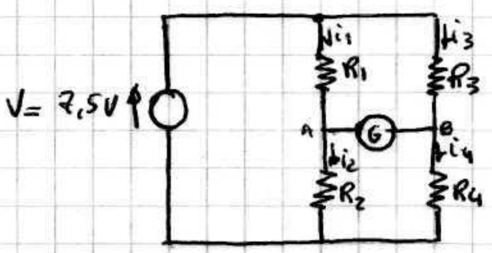
LENTINI PEDRO
COM M.M.

CAPITULO 4

PROBLEMA 4.1

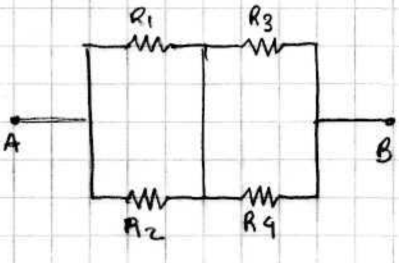


$R_1 = R_3 = 1000\,\Omega$

$R_4 = 129{,}2\,\Omega$

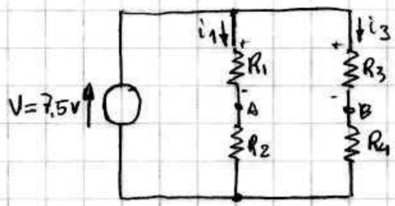
$R_2 \rightarrow$ varia de acuerdo a la tabla.

Calculo R_{TH} en A-B



$$R_{TH} = \frac{R_1 . R_2}{R_1 + R_2} + \frac{R_3 . R_4}{R_3 + R_4}$$

Calculo E_{TH}

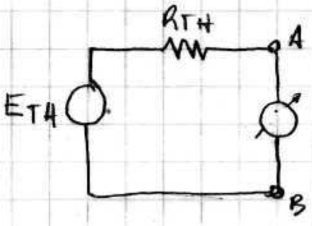


$$i_1 = \frac{V}{R_1 + R_2} \qquad i_3 = \frac{V}{R_3 + R_4}$$

$$V_A + V . \frac{R_1}{R_1 + R_2} - V \frac{R_3}{R_3 + R_4} = V_B$$

$$E_{TH} = V_A - V_B = V \left(\frac{R_3}{R_3 + R_4} - \frac{R_1}{R_1 + R_2} \right)$$

Equivalente de Thevenin



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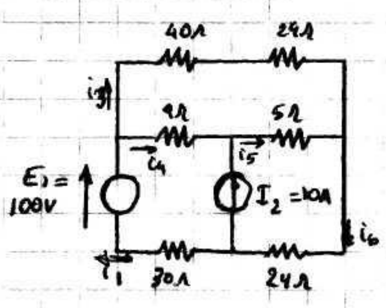
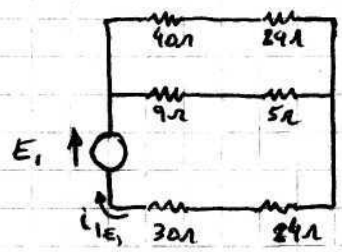
PROBLEMA 4.2



$P_{E_1} = ?$

Por superposición

Pasivo I_1

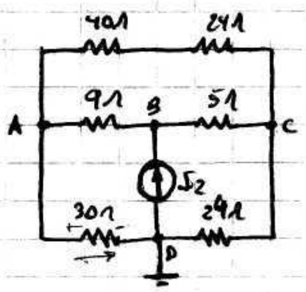


$$R_{eq} = \frac{64\Omega \cdot 14\Omega}{64\Omega + 14\Omega} + 54\Omega$$

$$R_{eq} = 65{,}49\,\Omega$$

$$i_{1E_1} = \frac{E_1}{R_{eq}} = \frac{100V}{65{,}49\Omega} \qquad \boxed{i_{1E_1} = 1{,}53\ A}$$

Pasivo E_1



Resuelto por el método sist. de nodos.

$$\begin{vmatrix} 0A \\ 10A \\ 0A \end{vmatrix} = \begin{vmatrix} \frac{1}{64\Omega} + \frac{1}{9\Omega} + \frac{1}{30\Omega} & -\frac{1}{9\Omega} & -\frac{1}{64\Omega} \\ -\frac{1}{9\Omega} & \frac{1}{9\Omega} + \frac{1}{5\Omega} & -\frac{1}{5\Omega} \\ -\frac{1}{64\Omega} & -\frac{1}{5\Omega} & \frac{1}{64\Omega} + \frac{1}{24\Omega} + \frac{1}{5\Omega} \end{vmatrix} \cdot \begin{vmatrix} V_A \\ V_B \\ V_C \end{vmatrix}$$

$$\Delta = 2{,}463 \cdot 10^{-3}\ \frac{1}{\Omega^3}$$

$$\Delta_{V_A} = 0{,}3171\ \frac{A}{\Omega^2}$$

$$V_A = \frac{\Delta V_A}{\Delta} = \frac{0{,}3171}{2{,}463 \cdot 10^{-3}}\ \frac{A \cdot \Omega^3}{\Omega^2} = 128{,}78\ V$$

4

$$V_A - i_{I_2} 30\Omega = V_D \qquad V_D = 0$$

$$V_A = i_{I_2} 30\Omega$$

$$i_{I_1} = \frac{V_A}{30\Omega} = \frac{+128,78V}{30\Omega} = -4,29\,A$$

$$I_1 = i_{1E_1} - i_{1I_2} = 1,53\,A + 4,29\,A$$

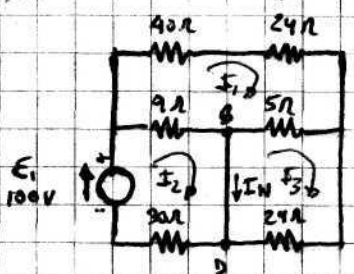
$$\boxed{I_1 = -2,76\ A}$$

$$P_{E_1} = E_1 \cdot I_1$$

$$P_{E_1} = 100V \cdot -2,76\,A$$

$$\boxed{P_{E_1} = -276\,W}$$

PROBLEMA 4.3



$I_N = ?$ $\quad V_{BD} = ?$ $\quad P_{I_2}$

$I_N = 2,58A$

Método sistemático de Mayas.

$$\begin{pmatrix} 0 \\ +100V \\ 0 \end{pmatrix} = \begin{pmatrix} 40\Omega+24\Omega+5\Omega+9\Omega & -9\Omega & -5\Omega \\ -9\Omega & 9\Omega+30\Omega & 0 \\ -5\Omega & 0 & 5\Omega+24\Omega \end{pmatrix} \cdot \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix}$$

$$\Delta = 84.894\,\Omega^3$$

$$\Delta I_1 = +26.100\ V.\Omega^2 \qquad I_1 = \frac{\Delta I_1}{\Delta} = +0,307\,A$$

$$\Delta I_2 = +223.700\ V.\Omega^2 \qquad I_2 = \frac{\Delta I_2}{\Delta} = +2,635\,A$$

$$\Delta I_3 = 4.500\ V\Omega^2 \qquad I_3 = \frac{\Delta I_3}{\Delta} \simeq 0,053\,A$$

$$I_N = I_2 - I_3 \Rightarrow \boxed{I_N = 2,582\,A}$$

NOTA

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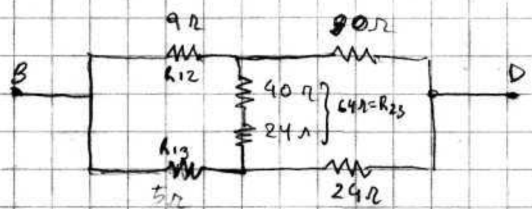
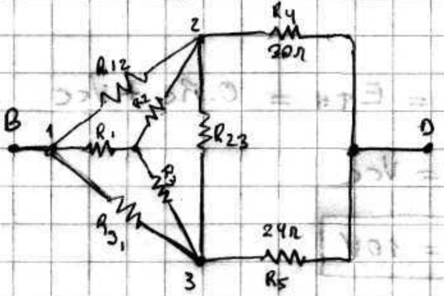
Calculo la R_N





$$R_1 = \frac{R_{12} \cdot R_{31}}{R_{12} + R_{23} + R_{31}} = 0,577\,\Omega$$

$$R_2 = \frac{R_{12} \cdot R_{23}}{R_{12} + R_{23} + R_{31}} = 7,385\,\Omega$$

$$R_3 = \frac{R_{23} \cdot R_{31}}{R_{12} + R_{23} + R_{31}} = 4,103\,\Omega$$

$$R_N = R_1 + \frac{R_{24} \cdot R_{35}}{R_{24} + R_{35}} = \boxed{16,62\Omega = R_N}$$

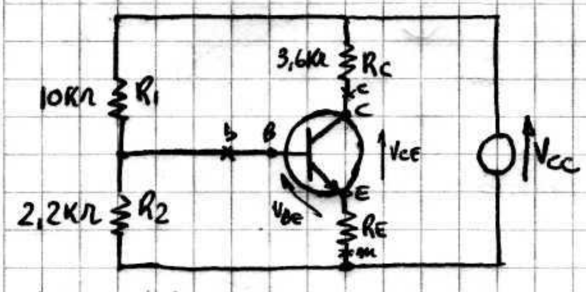
$R_{24} = R_2 + R_4 \qquad R_{35} = R_3 + R_5$

$$V_{BD} = (I_N + I_2) \cdot R_N$$

$$V_{BD} = (12,582\,A) \cdot 16,62\Omega \Rightarrow \boxed{V_{BD} = 209,11V}$$

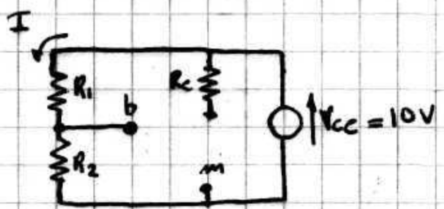
$$P_{I_2} = V_{BD} \cdot I_2 = \boxed{2091,1\,W = P_{I_2}}$$

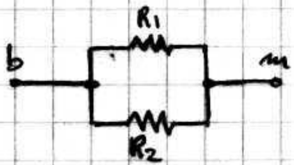
PROBLEMA 4.4



Thevenin equivalentes vistos desde el transistor hacia el circuito externo entre los nodos "b-m" y "c-m"

Thevenin en b-m





$R_{TH} = R_1 // R_2$

$$I = \frac{V_{CC}}{R_1 + R_2} = \frac{10V}{12,2K\Omega} = 819,7\,\mu A$$

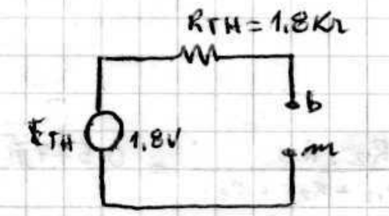
$$R_{TH} = \frac{R_1 \cdot R_2}{R_1 + R_2} = 1,80K\Omega$$

$$V_{b-m} = V_{TH} = I \cdot R_2 = 1,80\,V = E_{TH}$$

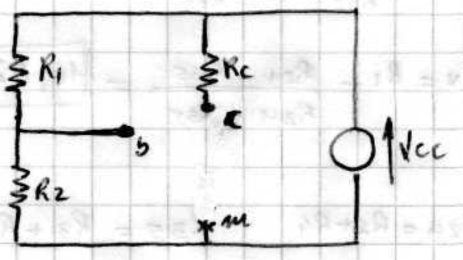
$$\boxed{R_{TH} = 1,80K\Omega}$$

$$\boxed{E_{TH} = 1,80V}$$

NOTA



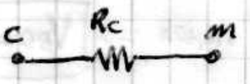
Thevenin en c-m



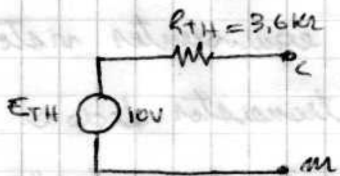
$V_{c-m} = E_{TH} = 0 \cdot R_c + V_{cc}$

$E_{TH} = V_{cc}$

$\boxed{E_{TH} = 10V}$



$R_{TH} = R_C \quad \Rightarrow \quad \boxed{R_{TH} = 3,6K\Omega}$



NOTA

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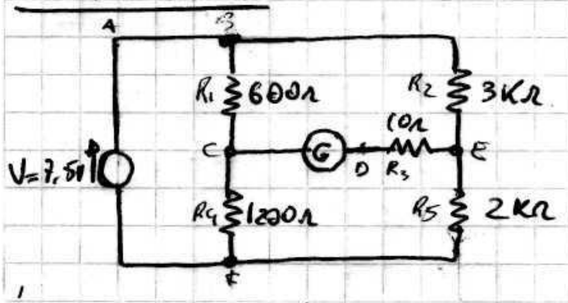
HOJA N° 7

FECHA

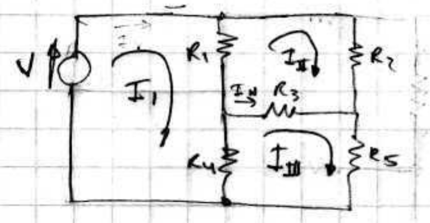
PROBLEMA 4.5



$$I_G = I_{III} - I_{II}$$

$$\boxed{I_G = 1{,}242 \; mA}$$

Mallas



$$\begin{vmatrix} V \\ 0 \\ 0 \end{vmatrix} = \begin{vmatrix} R_1+R_4 & -R_1 & -R_4 \\ -R_1 & R_2+R_3+R_1 & -R_3 \\ -R_4 & -R_3 & R_4+R_3+R_5 \end{vmatrix} \cdot \begin{vmatrix} I_1 \\ I_{II} \\ I_{III} \end{vmatrix}$$

$$I_3 = \frac{\Delta I_3}{\Delta}$$

$$\begin{vmatrix} 7{,}5\,V \\ 0 \\ 0 \end{vmatrix} = \begin{vmatrix} 1800\Omega & -600\Omega & -1200\Omega \\ -600\Omega & 3.610\Omega & -10\Omega \\ -1200\Omega & -10\Omega & 3.210\Omega \end{vmatrix} \cdot \begin{vmatrix} I_1 \\ I_{II} \\ I_{III} \end{vmatrix}$$

$$\boxed{I_3 = 2{,}245 \; mA}$$

$$\Delta = 1800\Omega \cdot 11.588\,K\Omega + 600\Omega \cdot (-1.938\,K\Omega) - 1200\Omega \cdot (+4.338\,K\Omega)$$

$$\Delta = 1{,}449 \cdot 10^{10}\ \Omega^3$$

$$\Delta I_1 = 7{,}5V \cdot 11.588\,K\Omega = 8691 \times 10^7\ V.\Omega$$

$$\boxed{I_1 = 5{,}998 \; mA}$$

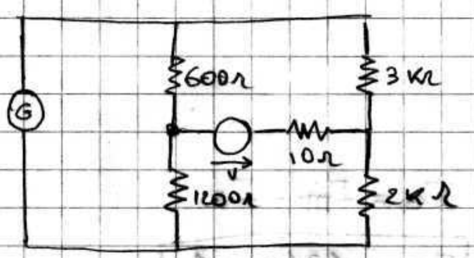
$$\Delta I_2 = 1800\Omega \begin{pmatrix} 0 & -10\Omega \\ 0 & 3.200\Omega \end{pmatrix} - 7{,}5V \begin{vmatrix} -600\Omega & -10\Omega \\ -1200\Omega & 3.210\Omega \end{vmatrix} + 1200\Omega \cdot \begin{vmatrix} -600\Omega & 0V \\ -1200\Omega & 0V \end{vmatrix}$$

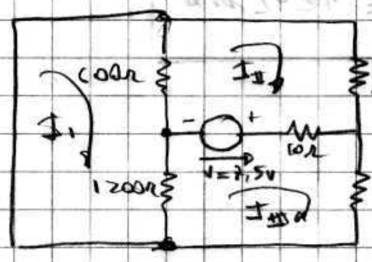
$$\Delta I_2 = -7{,}5V \cdot (-1{,}438 \cdot 10^6\,\Omega^2) = 1{,}4535 \cdot 10^7\ V.\Omega^2$$

$$\boxed{I_2 = \frac{\Delta I_2}{\Delta} = 1{,}003 \; mA}$$

$$\Delta I_3 = 1800\Omega \begin{pmatrix} 3.610\Omega & 0 \\ -10\Omega & 0 \end{pmatrix} + 600\Omega \cdot \begin{pmatrix} -600\Omega & 0 \\ -1200\Omega & 0 \end{pmatrix} + 7.5V \cdot \begin{pmatrix} -600 & 3610 \\ -1200 & -10\Omega \end{pmatrix} = 3{,}2535 \cdot 10^7$$

NOTA





$$\begin{pmatrix} 0 \\ -7{,}5V \\ +7{,}5V \end{pmatrix} = \begin{pmatrix} 1800\Omega & -600\Omega & -1200\Omega \\ -600\Omega & 3610\Omega & -10\Omega \\ -1200\Omega & -10\Omega & 3210\Omega \end{pmatrix} \cdot \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix}$$

$$\Delta = 1{,}449 . 10^{10}\ \Omega^3$$

$$\Delta I_1 = +600\Omega \begin{pmatrix} -7{,}5V & -10\Omega \\ 7{,}5V & 3210\Omega \end{pmatrix} - 1200\Omega \begin{pmatrix} -7{,}5V & 3610\Omega \\ 7{,}5V & -10\Omega \end{pmatrix}$$

$$\Delta I_1 = 600\Omega(-2{,}4 . 10^4\ V.\Omega) - 1200\Omega(-2{,}7 . 10^4\ V\Omega)$$

$$\Delta I_1 = 1{,}8 . 10^{7}\ V.\Omega^2 \Rightarrow I_1 = \frac{\Delta I_1}{\Delta} \quad \boxed{I_1 = 1{,}24\ mA = I_G}$$

Como la corriente sobre el galvanómetro en el primer circuito y en el segundo son iguales (se intercambia la fuente de tensión por el galvanometro) la corriente en el galvanómetro es la misma.

NOTA

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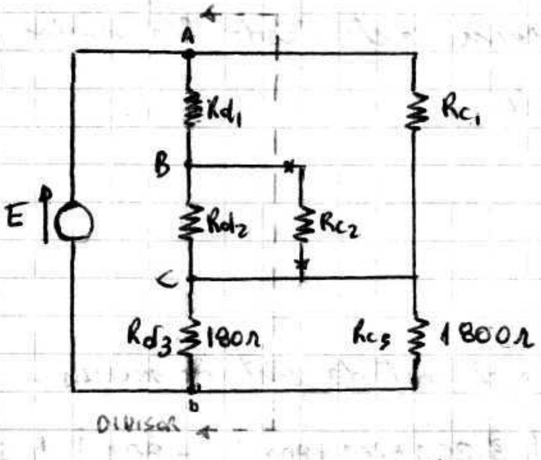
PROBLEMA 4.6



$R_{C1} = 1800\Omega$

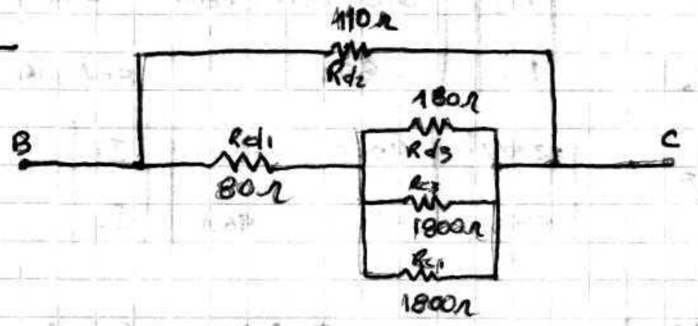
$R_{C2} = 1100\Omega$: represento la carga en +5V

$R_{C3} = 1800\Omega$

$R_{d1} = 80\Omega$ $\quad R_{d3} = 180\Omega$

$R_{d2} = 110\Omega$ $\quad E = 9V$

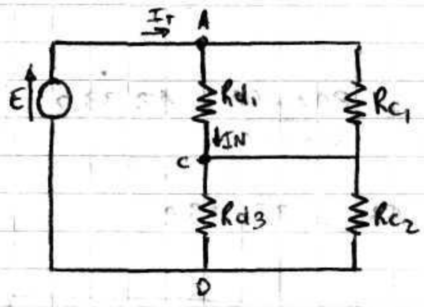
R_N



$$R_{d3} // R_{c3} // R_{c1} = \frac{180\Omega \cdot 900\Omega}{180\Omega + 900\Omega} = 150\Omega$$

$$R_N = (R_{d1} + R_{d3}//R_{c3}//R_{c1}) // R_{d2} = \frac{230\Omega \cdot 110\Omega}{230\Omega + 110\Omega} = \boxed{74{,}41\ \Omega = R_N}$$

Calculo la I_N



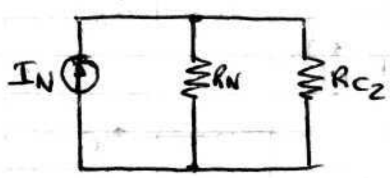
$$I_T = \frac{V_{AD}}{R_{d1}//R_{c1} + R_{d3}//R_{c2}} = \frac{9V}{240{,}23\Omega} = 37{,}46\ mA$$

$$R_{d1}//R_{c1} = \frac{R_{d1} \cdot R_{c1}}{R_{d1} + R_{c1}} = 76{,}60\Omega$$

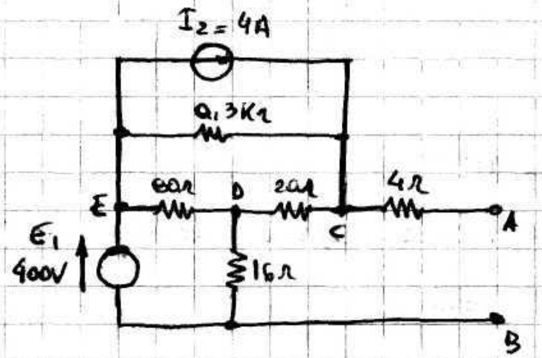
$$R_{d3}//R_{c2} = \frac{R_{d3} \cdot R_{c2}}{R_{d3} + R_{c2}} = 163{,}63\Omega$$

$V_{AC} = I_T \cdot R_{d1}//R_{c1} = 2{,}87\ V$

$$I_N = \frac{V_{AC}}{R_{d1}} = \frac{2{,}87V}{80\Omega} \Rightarrow \boxed{I_N = 35{,}88\ mA}$$

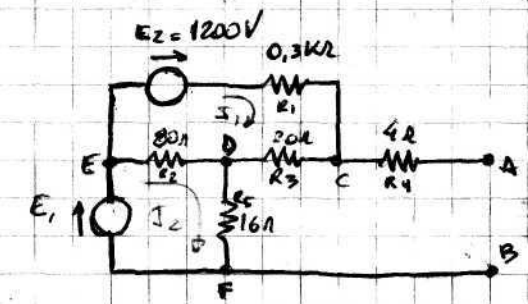


PROBLEMA 4.7



Encontrar el equivalente de Thevenin visto desde los nodos "A" y "B".

Calculo lo E_{TH}



Utilizo el metodo sist. de mayas -

$$\begin{vmatrix} E_2 \\ E_1 \end{vmatrix} \begin{vmatrix} 300\Omega + 20\Omega + 80\Omega & -80\Omega \\ -80\Omega & 80\Omega + 16\Omega \end{vmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$\begin{vmatrix} 1200V \\ 400V \end{vmatrix} \begin{vmatrix} 400\Omega & -80\Omega \\ -80\Omega & 96\Omega \end{vmatrix} \begin{vmatrix} I_1 \\ I_2 \end{vmatrix}$$

$$\Delta = (400 \cdot 96 - 80)\Omega^2 = 32.000\,\Omega^2$$

$$\Delta I_1 = 1200V \cdot 96\Omega + 400V \cdot 80\Omega = 147.200\ V \cdot \Omega$$

$$\Delta I_2 = 400\Omega \cdot 400V + 80\Omega \cdot 1200V = 256.000\ V \cdot \Omega$$

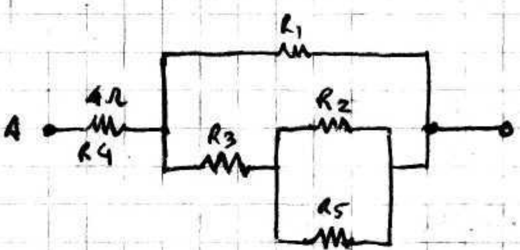
$$I_1 = \frac{\Delta I_1}{\Delta} = 4,6\ A$$

$$I_2 = \frac{\Delta I_2}{\Delta} = 8\ A$$

$$E_{TH} = V_{DC} + V_{DF}$$

$$= I_1 \cdot 20\Omega + I_2 \cdot 16\Omega = \boxed{220V = E_{TH}}$$

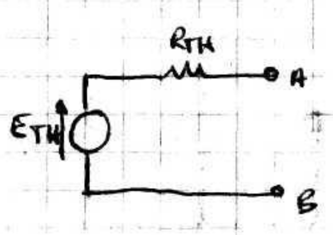
Calculo lo R_{TH}



$$R_{25} = \frac{R_2 \cdot R_5}{R_2 + R_5} = \frac{80\Omega \cdot 16\Omega}{80\Omega + 16\Omega} = 13,33\Omega$$

$$R_{325} = R_3 + R_{25} = 33,33\Omega$$

$$R_{TH} = R_4 + \frac{R_1 \cdot R_{325}}{R_1 + R_{325}} = \boxed{34\,\Omega = R_{TH}}$$



NOTA

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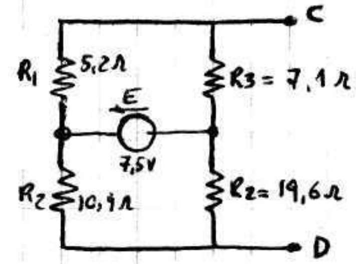
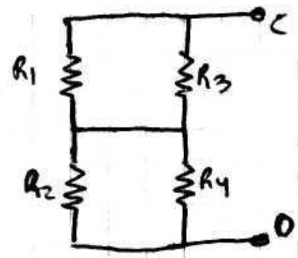
PROBLEMA 4.8



Qué valor de resistencia habrá que conectar entre "C - D" para tener máxima transferencia de energía?
Se obtendrá la máx transf de energía cuando $R_{TH} = R_{C-D}$

Calculo la R_{TH}

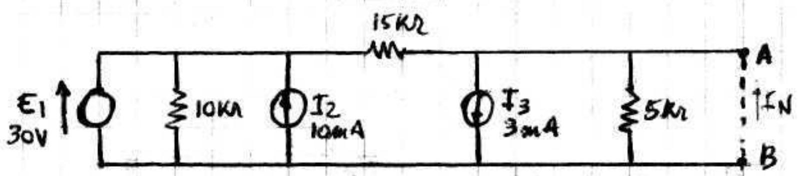


$$R_{TH} = R_1 // R_3 + R_2 // R_4$$

$$R_{TH} = \frac{R_1 \cdot R_3}{R_1 + R_3} + \frac{R_2 \cdot R_4}{R_2 + R_4}$$

$$R_{TH} = 3{,}00\,\Omega + 7{,}00\,\Omega \Rightarrow \boxed{R_{TH} = 10\,\Omega}$$

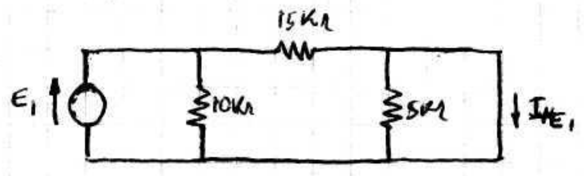
PROBLEMA 4.9



Equivalente de Norton entre nodos "A - B"

Por el método de superposición.

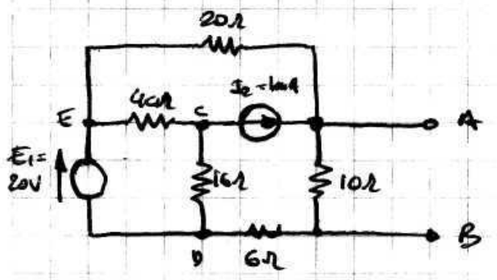
Pasivo I_2 e I_3



$$I_{NE_1} = \frac{E_1}{15K\Omega} = \frac{30V}{15K\Omega} \Rightarrow \boxed{I_{NE_1} = 2mA}$$

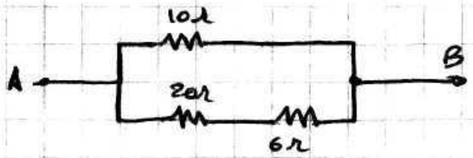
LENTINI PEDRO

PROBLEMA 4.10



Encontrar el equivalente de Thevenin visto desde los nodos "A" y "B"

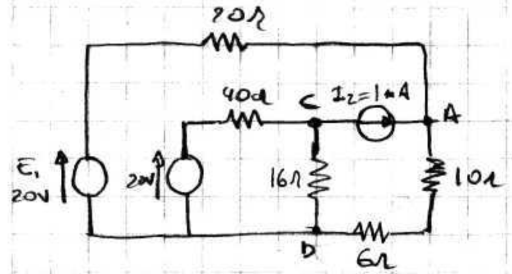
Calculo R_{TH}



$$R_{TH} = \frac{10\Omega \cdot 26\Omega}{(10\Omega + 26\Omega)} = 7{,}22\ \Omega$$

$$\boxed{R_{TH} = 7{,}22\ \Omega}$$

Calculo V_{TH}. $V_{TH} = V_{AB}$.



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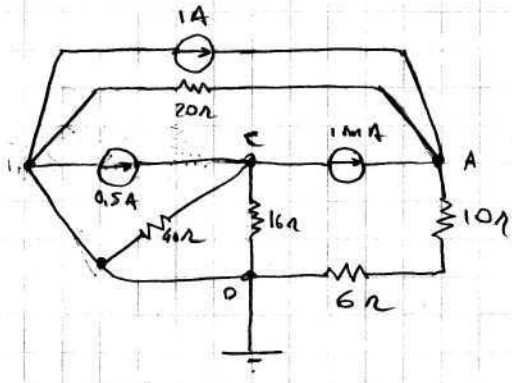

$$A \quad \begin{pmatrix} 1{,}001\ A \\ 0{,}499\ A \end{pmatrix} = \begin{pmatrix} \frac{1}{20\Omega} + \frac{1}{16\Omega} & 0 \\ 0 & \frac{1}{40\Omega} + \frac{1}{16\Omega} \end{pmatrix} \begin{pmatrix} V_A \\ V_C \end{pmatrix}$$

$$\Delta = \left(\frac{1}{20\Omega} + \frac{1}{16\Omega}\right) \cdot \left(\frac{1}{40\Omega} + \frac{1}{16\Omega}\right) = 9{,}844 \cdot 10^{-3}\ \frac{1}{\Omega^2}$$

$$\Delta V_A = 8{,}758 \cdot 10^{-2}\ \frac{A}{\Omega} \Rightarrow V_A = \frac{\Delta V_A}{\Delta} \quad \boxed{V_A = 8{,}90V = V_{AD}}$$

$$\Delta V_C = 5{,}614 \cdot 10^{-2}\ \frac{A}{\Omega} \Rightarrow V_C = \frac{\Delta V_C}{\Delta} \quad V_C = 5{,}7\ V$$

$$I \cdot 16\Omega = 8{,}90V$$

$$I = 0{,}556\ A \Rightarrow V_{10\Omega} = 0{,}556\ A \cdot 10\Omega \Rightarrow \boxed{V_{TH} = 5{,}56\ V}$$