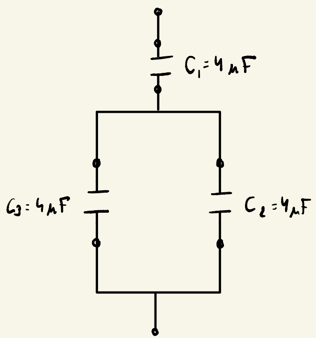
C_{AC}? → Capacidad de todo el circuito

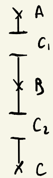
E_T? → Energía total almacenada

Q_i? → carga almacenada en cada uno de los condensadores



$\Delta V = 100\,V$

$C = \frac{Q}{\Delta V}$; $E = \frac{1}{2} C V^2$; $u = \frac{E}{Vol} = \frac{1}{2}\varepsilon_0 E^2$



Paralelas. $C_{eq} = C_1 + C_2 + C_3$; $V_1 = V_2 = V_3$

$Q_{23} = Q_2 + Q_3$

$C_{23} = C_2 + C_3 = 8\,\mu F$

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_{23}} \rightarrow C_{eq} = \frac{32}{12} = \frac{8}{3}$

$Q_{eq} = Q_1 = Q_{23}$

$V_{AC} = V_{23} + V_1$

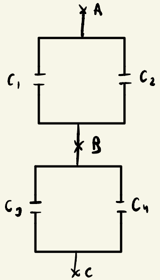
$E_T = \frac{1}{2} C V^2 = \frac{1}{2} \frac{8}{3} (100)^2 \cdot 10^{-6} = \frac{4}{3} \cdot 10^{-2}\ J$

$Q_1 = Q_{AC} = \frac{8}{3}\, 100 = \frac{800}{3}\ \mu C$

$Q_{AC} = Q_1 = Q_{23}$

$V_{BC} = \frac{Q_3}{C_3} = \frac{Q_2}{C_2} = \frac{800/3}{8} = \frac{100}{3}\ V$

$Q_2 = Q_3 = V_{BC}\, C_3 = \frac{100}{3} \cdot 4 = \frac{400}{3}\ \mu C$



$C_1 = C_2 = C_3 = C_4 = 4\,\mu F$

$\Delta V = 100\,V$

a) $C_{12} = C_1 + C_2 = 4 + 4 = 8\,\mu F$

$C_{34} = C_3 + C_4 = 4 + 4 = 8\,\mu F$

$$\frac{1}{C_{eq}} = \frac{1}{C_{12}} + \frac{1}{C_{34}} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8} \; ; \quad C_{eq} = 4\,\mu F$$

b) $C_T = \frac{1}{2} C V^2 = \frac{1}{2}\, 4 \cdot 100^2 \cdot 10^{-6} = 2 \cdot 10^{-2}\,J$

c) $Q_{12} = C_{eq} \cdot \Delta V = 4 \cdot 100 = 400\,\mu C$

$$V_{12} = \frac{Q_{12}}{C_{12}} = \frac{400}{8} = 50\,V$$

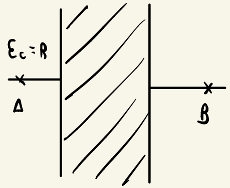
$Q_1 = Q_2 = Q_3 = Q_4 = V_{12} \cdot C_1 = 50 \cdot 4 = 200\,\mu C$

Capacidad condensador?

$\varepsilon_R = 2,3$

$d = 0,3 \text{ mm}$

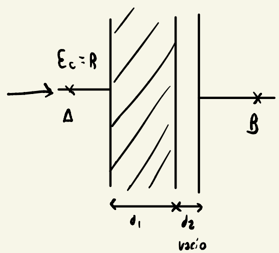
$A = 400 \text{ cm}^2 = 4 \cdot 10^{-2} \text{ m}^2$



$$C_0 = \frac{\varepsilon_0 S}{d}$$

$$C = \varepsilon_c C_0 = \frac{\varepsilon_c \varepsilon_0 S}{d}$$

$$C_1 = \frac{\varepsilon_R \varepsilon_0 \; A}{d} = \frac{2,3 \cdot 8,82 \cdot 10^{-12} \cdot 4}{3 \cdot 10^{-4}}$$



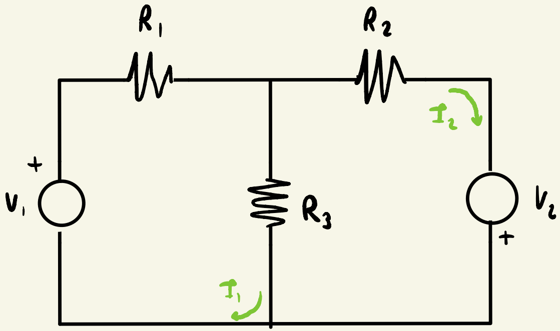
$$d_1 = 0,225 \cdot 10^{-3} = 2,25 \cdot 10^{-4}$$

$$d_2 = (3 - 2,25) \cdot 10^{-4} = 7,5 \cdot 10^{-5}$$

$$C_1 = \frac{\varepsilon_0 \varepsilon_c \; S \cdot 10^{-2}}{(3 - d_2) \, 10^{-4}}$$

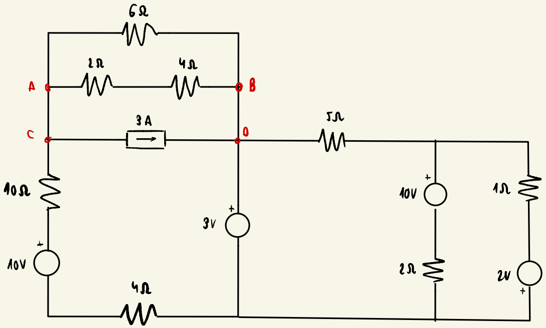
$$C_2 = \frac{\varepsilon_0 S \cdot 10^{-2}}{d_2 \, 10^{-4}}$$

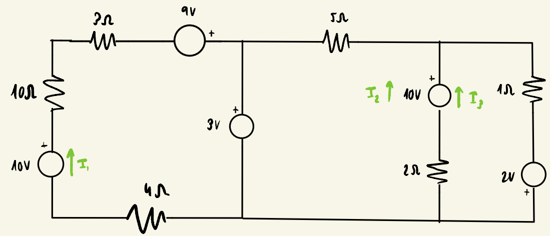
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$



$$\left.\begin{aligned} V_1 &= I_1 R_1 + (I_1 - I_2) R_3 = I_1 R_1 + I_1 R_3 - I_2 R_3 = I_1 (R_1 + R_3) - I_2 R_3 \\ V_2 &= I_2 R_2 + (I_2 - I_1) R_3 = I_2 R_2 + I_2 R_3 - I_1 R_3 = I_2 (R_2 + R_3) - I_1 R_3 \end{aligned}\right\} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} I_1 \\ I_2 \end{pmatrix} \begin{pmatrix} R_1 + R_3 & -R_3 \\ -R_3 & R_2 + R_3 \end{pmatrix}$$

$$I_1 = \frac{\begin{vmatrix} V_1 & -R_3 \\ V_2 & R_2 + R_3 \end{vmatrix}}{\begin{vmatrix} R_1 + R_3 & -R_3 \\ -R_3 & R_2 + R_3 \end{vmatrix}} \qquad I_2 = \frac{\begin{vmatrix} R_1 + R_3 & V_1 \\ -R_3 & V_2 \end{vmatrix}}{\begin{vmatrix} R_1 + R_3 & -R_3 \\ -R_3 & R_2 + R_3 \end{vmatrix}} \longrightarrow \begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} I_1 \\ I_2 \end{pmatrix} \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix}$$





$R_{AB} = 2 + 4 = 6\Omega$

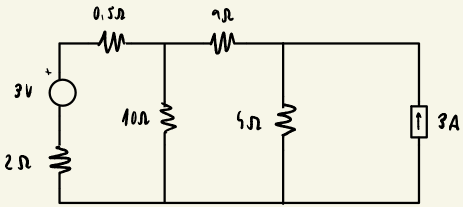
$\frac{1}{R_{CD}} = \frac{1}{6} + \frac{1}{6} = \frac{1}{3}$; $R_{CD} = 3\Omega$

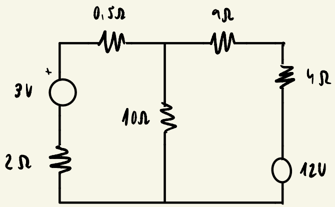
$V_{CD} = RI = 3 \cdot 3 = 9V$

$$\begin{pmatrix} V_1 \\ V_2 \\ V_3 \end{pmatrix} = \begin{pmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} \rightarrow \begin{pmatrix} 10+9-3 \\ 10-3 \\ 10+2 \end{pmatrix} = \begin{pmatrix} 10+3+4 & 0 & 0 \\ 0 & 5+2 & 2 \\ 0 & 2 & 3 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix}$$

$$I_1 = \frac{\begin{vmatrix} {} & 0 & 0 \\ 7 & 7 & 2 \\ 12 & 2 & 3 \end{vmatrix}}{\begin{vmatrix} 17 & 0 & 0 \\ 0 & 7 & 2 \\ 0 & 2 & 3 \end{vmatrix}} = 0{,}94A$$

$P_1 = 4(0{,}94)^2 = 3{,}5344\ W$





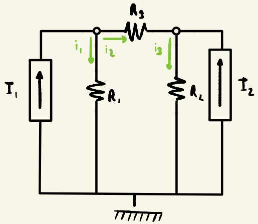
$V = RI = 4 \cdot 3 = 12V$

$$\begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix} \rightarrow \begin{pmatrix} 3 \\ 12 \end{pmatrix} = \begin{pmatrix} 10+2+0,5 & 10 \\ 10 & 10+9+4 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$I_1 = \frac{\begin{vmatrix} 3 & 10 \\ 12 & 23 \end{vmatrix}}{\begin{vmatrix} 12,5 & 10 \\ 10 & 23 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} 12,5 & 10 \\ 10 & 23 \end{vmatrix}}{\begin{vmatrix} 12,5 & 10 \\ 10 & 23 \end{vmatrix}}$$

método de tensiones de nudos



Nudo $I_1 = i_1 + i_3 \rightarrow I_1 = \left(\frac{1}{R_1}\right)V_1 + \left(\frac{1}{R_3}\right)(V_1 - V_2) \rightarrow I_1 = G_1 V_1 + G_3 V_1 - G_3 V_2$

Nudo $I_2 = I_2 + i_3 = i_2 \rightarrow I_2 = i_2 - i_3 \rightarrow I_2 = \left(\frac{1}{R_2}\right)V_2 - \left(\frac{1}{R_3}\right)(V_1 - V_2) \rightarrow I_2 = G_2 V_2 - G_3 V_1 + G_3 V_2$

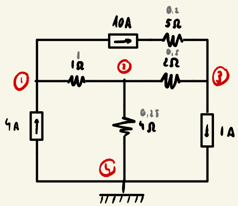
$$\left.\begin{aligned} I_1 &= V_1(G_1 + G_3) - V_2 G_3 \\ I_2 &= -V_1 G_3 + V_2 (G_2 + G_3) \end{aligned}\right.$$

$$i_1 = \frac{V_1}{R_1} = \left(\frac{1}{R_1}\right)V_1$$

$$i_2 = \frac{V_2}{R_2} = \left(\frac{1}{R_2}\right)V_2$$

$$i_3 = \frac{V_1 - V_2}{R_3} = \left(\frac{1}{R_3}\right)(V_1 - V_2)$$

$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} G_1 + G_3 & -G_3 \\ -G_3 & G_2 + G_3 \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$



$$\begin{pmatrix} \Sigma I_1 \\ \Sigma I_2 \\ \Sigma I_3 \end{pmatrix} = \begin{pmatrix} G_{11} & -G_{12} & -G_{13} \\ -G_{21} & G_{22} & -G_{23} \\ -G_{31} & -G_{32} & G_{33} \end{pmatrix} \rightarrow \begin{pmatrix} -6 \\ 0 \\ 9 \end{pmatrix} = \begin{pmatrix} 1{,}2 & -1 & -0{,}2 \\ -1 & 1{,}75 & -0{,}5 \\ -0{,}2 & -0{,}5 & 0{,}7 \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \\ V_3 \end{pmatrix}$$

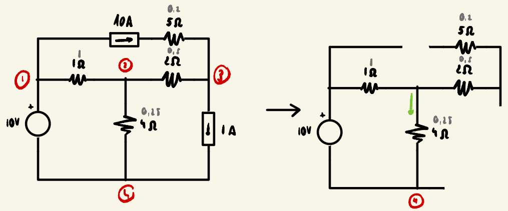
$$P = I^2 R = \frac{V^2}{R}\ W$$

- inversa de R

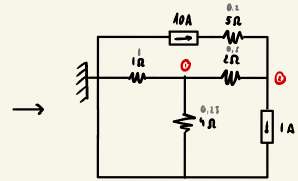
$$V_2 = \frac{\begin{vmatrix} -1{,}2 & -6 & -0{,}2 \\ -1 & 0 & -0{,}5 \\ -0{,}2 & 9 & 0{,}7 \end{vmatrix}}{\begin{vmatrix} 1{,}2 & -1 & -0{,}2 \\ -1 & 1{,}75 & -0{,}5 \\ -0{,}2 & -0{,}5 & 0{,}7 \end{vmatrix}}$$

$$P = \frac{(V_2)^2}{4}\ W$$

Método de superposición



$i_4 = \frac{10}{5} = 2A\downarrow$ (F. tensión)



$$\begin{pmatrix} 0 \\ 9 \end{pmatrix} = \begin{pmatrix} 1,75 & -0,5 \\ -0,5 & 0,7 \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

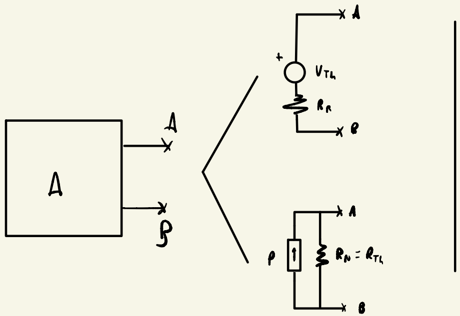
$$V_1 = \frac{\begin{vmatrix} 0,5 & -0,5 \\ 9 & 0,7 \end{vmatrix}}{\begin{vmatrix} 1,75 & -0,5 \\ -0,5 & 0,7 \end{vmatrix}} = \frac{-4,5}{1,225 - 0,025} = \frac{-4,5}{1,2} = -3,75\,V$$

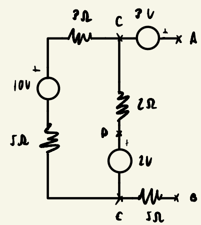
$$i_4 = \frac{3,75}{4} = 0,93\,A\uparrow$$

$$I_{T4} = 2A(\downarrow) - 0,93A(\uparrow) = 1,07\,A(\downarrow)$$

$$P = i^2 R = (1,07)^2\, 4 = \quad W$$

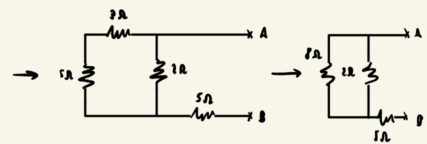
Método de Thevenin y Norton



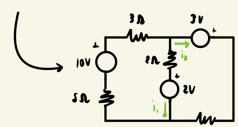


$V_{TH} = V_{AB}$

$$V_{AB} = V_{AC} + V_{CD} + V_{DE} + V_{EB} = 3 + \frac{10-2}{10} \times 2 + 2 + 0 = 6,6V = V_{TH}$$

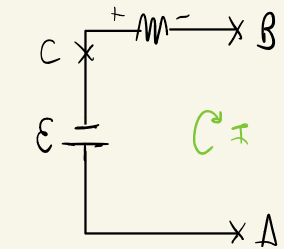


$$R_{TH} = \frac{8 \cdot 2}{8+2} = 1,6$$



$$\begin{pmatrix} 8 \\ 5 \end{pmatrix} = \begin{pmatrix} 10 & -2 \\ -2 & 7 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$I_N = I_{cc} = \frac{\begin{vmatrix} 10 & -2 \\ 8 & 5 \end{vmatrix}}{\begin{vmatrix} 10 & -2 \\ -2 & 7 \end{vmatrix}} = \frac{50+16}{70-4} = 1A$$



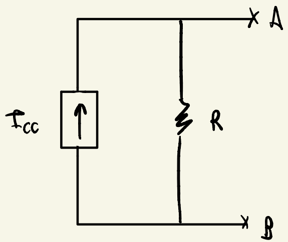
$I_{CL} = \frac{\mathcal{E}}{RJ}$ $\mathcal{E} = I_{cc} R$

$\longleftrightarrow$

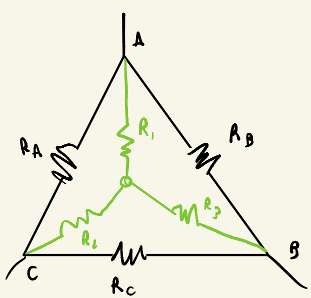
$R = R$

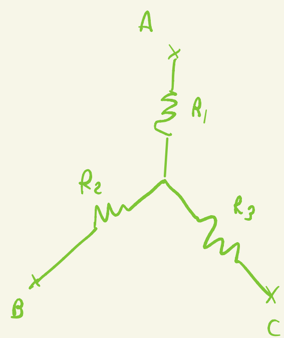
$V_{CB} = IR$

$V_{BC} = -IR$



$I_{cc} = \frac{\mathcal{E}}{R}$

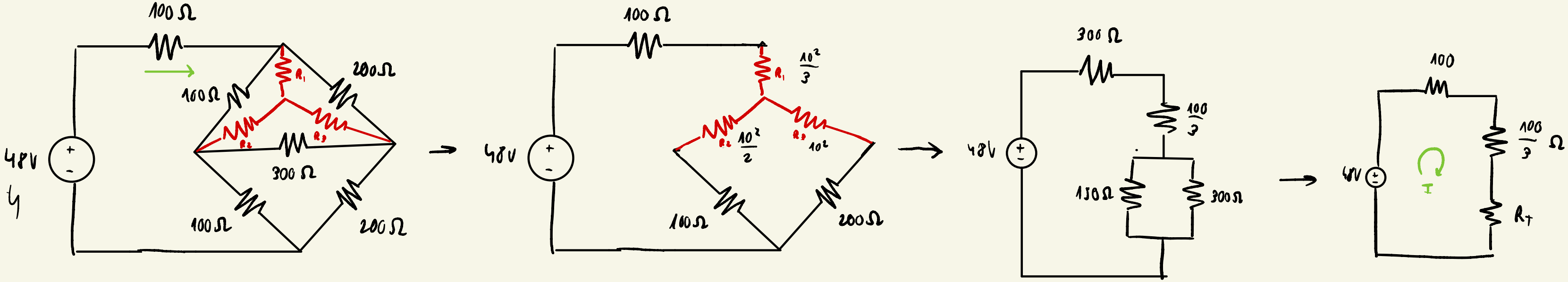




$$R_1 = \frac{R_A R_B}{R_A + R_B + R_C}$$

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_B R_C}{R_A + R_B + R_C}$$



$$R_1 = \frac{2 \cdot 10^4}{6 \cdot 10^2} = \frac{1}{3} \cdot 10^2$$

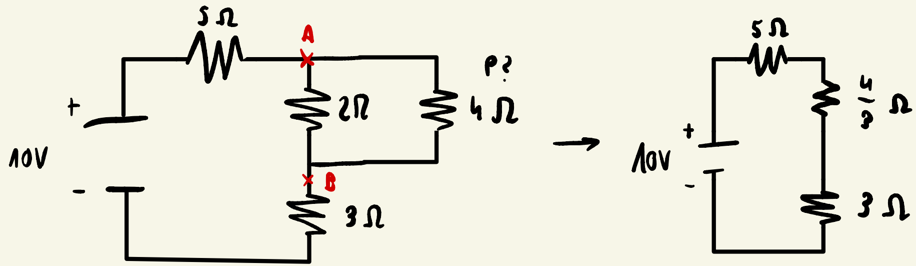
$$R_2 = \frac{3 \cdot 10^4}{6 \cdot 10^2} = \frac{1}{2} \cdot 10^2$$

$$R_3 = \frac{6 \cdot 10^4}{6 \cdot 10^2} = 10^2$$

$$I = \frac{\Sigma E - \Sigma E'}{\Sigma R} = \frac{48}{700/3} = \frac{48 \cdot 3}{700}$$

$$R_T = \frac{150 \cdot 300}{450} = \frac{4500}{45} = 100\ \Omega$$

$$R_T = 200 + \frac{100}{3} = \frac{700}{3}$$



$$I = \frac{\varepsilon}{\sum R} = \frac{10}{5+3+4/3} = \frac{10 \cdot 3}{15+9+4} = \frac{30}{28} \text{ A}$$

$$V_{AB} = R_{eq} \cdot \frac{30}{28} = \frac{4}{3} \cdot \frac{30}{28} = \frac{40}{28}$$

$$I = \frac{V}{R} = \frac{40/28}{4} = \frac{10}{28} \text{ A}$$

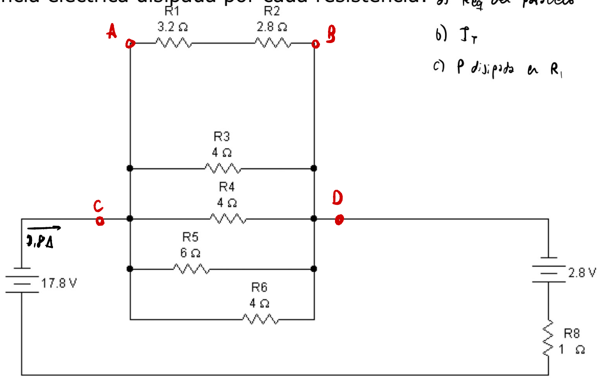
$$P = I^2 R = 4 \left(\frac{10}{28}\right)^2 \text{ W}$$

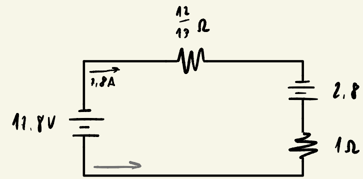
9.- Completar el siguiente cuadro con el voltaje, la intensidad de corriente y la potencia eléctrica disipada por cada resistencia:

a) R_{eq} del paralelo

b) I_T

c) P disipada en R_1





a) $R_{AB} = 2,8 + 3,2 = 6\ \Omega$

$R_{CD}: \frac{1}{R_{CD}} = \frac{1}{6} + \frac{1}{4} + \frac{1}{4} + \frac{1}{6} + \frac{1}{4} = \frac{2}{6} + \frac{3}{4} = \frac{13}{12}$; $R_{CD} = \frac{12}{13}\ \Omega$

b) $I_T = \frac{\Sigma\varepsilon - \Sigma\varepsilon'}{R_T} = \frac{17,8 - 2,8}{1 + 12/13} = \frac{15}{25/13} = 7,8\ A$

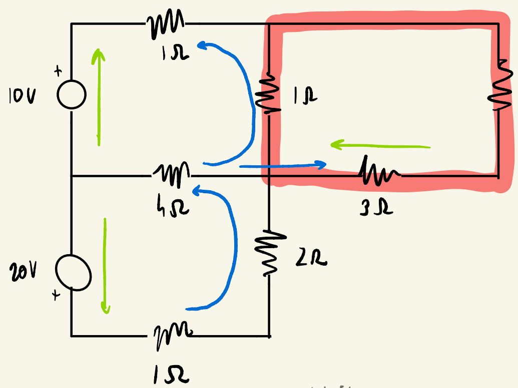
c) $V_{CD} = I_T R_{eq} = 7,8 \frac{12}{13} = 7,2\ V$

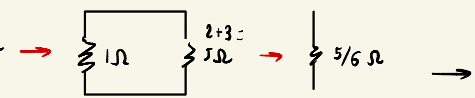
$i_{3,2} = \frac{V_{AB}}{R_{AB}} = \frac{7,2}{6}\ A$

$P_{R_1} = I^2 R_1 = \left(\frac{7,2}{6}\right)^2 3,2 = 4,6\ W$

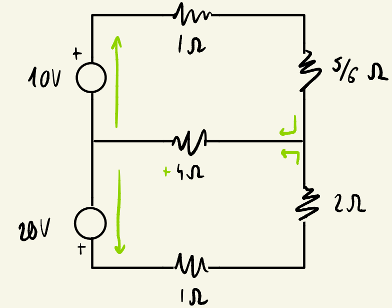
2) En el circuito calcula la intensidad de la rama donde esta $R = 3\Omega$ así como la cantidad de calor disipado en la $R = 4\Omega$ en $t = 60\,s$

a) $I_{3\Omega}$ b) $W_{4\Omega}$ $t = 60\,s$





$\frac{1}{R} = 1 + \frac{1}{5} = \frac{6}{5}$



$$\begin{pmatrix} \Sigma E_1 \\ \Sigma E_2 \end{pmatrix} = \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix} \rightarrow \begin{pmatrix} 10 \\ 20 \end{pmatrix} = \begin{pmatrix} \overset{1+4+5/6}{35/6} & 4 \\ 4 & \underset{1+2+4}{7} \end{pmatrix}$$

$$I_1 = \frac{\begin{vmatrix} 10 & 4 \\ 20 & 7 \end{vmatrix}}{\begin{vmatrix} 35/6 & 4 \\ 4 & 7 \end{vmatrix}} = \frac{70 - 80}{\frac{245}{6} - 16} = -0{,}4027\ A \uparrow$$ → cambiamos el sentido. $I_1 = 0{,}4027\ A \downarrow \uparrow$

$$I_2 = \frac{\begin{vmatrix} 35/6 & 10 \\ 4 & 20 \end{vmatrix}}{\begin{vmatrix} 35/6 & 4 \\ 4 & 7 \end{vmatrix}} = \frac{\frac{700}{6} - 40}{\frac{245}{6} - 16} = 3{,}09\ A \downarrow \uparrow$$

a) $V_{AB} = I_1 R_{eq} = 0{,}4 \cdot \frac{5}{6} = \frac{1}{3}\ V$

$i_3 = \frac{V}{R_{serie}} = \frac{1/3}{5} = \frac{1}{15}\ A$

b) $I_{4\Omega} = I_2 - I_1 = 3{,}09 - 0{,}4 = 2{,}69\ A$

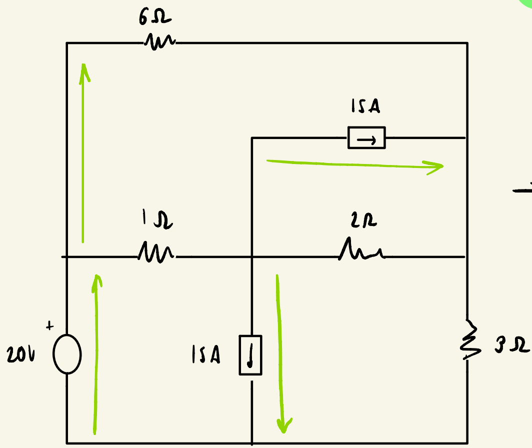
como tienen distinto sentido mayor - menor

$P = I_{4\Omega}^2 R_{4\Omega} = 2{,}69^2 \cdot 4 = 28{,}9444\ W$

para pasar a cal

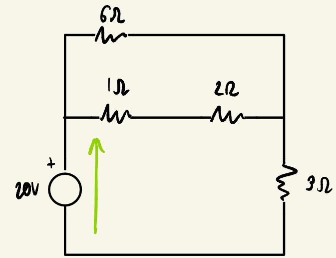
$Q = P \cdot 0{,}24 \cdot t = 28{,}9444 \cdot 0{,}24 \cdot 60 = 416{,}7999$

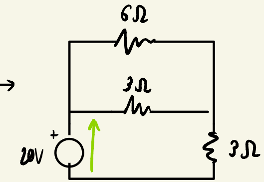
Caída de tensión en $R_{3\Omega}$



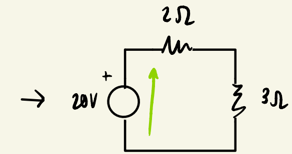
Superposición

1º elimino f. intensidad

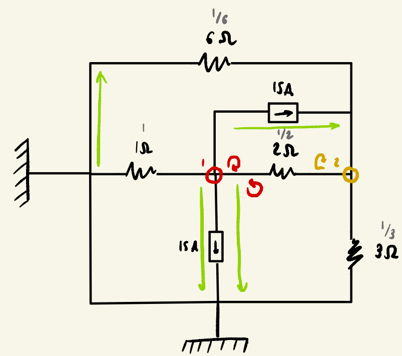




$\frac{1}{R} = \frac{1}{6} + \frac{1}{3} = \frac{3}{6} = \frac{1}{2}$



2º elimino f. tensión



$$\begin{pmatrix} \Sigma I_1 \\ \Sigma I_2 \end{pmatrix} = \begin{pmatrix} G_{11} & -G_{12} \\ -G_{21} & G_{22} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

$$\begin{pmatrix} -30 \\ 15 \end{pmatrix} = \begin{pmatrix} 1{,}5 & -0{,}5 \\ -0{,}5 & 1 \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

$$V_2 = \frac{\begin{vmatrix} 1{,}5 & -30 \\ -0{,}5 & 15 \end{vmatrix}}{\begin{vmatrix} 1{,}5 & -0{,}5 \\ -0{,}5 & 1 \end{vmatrix}} = 6V$$

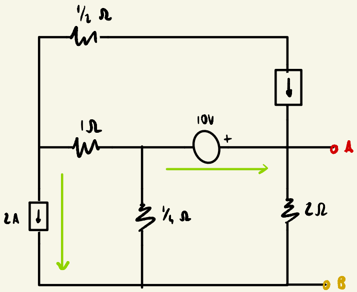
$$I_2 = \frac{6}{3} = 2A$$

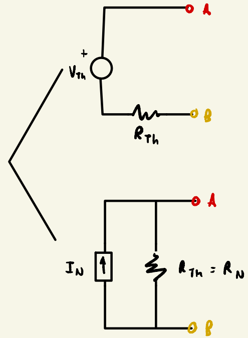
$$I_T = 4 + 2 = 6A$$

$$V_{3\Omega} = 6 \cdot 3 = 18V$$

a) Calcular equivalente entre A y B

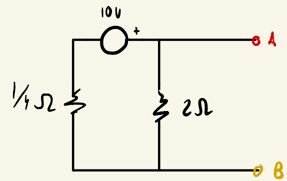
b) Potencia disipada en $R = 4\Omega$ que se colocara entre A y B





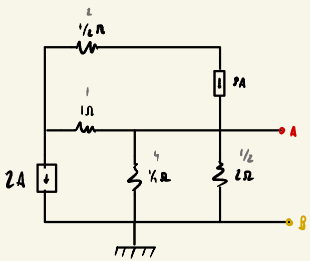
Superposición

1º elimino f. intensidad



$$V_{AB} = IR = 2I = 2\left(\frac{\varepsilon}{\Sigma R}\right) = 2\left(\frac{10}{1/4 + 2}\right) = \frac{80}{9}\ V$$

2º elimino f. tensión

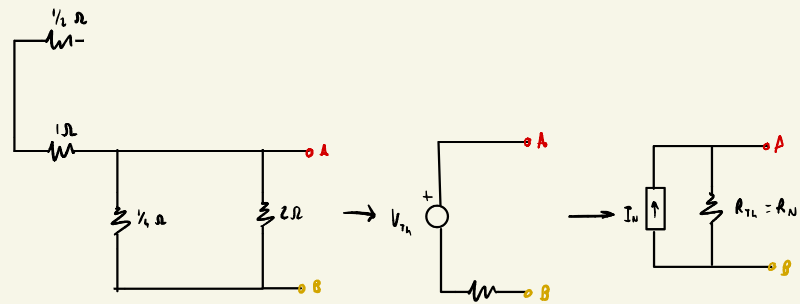


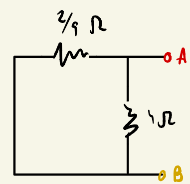
$$\begin{pmatrix} \Sigma I_1 \\ \Sigma I_2 \end{pmatrix} = \begin{pmatrix} G_{11} & -G_{12} \\ -G_{21} & G_{22} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

$$\begin{pmatrix} 3 \\ -2 \end{pmatrix} = \begin{pmatrix} 5,5 & -3 \\ -3 & 3 \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

$$V_1 = \frac{\begin{vmatrix} 3 & -3 \\ -2 & 3 \end{vmatrix}}{\begin{vmatrix} 5,5 & -3 \\ -3 & 3 \end{vmatrix}} = \frac{3}{7,5} = 0,4\ V$$

$$V_{Th} = V_{AB} + V_1 = \frac{80}{9} + 0,4 = 9,28$$





$$R_{Th} = \frac{1}{\frac{1}{1/4} + \frac{1}{2}} = \frac{2}{9}\ \Omega$$

$$V_{Th} = IR = I \cdot \frac{2}{9} = 9,3\ V$$

$$P = I^2 R = \left(\frac{9,3}{4 + \frac{2}{9}}\right)^2 \cdot 4 = 19,4063\ W$$

a) Calcular equivalente entre A y B

b) Potencia disipada en $R = 4\Omega$ que se colocara entre A y B