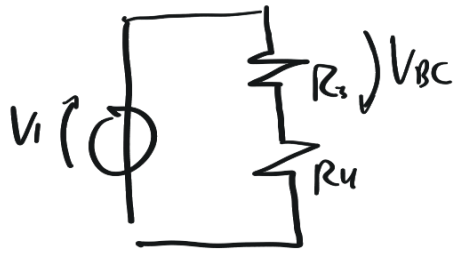
$V_{AB} = 0$

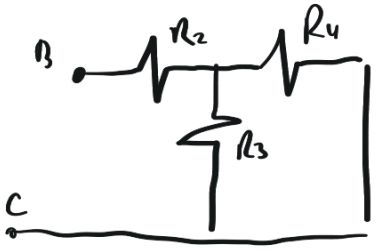
$R_{AB} = R_1 + R_2 = 15\Omega$

BC



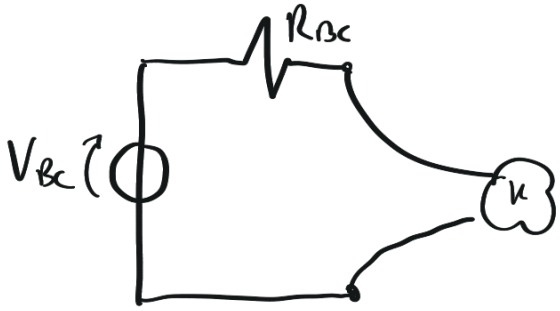
$$V_{BC} = \frac{R_3}{R_3 + R_4} V_1 = -4V$$



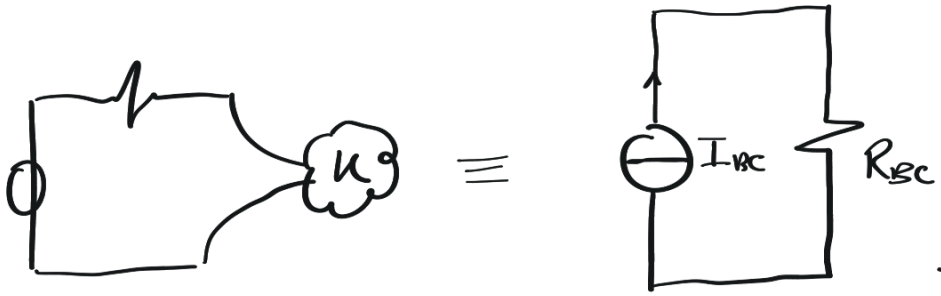


$$R_{BC} = R_2 + \frac{R_3 + R_4}{R_3 + R_4}$$

$$= 22\,\Omega$$

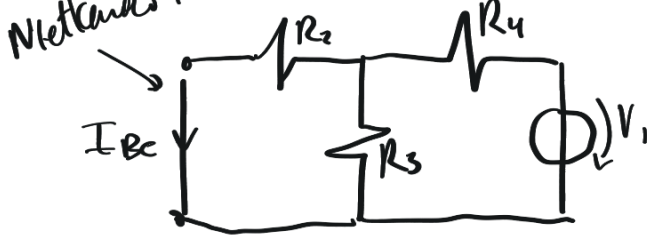


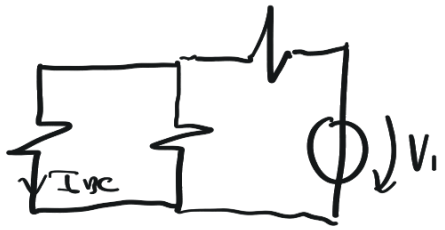
Facendo Norton per volere

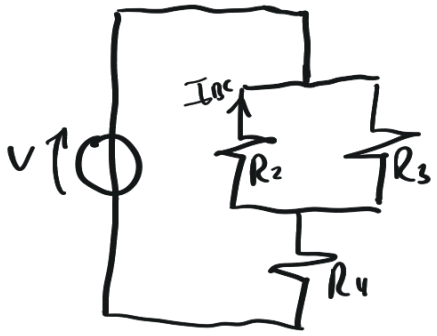


$$I_{BC} = \frac{V_{BC}}{R_{BC}}$$

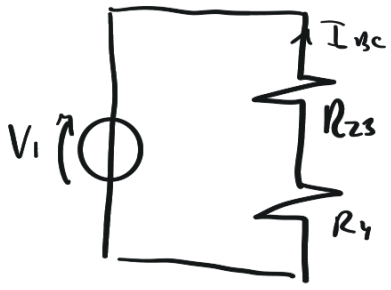
Metterndo in corto circuito







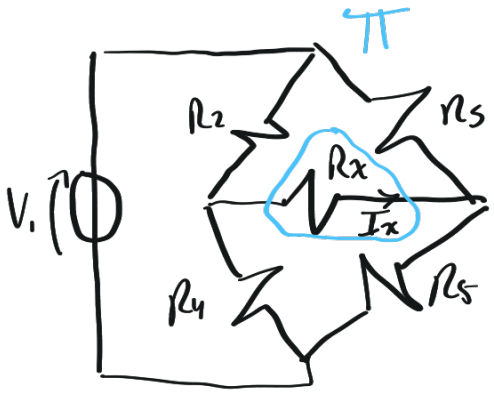
$$R_{23} = 6{,}67\,\Omega$$

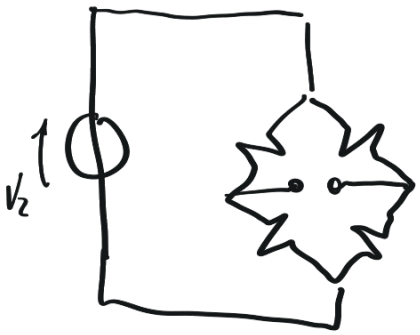


$$I = \frac{V_1}{R_{23} + R_4} = 0{,}27\,A$$

$$I_{BC} = -\frac{R_3}{R_2+R_3} I = -0{,}18\,A \qquad I_{BC} = \frac{V_{BC}}{R_{BC}} = -0{,}18$$

Esercizio 2





$R_2 = 4\,\Omega$ $\quad |I_x| = 1\,A$

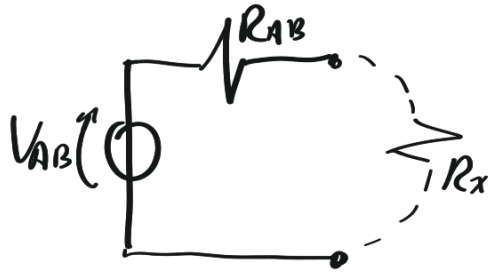
$R_3 = 3\,\Omega$ $\quad R_x = ?$

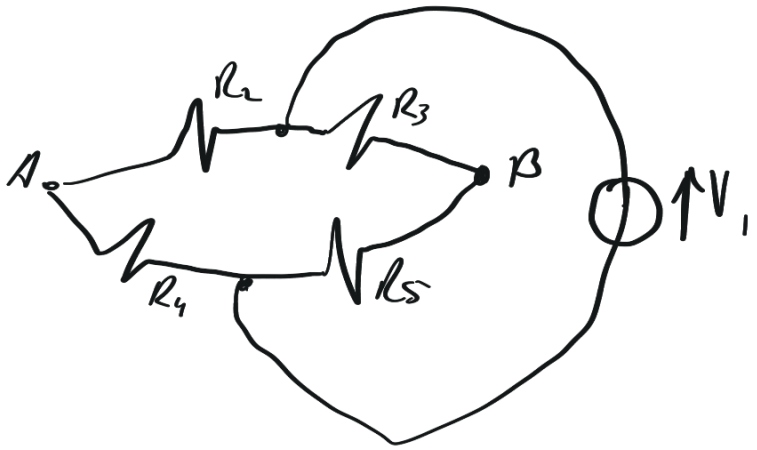
$R_4 = 2\,\Omega$

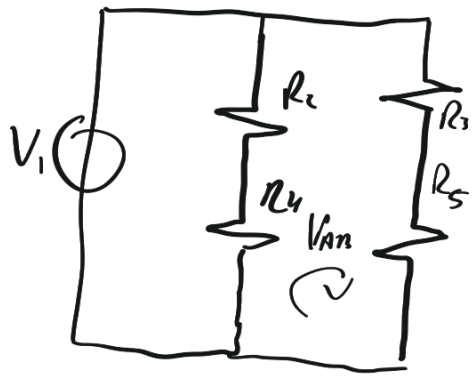
$R_5 = 6\,\Omega$

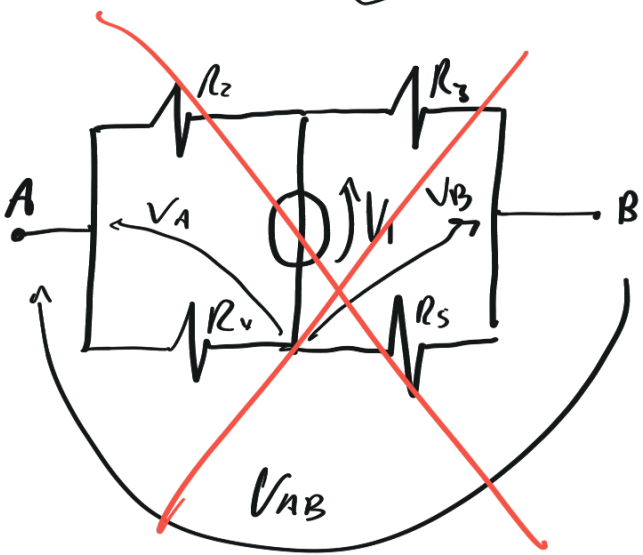
$V_1 = 50\,V$

$\equiv$





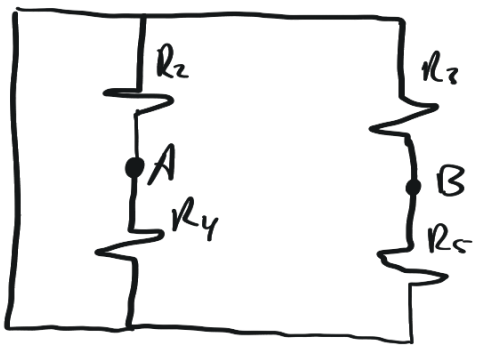


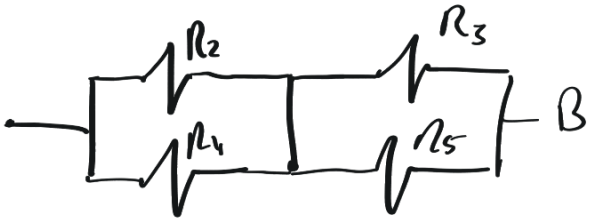


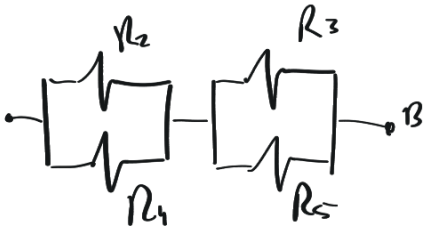
$$V_{AB} = V_{R4} - V_{R5} = -10\,V$$

$$V_{R4} = \frac{R_4}{R_2+R_4} V_1 = 10\,V$$

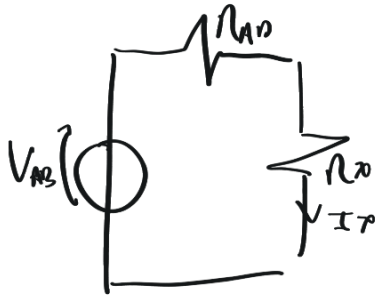
$$V_{R5} = \frac{R_5}{R_4+R_5} V_2 = 20\,V$$







$$R_{AB} = \frac{R_2 R_4}{R_2 + R_4} + \frac{R_3 R_5}{R_3 + R_5} = 3{,}333\,\Omega$$



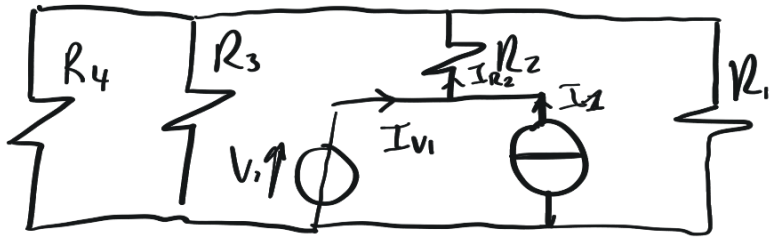
$$I_x = \frac{V_{AB}}{R_{AB} + R_x}$$

$$R_x = \frac{V_{AB} - R_{AB} I_x}{I_x}$$

$$= \frac{V_{AB}}{I_x} - R_{AB}$$

$$\frac{10}{-1} - 3{,}33 = 10 - 3{,}333 = 6{,}666\,\Omega$$

Esercizio 3



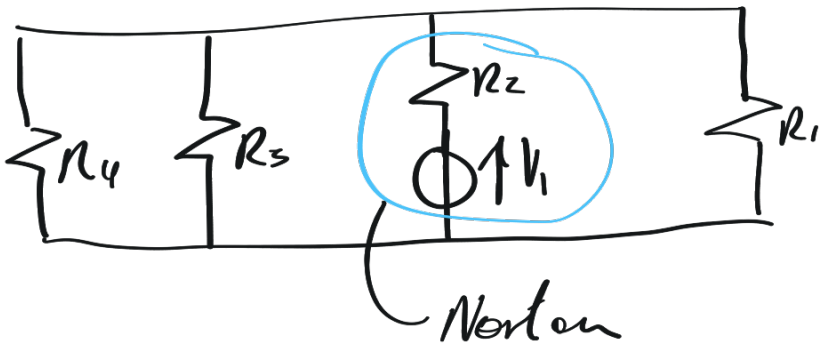
$R_1 = 5\Omega$ $V_1 = 18V$

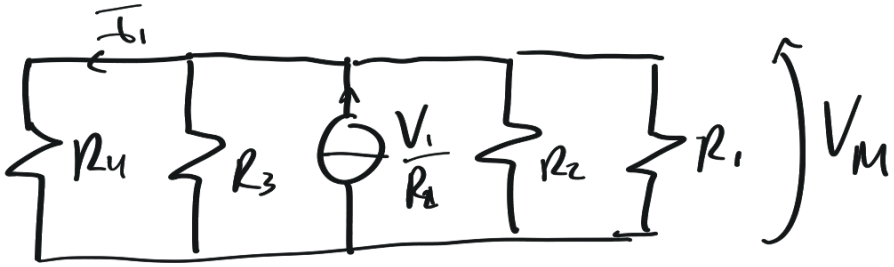
$R_2 = 6\Omega$ $I_1 = 12A$

$R_3 = 3\Omega$ $P_{R4} = ?$

$R_4 = 6\Omega$

Sappiamo che





Si può usare il particolare di corrente per trovare I_{R4}

$$I_{R4} = \frac{G_{R4}}{G_{R1}+G_{R2}+G_{R3}+G_{R4}} \frac{V_1}{R_2}$$

$$P_{R4} = R_4 I_{R4}^2$$

Alternativa → Millman

$$V_M = \frac{\frac{V_1}{R_2}\,(3A)}{G_{R1}^{5}+G_{R2}^{6}+G_{R3}^{3}+G_{R4}^{6}} = 3,46\,V$$

$$P_{R4} = \frac{V_M^2}{R_4} = 1,99\,W$$

Se chiedesse P_{V1}?

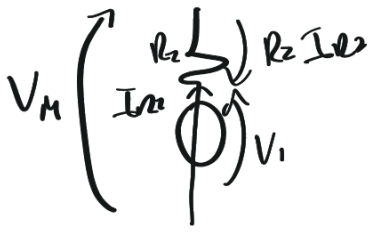
La equivalenza per Thevenin non possiamo più usarlo, quindi

$$P_{V1} = I_{V1} V_1$$

Aggiungendo I_{V1} e facendo LKC al nodo troviamo che:

$$I_{V1} + I_1 - I_{R2} = 0 \rightarrow I_{V1} = I_{R2} - I_1 = -9,58$$

I_{R2} lo troviamo da dopo la semplificazione



$R_2 I_{R2} = -V_1 + V_M$

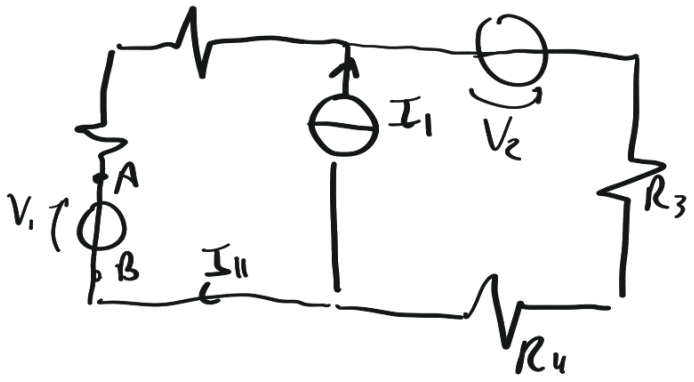
$$I_{R2} = \frac{V_M - V_1}{R_2}$$

$I_{V_1} = 2,42 - 12 = -9,58 = A$

$P_{V_1} = V_1 I_{V_1} = -172,44W$ → se generatori ha P<0 assorbono; se hanno P>0 erogano

La potenza è assorbita da V_1 quindi troviamo che A_1 è l'elemento che eroga potenza e perciò è l'elemento più importante energeticamente a monte

Esercizio 4



$R_1 = 5\Omega$
$R_2 = 3\Omega$
$R_3 = 2\Omega$
$R_4 = 6\Omega$
$V_1 = 18V$
$V_2 = 20V$
$I_1 = 12A$

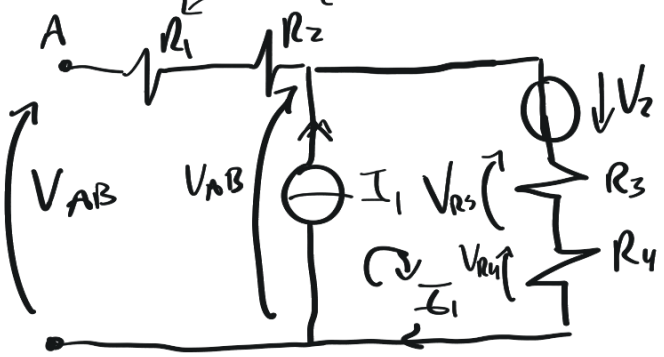
$I_{11} = ?$
P_{V_1}

Se tutte le domande sono rispetto ad un elemento proviamo a prendere morsetti che lo rendono bipolare

Lo rendiamo un circuito bipolare riconoscendo i morsetti A,B, perché tutti i richiesti sono su V_1

Si potrebbe risolvere con Millman ma no perché non vale

Dato che V_{R1} e V_{R2} sono = 0 in questo caso si può muovere V_{AB}



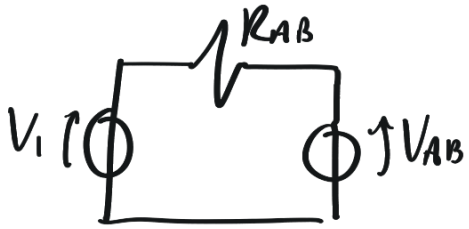
$$V_{AB} + V_2 - V_{R3} - V_{R4} = 0$$

$$V_{AB} = V_{R3} + V_{R4} - V_2$$

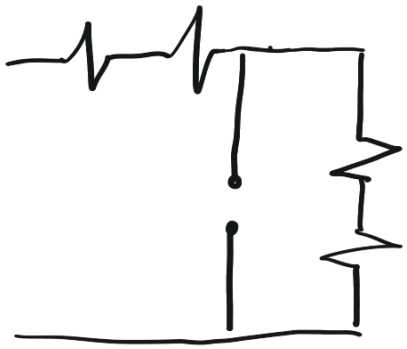
$$= R_3 I_1 + R_4 I_2 - V_2 = 76V$$

$$24 \quad 72 \quad 20$$

Facciamo questo perché vogliamo



Troviamo Req



$$R_{AB} = R_1 + R_2 + R_3 + R_4$$

$$= 16\Omega$$

$$V_1 - V_{RAB} - V_{AB} = 0$$

$$V_{RAB} = V_1 - R_{AB}$$

$$R_{AB} I_{II} = V_1 - V_{AB}$$

$$I_{II} = \frac{V_1 - V_{AB}}{R_{AB}} = \frac{56}{16} = 3,62A$$

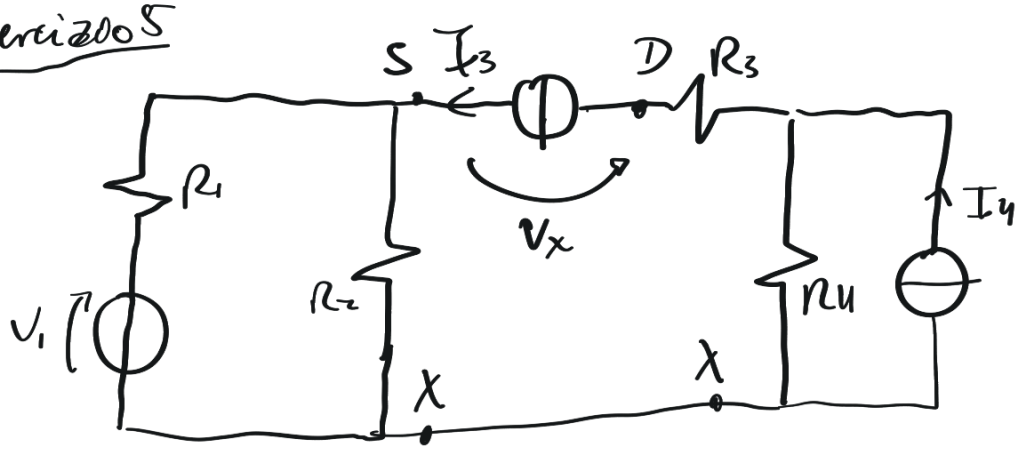
$$P_{V1} = V_1 \cdot I_{II} = -65,2W$$

↑ ↑

Stessa direzione, non dobbiamo mettere un (-)

Negativo che anche se la direzione presa è la stessa, I_{II} ha in realtà direzioni opposte, quindi occorre un valore negativo

Esercizio 5

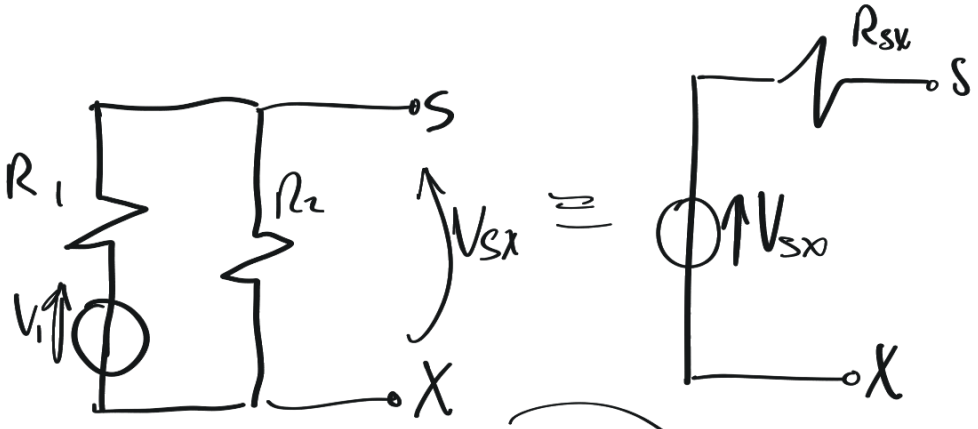


$R_1 = 10\,\Omega$ $V_1 = 30V$ $V_x = ?$

$R_2 = 5\,\Omega$ $I_4 = 18A$

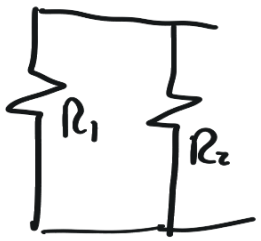
$R_3 = 3\,\Omega$ $I_3 = 6A$

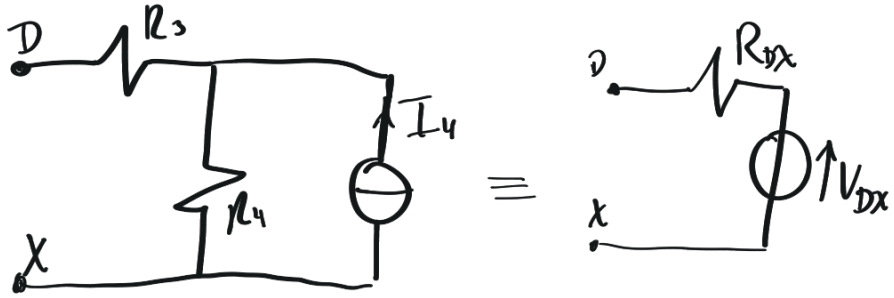
$R_4 = 4\,\Omega$

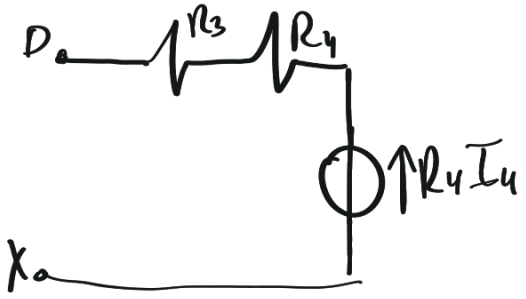


$$V_{SX} = \frac{R_2}{R_1 + R_2} V_1 = 10V$$

$$R_{SX} = \frac{R_1 R_2}{R_1 + R_2} = 3{,}33\ \Omega$$



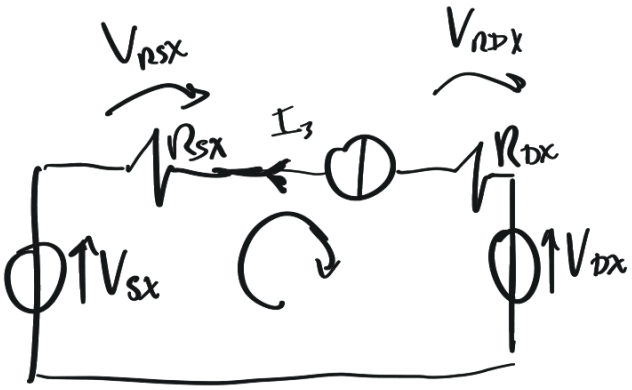




$R_{DX} = R_3 + R_4 = 7\,\Omega$

$V_{TH} = R_4 I_4 = 72\ V$

(il verso crociato è tensione che attraversa R_3)



$$V_{SX} + V_{RSX} + V_{RDX} - V_{DX} - V_\lambda = 0$$

$V_{RSX} \downarrow$ $R_{SX} \cdot I_3$; $V_{RDX} \downarrow$ $R_{DX} I_3$

$$V_\lambda = -V_{SX} - (R_{SX} + R_{DX}) I_3 + V_{DX}$$

$$= -10 - (10{,}333)\,6 + 72$$

$$= 10 - 60 - 2 + 72 = 0$$

$$V_\lambda = 0 \Rightarrow P_{I3} = 0$$