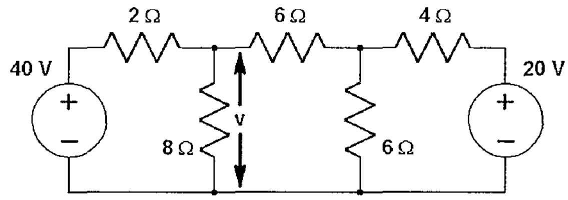
**PROBLEMAS DE CIRCUITOS ELECTRÓNICOS**
2° Curso de Grado en Ingeniería Informática – 17/18

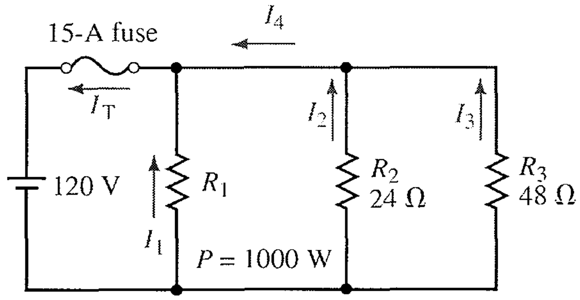
**TEMA 1: Repaso de la Teoría de redes lineales**

1.-Para el circuito de la figura, calcular la diferencia de potencial en bornas de la resistencia de 8 Ω.



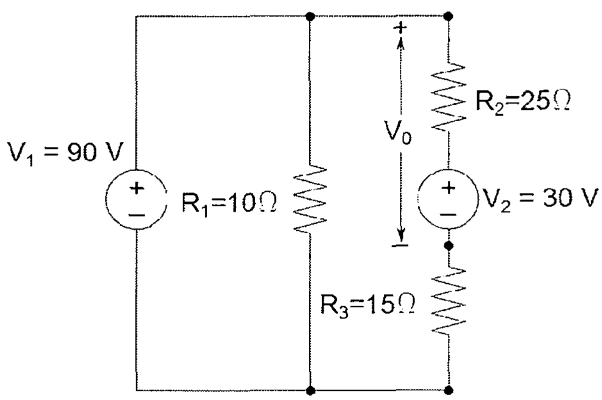

2.-Se desea diseñar una luneta térmica para un automóvil con 15 líneas, siendo cada una de ellas resistencia eléctrica. Obtener el valor y la disposición de las mismas para que el circuito disipe una potencia de 50W si usamos una fuente de alimentación de 12V en continua.

3.-Para el circuito de la figura
 a) Determinar las corrientes indicadas si la potencia disipada en $R_1$ es de 1000W. ¿Soportará el fusible la corriente que lo atraviesa?
 b) Calcular el valor de $R_3$ para que la corriente total del circuito sea $I_T$ = 15A.

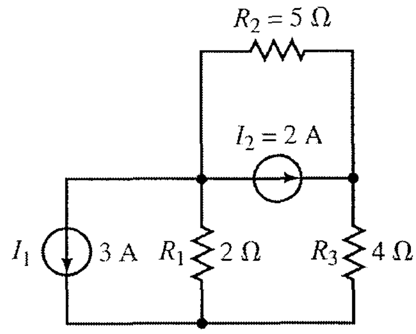



4.- Se quiere utilizar una bombilla de 3V y 300 mA para iluminar el dial de una radio de 120V. ¿Cuál será el valor de la resistencia en serie con la bombilla para que ésta no estalle?

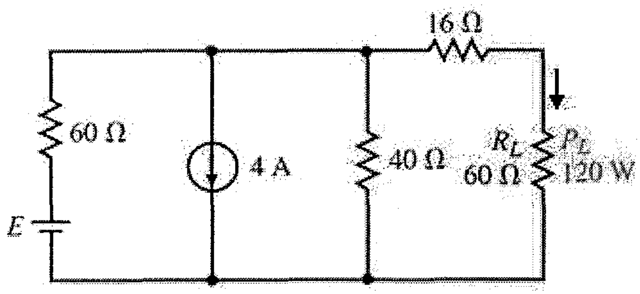
5.- Obtener las corrientes $I_1, I_2$ (que circulan por las resistencias $R_1$ y $R_2$ respectivamente) y la tensión $V_0$ para el circuito de la figura



6.- Calcular las corrientes que circulan por cada una de las resistencias del circuito adjunto escribiendo las ecuaciones correspondientes a cada uno de los nodos.



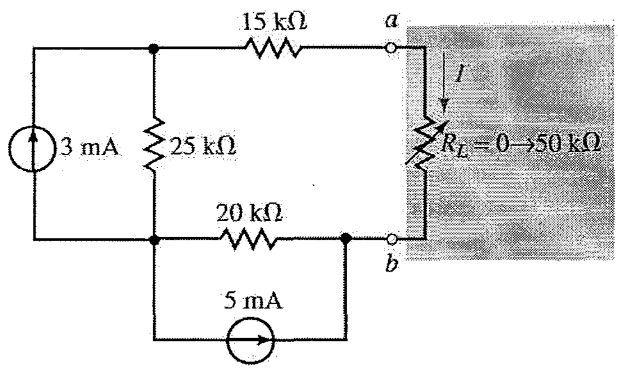

7.- Si la resistencia de carga $R_L$ que aparece en el circuito tiene que disipar 120 W de potencia, calcular el valor de la fuente de voltaje $E$ (suponer que la corriente circula por la resistencia de carga en el sentido indicado en la figura). Comprobar el resultado utilizando el principio de superposición.



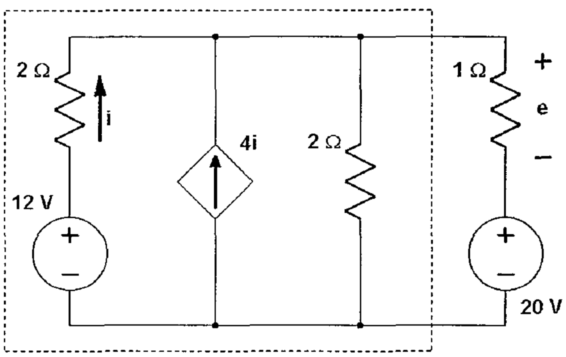

8.- Para el circuito de la figura,

*a)* Calcular el circuito equivalente de Thévenin entre los terminales de la resistencia de carga.

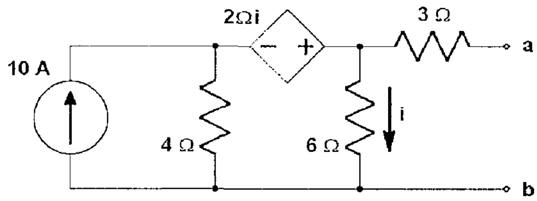
*b)* Usar dicho circuito equivalente para calcular la corriente I cuando la resistencia de carga vale 0, 10kΩ y 50kΩ



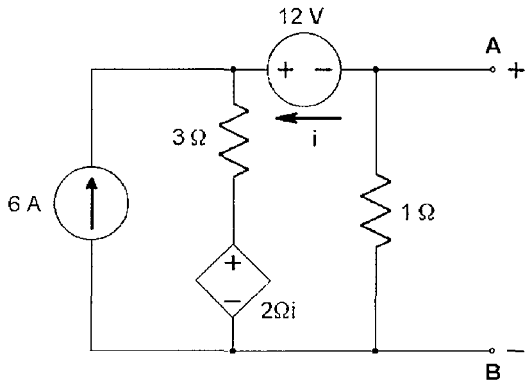

9.- Substituir la porción de red encerrada en la línea de trazos por su equivalente Thévenin, y calcular después la tensión e.



10.- Calcular los equivalentes Norton y Thévenin entre los terminales a y b.



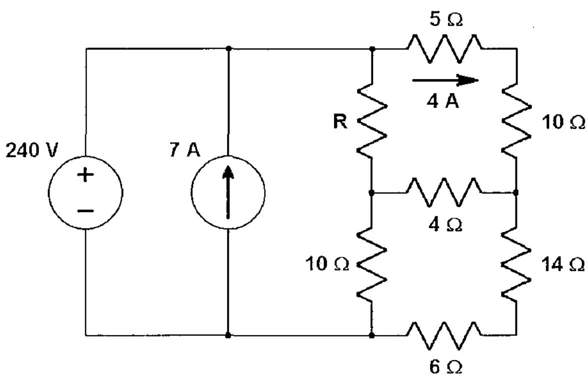

11.- En el circuito de la figura, calcular $V_{Th}$, $I_N$ y $R_{eq}$ entre los terminales A y B.




12.- En el circuito de la figura, determínese:

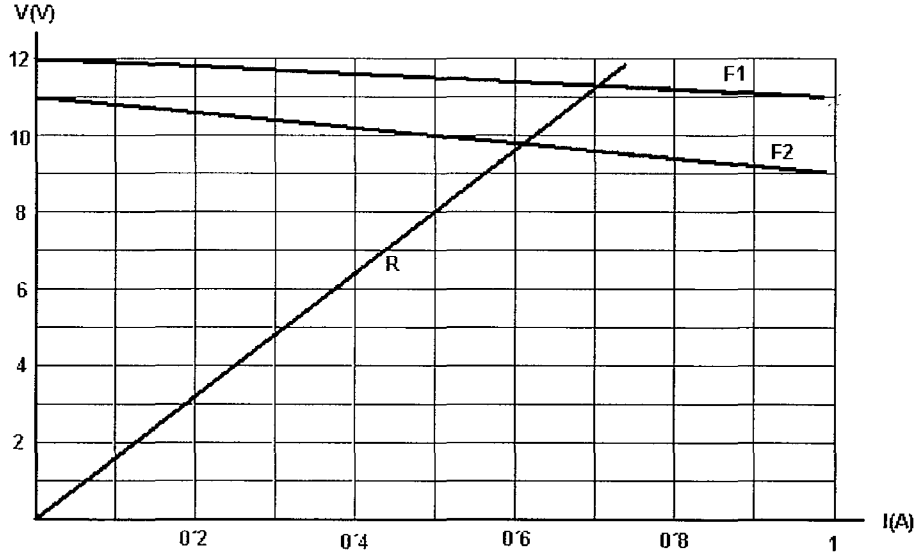
*a)* El valor de la resistencia R.

*b)* La potencia suministrada por la fuente de tensión.




13.- Cuando se conecta a una radio de automóvil una batería, proporciona 12.72 V a la radio. Cuando se la conecta a un par de faros, proporciona 12 V a los mismos. Suponga que se puede modelar la radio como una resistencia de 6.36 Ω y que los faros pueden modelarse como una resistencia de 0.6 Ω. ¿Cuáles son los equivalentes de Thévenin y de Norton de la batería?

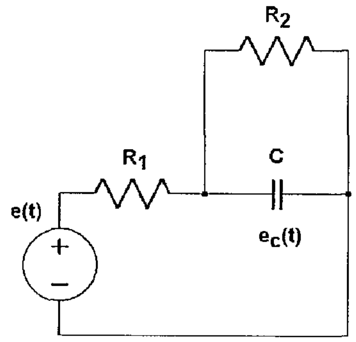
14.- Disponemos de dos fuentes de alimentación, F1 y F2, y de una resistencia, R, cuyas curvas de regulación y curva característica, respectivamente, se muestran en la figura. Determinar, cuando esos tres elementos se conectan en paralelo, la potencia suministrada por cada una de las fuentes.




ALTERNA

15.- La tensión $e(t)$ del generador del circuito de la figura es: $e(t) = 1V\cos(10^2 t)$, donde la frecuencia angular, ω, está dada en rad/s Hallar la tensión $e_c(t)$ en bornas del condensador.

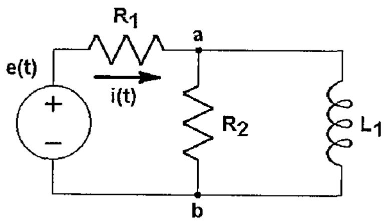
Datos: $R_1 = R_2 = 1\Omega$;
$C = 0.01$ F

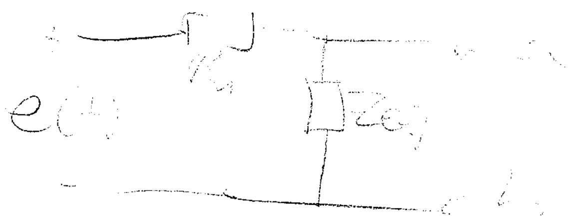



16.- Un circuito está formado por tres elementos en serie, los cuales producen una corriente $I = 10\sin(400t + 70)$ A como resultado de un voltaje $V = 50\sin(400t + 15)$ V, estando expresada la frecuencia angular en rad/s y los ángulos de fase en grados. Si uno de los elementos es una inductancia de 16 mH, ¿cuáles son los otros elementos?

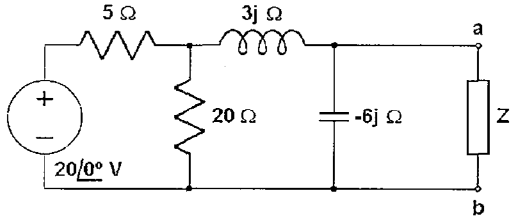
17.- En el circuito de la figura $e(t) = 3\cos(10t)$ V, (ω en rad/s). Calcular el equivalente Thévenin entre los dos puntos indicados y, a posteriori, calcular $i(t)$.

Datos: $R_1 = 2\,\Omega$;
$R_2 = 1\,\Omega$;
$L_1 = 0.2$ H.



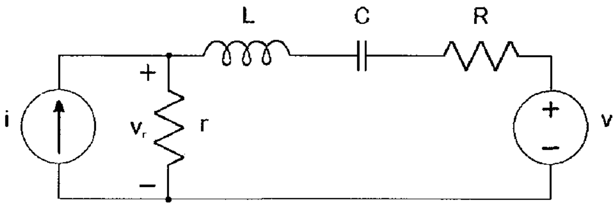



18.- Determinar la impedancia $Z$ que hace máxima la potencia transferida por el circuito.

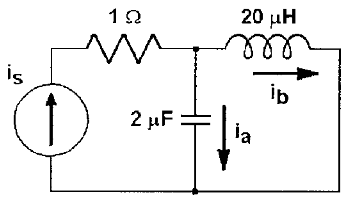



19.- Calcular la tensión $v_r$ (tensión en bornas de la resistencia r).

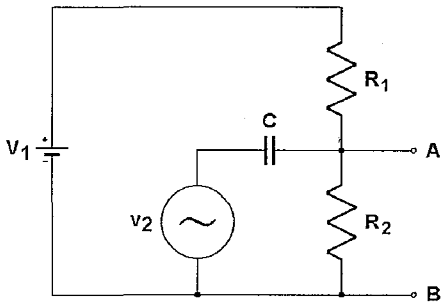
Datos: $v(t) = 26\cos(3t + 30°)$ V
$i(t) = 3\cos(2t)$ A
$r = R = 2\,\Omega$
$C = 1/4$ F,
$L = 1$ H;
ω en rad/s.




20.- La fuente de corriente sinusoidal del circuito está descrita por $i_s(t) = 10.5\cos(10^5 t)$ A, siendo ω = $10^5$ rad/s. Encontrar las respuestas en estado estacionario para $i_a$, $i_b$ y la tensión en bornas del condensador.



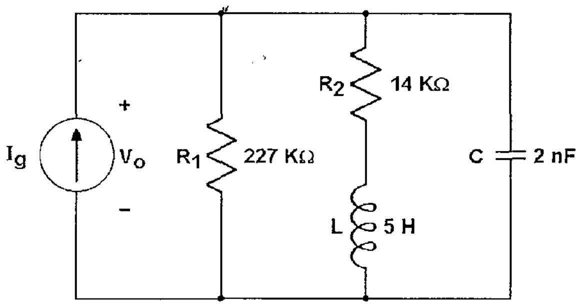

21.- Calcular el valor del voltaje $v_{AB}(t)$ del circuito de la figura, siendo $v_2(t) = V_2\cos(\omega t)$. Además, se desea obtener en $v_{AB}$ la superposición de una componente continua de valor $0.5 \cdot V_1$ junto con una alterna producida por $v_2(t)$. Calcular la relación entre $R_1$ y $R_2$.




22.- La fuente de corriente del circuito de la figura suministra una señal sinusoidal $I_g(t) = I_o\sin(\omega t)$, cuya frecuencia podemos ajustar a voluntad.

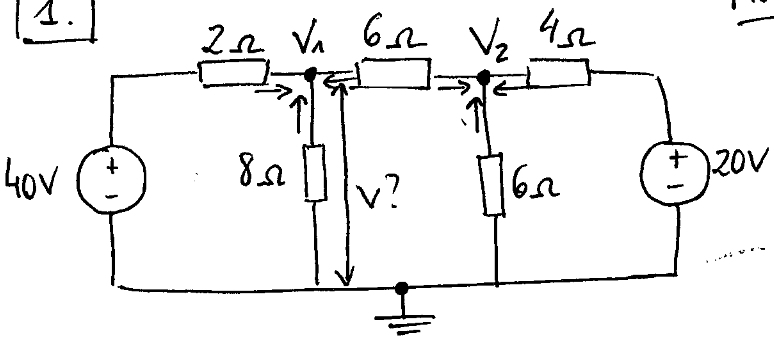
*a)* ¿A qué valor habrá que fijar la frecuencia para que la corriente $I_g$ se encuentre en fase con la tensión soportada por la fuente $V_o$?

*b)* A la frecuencia anterior, ¿cuánto vale la tensión $V_o$ si $I_o = 250$ μA?



# PROBLEMAS TEMA 1

**1.**

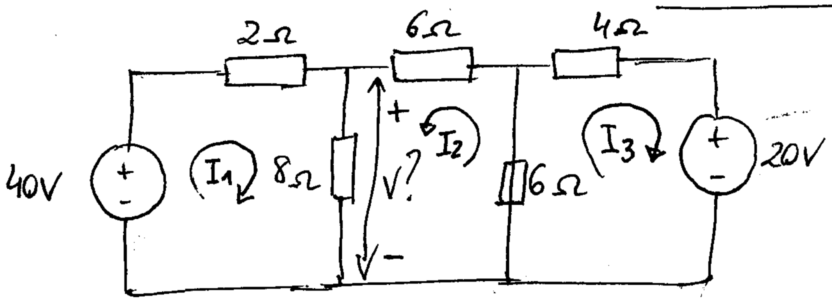



## Método de tensiones de nodos

$$\begin{cases} \dfrac{40 - V_1}{2\Omega} + \dfrac{V_2 - V_1}{6\Omega} + \dfrac{-V_1}{8\Omega} = 0 \\ \dfrac{V_1 - V_2}{6} + \dfrac{20 - V_2}{4} + \dfrac{-V_2}{6} = 0 \end{cases}$$

$$\Rightarrow \begin{cases} V_1 = 28'8\ V \\ V_2 = 16'8\ V \end{cases}$$

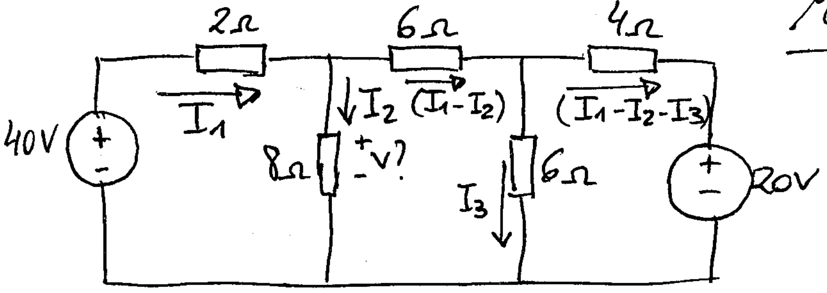
## Método de corrientes de mallas



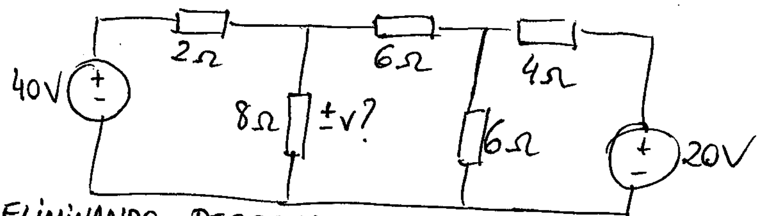

$$\begin{cases} 40 - 2I_1 + 8(I_1 + I_2) = 0 \\ 8(I_1 + I_2) + 6I_2 + 6(I_2 + I_3) = 0 \\ -6(I_2 + I_3) - 4I_3 - 20 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} I_1 \\ I_2 \\ I_3 \end{cases} \Rightarrow V = (I_1 + I_2).8$$

## Método 3º

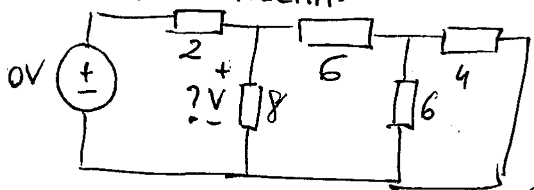


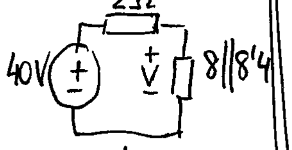

$$\begin{cases} 40 - 2I_1 - 8I_2 = 0 \\ 8I_2 - 6(I_1 - I_2) - 6I_3 = 0 \\ 6I_3 - 4(I_1 - I_2 - I_3) - 20 = 0 \end{cases}$$




## Método por el ppio. de superpos.

ELIMINANDO DERECHA:

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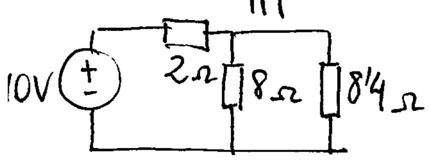
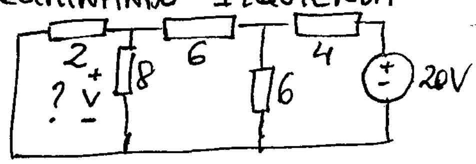



$$I = \frac{40}{2 + (8||8'4)}$$

$$V = I.(8||8'4) = 40 - 2I$$

ELIMINANDO IZQUIERDA:

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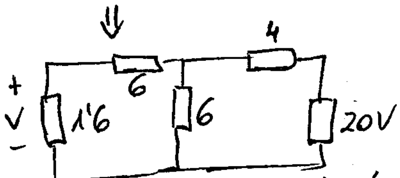
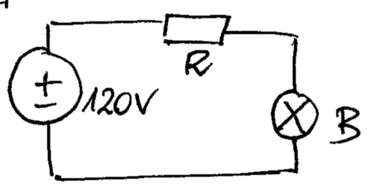



Resolver como toda la vida

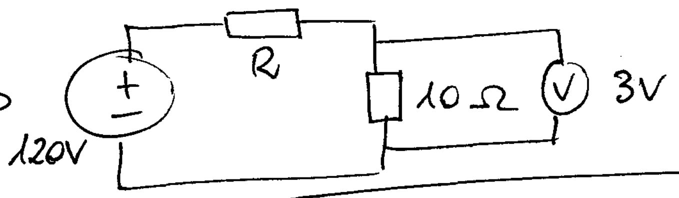
RESULTADO FINAL:

$$\boxed{V_{der} + V_{izq} = V_T}$$

$\boxed{4.}$ 3V - 300mA




$$Res_{bombilla} = \frac{3V}{300mA} = \frac{3V}{300.10^{-3}A} = \frac{3V}{0'3A} = 10\,\Omega$$




$$\boxed{3V = \frac{120}{R+10}\cdot 10 \Rightarrow R = 390\,\Omega}$$

¿cómo fue?

$$I_T = \frac{120}{R+10}$$

$$R = \frac{120-3}{I_T} = \frac{117}{120/R+10} = \frac{117(R+10)}{120} \Rightarrow$$

$$\Rightarrow 120R = 117R + 1170 \Rightarrow$$

$$\Rightarrow 3R = 1170 \Rightarrow R = \frac{1170}{3} = 390\,\Omega$$

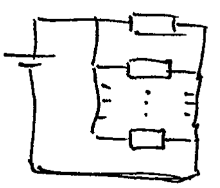
$\boxed{2.}$

DATOS $\begin{cases} 15 \text{ resist.} \\ P = 50W \\ V = 12V \end{cases}$

$$P = V.I \Rightarrow I = \frac{P}{V} = \frac{50w}{12V} = 4'1\widehat{6}\ A$$

$$Req = \frac{V}{I} = \frac{12V}{4'1\widehat{6}A} = 2'88\,\Omega$$

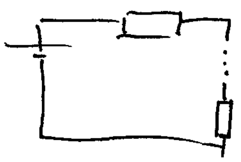
- Si colocamos las 15 resistencias en <u>paralelo</u>:



$$\frac{1}{Req} = \underbrace{\frac{1}{x} + \dots + \frac{1}{x}}_{15 \text{ veces}} \Rightarrow \frac{1}{2'88} = \frac{15}{x} \Rightarrow x = 2'88.15 = \boxed{43'2\,\Omega}$$

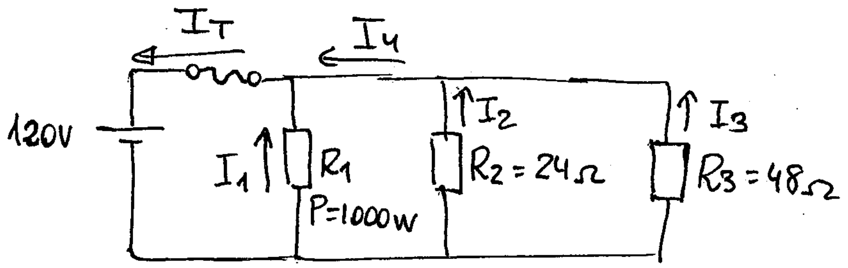
cada una

- Si colocamos las 15 resistencias en <u>serie</u>:



$$Req = 15x \Rightarrow x = \frac{2'88\,\Omega}{15} = \boxed{0'19\,\Omega}$$ cada una

3.




$I_T = I_4 + I_1$

$I_4 = I_2 + I_3$

$\boxed{I_T = I_1 + I_2 + I_3}$

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

a) $R_1 = \frac{V^2}{P} = \frac{120^2}{1000} = 14'4\,\Omega$

Dos formas de calcular $I_1$

$\rightarrow I_1 = \sqrt{P/R} = \sqrt{\frac{1000}{14'4}} = 8'\widehat{3}\,A$

$\rightarrow I_1 = \frac{V}{R_1} = \frac{-120V}{14'4\Omega} = -8'\widehat{3}\,A$

$I_2 = \frac{-120}{R_2} = \frac{-120}{24\Omega} = -5A$

$I_3 = \frac{-120}{R_3} = \frac{-120}{48} = -2'5\,A$

$I_4 = I_2 + I_3 = -5A - 2'5A = -7'5\,A$

$I_{fusible} = I_T = I_1 + I_4 = -8'\widehat{3} + (-7'5) = -15'8\widehat{3}\,A$

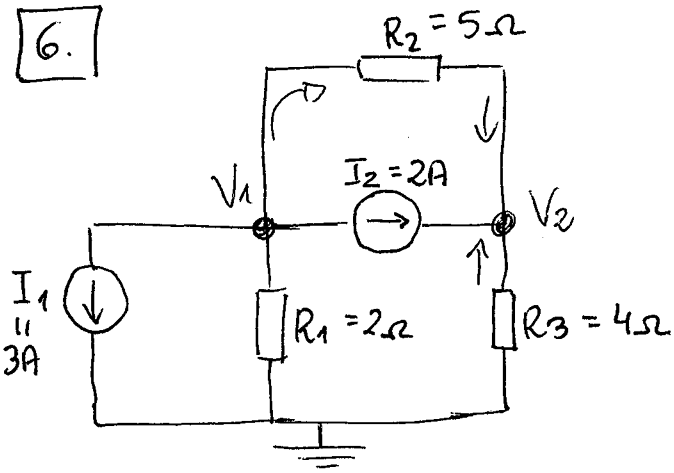
$|I_{fusible}| = 15'8\widehat{3}\,A \longrightarrow$ el fusible no aguntará el paso de corriente

b) $R_3$? para que $I_T = 15A$.

$\left.\begin{array}{l}|I_1| = 8'\widehat{3}A \\ |I_2| = 5A\end{array}\right\} \Rightarrow I_T = 15 = I_1 + I_2 + I_3 \Rightarrow I_3 = 15 - 8'\widehat{3} - 5 = 1'\widehat{6}\,A$

$V = R.I \Rightarrow R_3 = \frac{V}{I_3} = \frac{120}{1'\widehat{6}} = 72\,\Omega$

$\boxed{6.}$




En nodo $V_1$

$$3 + 2 + \frac{V_1 - V_2}{5} + \frac{V_1}{2} = 0$$

En nodo $V_2$

$$2 + \frac{V_1 - V_2}{5} + \frac{-V_2}{4} = 0$$

Sistema de dos ecuaciones y dos incógnitas $\rightarrow \cdots \rightarrow$

$$\rightarrow \begin{cases} V_1 = -6'73\,V \\ V_2 = 1'45\,V \end{cases}$$

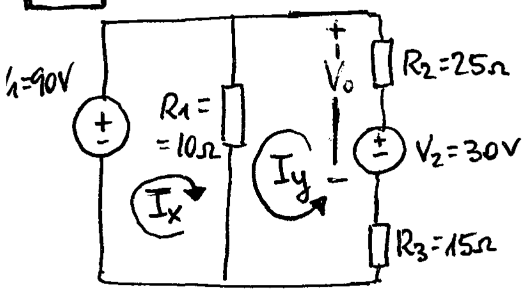
Corrientes:

$$I_{5\Omega} = \frac{V_1 - V_2}{5} = -1'64\,A$$

$$I_{4\Omega} = \frac{-V_2}{4} = -0'36\,A$$

$$I_{2\Omega} = \frac{-V_1}{2} = 3'36\,A$$

$\boxed{5.}$




$$\begin{cases} 90 - 10(I_x + I_y) = 0 \Rightarrow I_x + I_y = 9 \\ 30 - 25 I_y - 10(I_x + I_y) - 15y = 0 \Rightarrow I_x + 5I_y = 3 \end{cases}$$

$$\begin{cases} \cancel{I_x} + I_y = 9 \\ -\cancel{I_x} - 5I_y = -3 \end{cases}$$

$$-4 I_y = 6 \rightarrow I_y = -\frac{3}{2}\,A$$

$$|I_y| = 3/2\,A$$

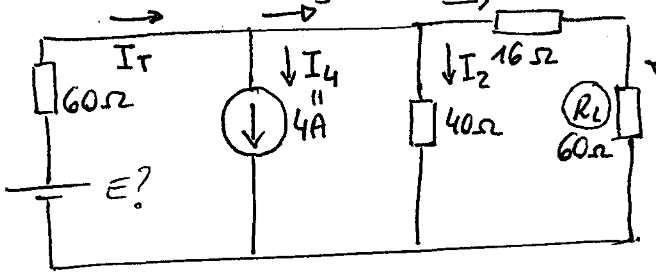
$$I_x = 9 - I_y = 9 - \left(-\frac{3}{2}\right) = 10'5\,A$$

$$I_{R_1} = I_x + I_y = 10'5A - \frac{3}{2}A = 9\,A$$

$$I_{R_2} = I_y = -\frac{3}{2}\,A \iff |I_{R_2}| = |I_y| = \frac{3}{2}\,A$$

$$V_0 = 30 - 25.\left(-3/2\,A\right) = 30 + 25.\frac{3}{2} = 67'5\,V$$

7. $R_L$ disipa 120 W . ¿E?

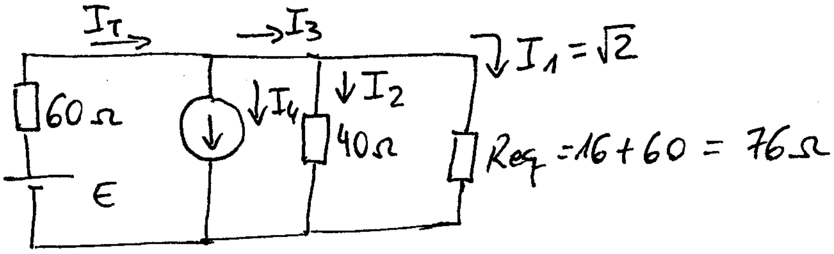



$I_T = I_3 + I_4 = I_3 + 4A$

$I_3 = I_1 + I_2$

$$\boxed{I_T = I_1 + I_2 + 4A}$$

$$P = V.I = R.I^2 \Rightarrow I_1 = \sqrt{\frac{P}{R_1}} = \sqrt{\frac{120\,W}{60\Omega}} = \sqrt{2}\ A$$




$$V_{Req} = I_1 . R_{eq} = \sqrt{2} . 76\Omega = 107'48\ V$$

$$I_2 = \frac{V_{Req}}{R_2} = \frac{107'48\,V}{40\Omega} = 2'69\ A$$

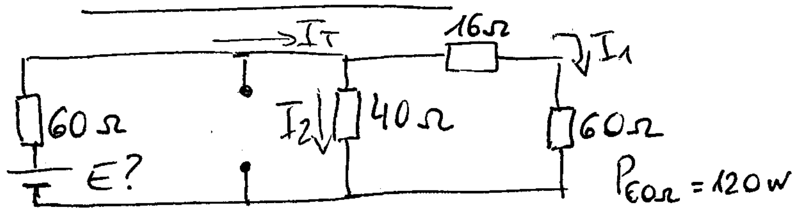
$$I_T = I_1 + I_2 + 4A = \sqrt{2} + 2'69 + 4 = 8'1\ A$$

$$E - 60 I_T - R_{eq} I_1 = 0 \Rightarrow E - 60 . 8'1 - R_{eq} . \sqrt{2} = 0 \Rightarrow$$

$$\Rightarrow E = 60 . 8'1 + 76\sqrt{2} = \boxed{593'48\ V}$$

▶ Comprobación por el ppio. de superposición.

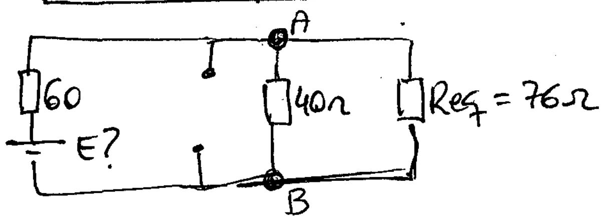
1. ANULANDO $I_1$:




$$\boxed{I_T = I_1 + I_2}$$

$$P = V.I = R.I^2 \Rightarrow I_1 = \sqrt{P/R_1} =$$

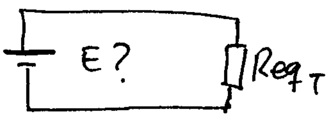
$$\Rightarrow I_1 = \sqrt{\frac{120}{60}} = \sqrt{2}$$




$$V_{AB} = I_1 . R_{eq} = \sqrt{2} . 76 = 107'48\ V$$

$$I_2 = \frac{V_{AB}}{R_2} = \frac{107'48}{40} = 2'69\ V$$

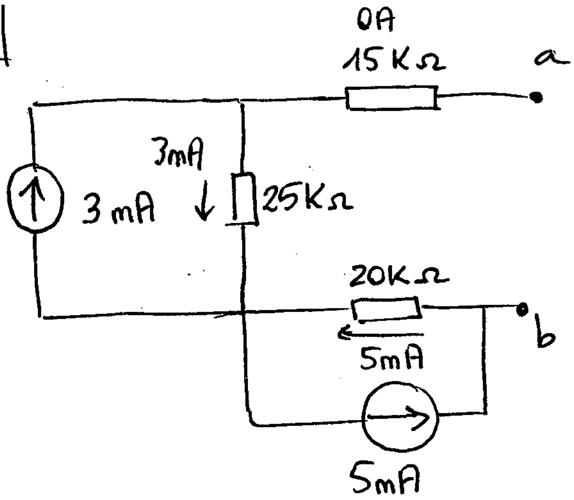
$$I_T = I_1 + I_2 = 4'1\ A$$




$$R_{eqT} = 60 + \frac{76 . 40}{76 + 40} = 86'21\Omega$$

$$E = 4'1 . 86'21 = \underline{\overline{353'45\,V}}$$

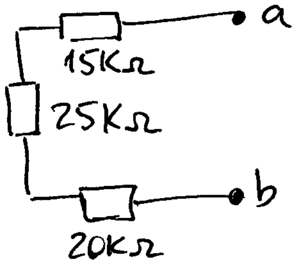
8.1



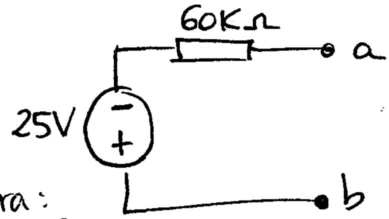

$$V_{ab} = -100V + 75V + 0.15K\Omega = -25V$$

Para CALCULAR LA CORRIENTE EQUIVALENTE DE NORTON:

- Anulamos las fuentes independientes (pq no hay dependientes)

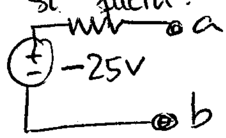


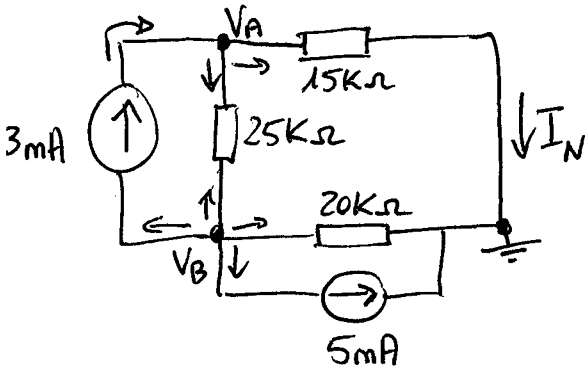

$$R_{eq} = 60 K\Omega$$




CIRCUITO EQUIVALENTE THÉVENIN

si fuera:

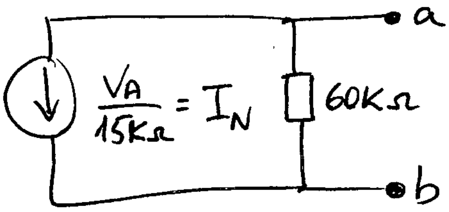



$$3mA = \frac{V_A - V_B}{25K\Omega} + \frac{V_A}{15K\Omega}$$

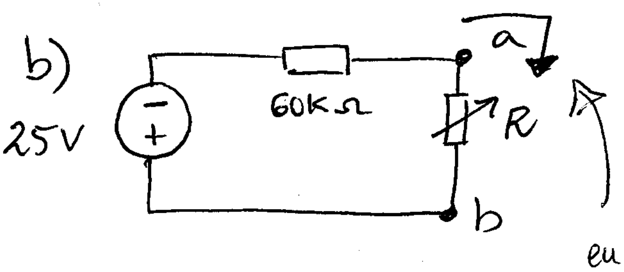
$$3mA + 5mA + \frac{V_B - V_A}{25K\Omega} + \frac{V_B}{20K\Omega} = 0$$

→ resuelves para $V_A$ y $V_B$ y sustituimos en $I_N = \frac{V_A - 0}{15K\Omega} = \frac{V_A}{15K\Omega}$




CIRCUITO EQUIVALENTE NORTON

b)

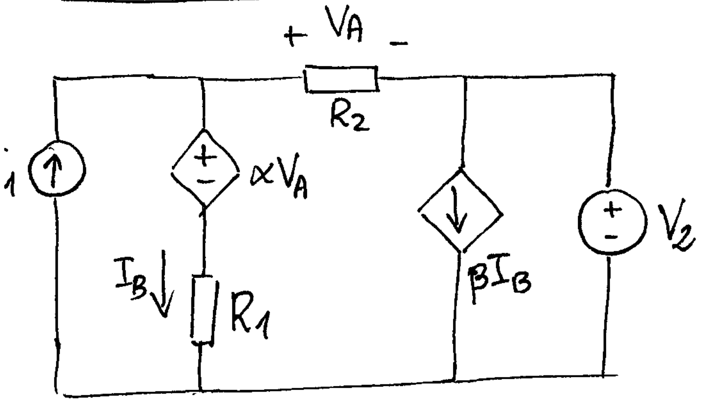



$$I = \frac{-25V}{60K\Omega + R} =$$

- $R = 0 \rightarrow -0'42\,mA$
- $R = 10K\Omega \rightarrow -0'36\,mA$
- $R = 50K\Omega \rightarrow -0'23\,mA$

en el sentido de la flecha

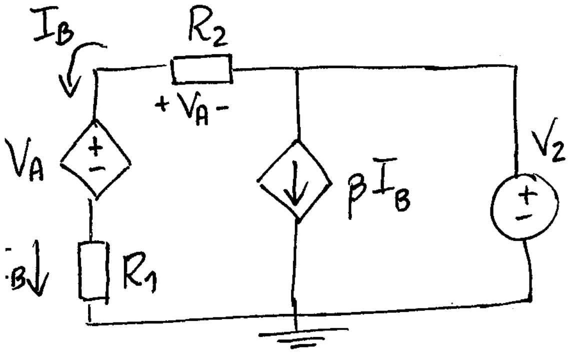
# EJERCICIO ADICIONAL




¿$V_A$, $I_B$?

Ppio. de superposición

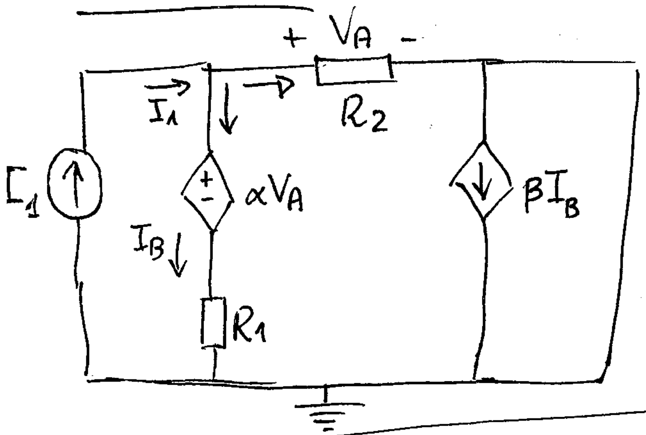
## Anulamos $I_1$:




$$\left.\begin{aligned} V_2 &= I_B R_1 - \alpha V_A + I_B R_2 \\ \boxed{V_A} &= -I_B R_2 \end{aligned}\right\}$$

$$\Rightarrow I_B = \frac{V_2}{R_1 + (1+\alpha) R_2} \quad ; \quad V_A = -\frac{R_2 V_2}{R_1 + (1+\alpha) R_2}$$

## Anulamos $V_2$



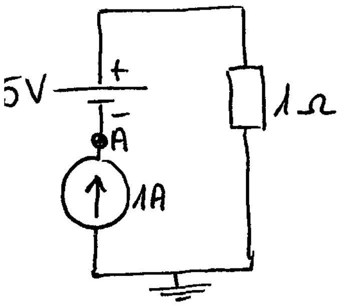

$$\left.\begin{aligned} I_1 &= I_B + \frac{V_A}{R_2} \\ I_B R_1 - \alpha V_A - V_A &= 0 \end{aligned}\right\}$$

$$\Rightarrow I_B = \frac{(1+\alpha) R_2}{R_1 + (1+\alpha) R_2} \cdot I_1$$

$$V_A = \frac{R_2 I_1 R_1}{R_1 + (1+\alpha) R_2}$$

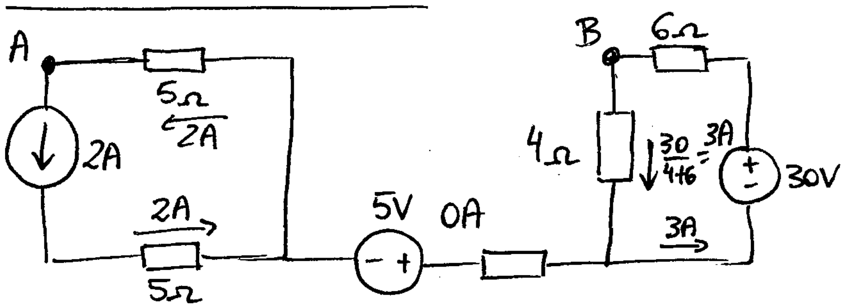
$\ast$
$$\left\{\begin{aligned} I_{B_T} &= \underset{\substack{\text{anulando} \\ I_1}}{I_B} + \underset{\substack{\text{anulando} \\ V_2}}{I_B} \\ V_A &= \underset{\substack{\text{anulando} \\ I_1}}{V_A} + \underset{\substack{\text{anulando} \\ V_2}}{V_A} \end{aligned}\right.$$

## EJERCICIO ADICIONAL




$V_A? \Rightarrow 1.5 - 5 = V_A \Rightarrow V_A = -4V$

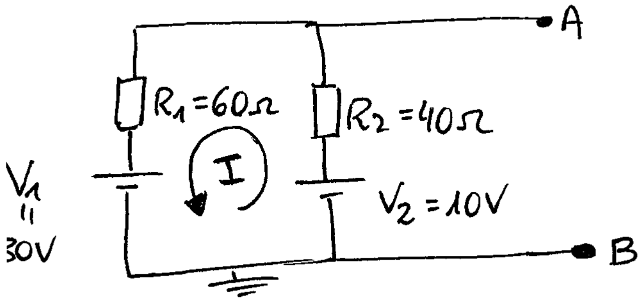
## EJERCICIO ADICIONAL




¿$V_{AB}$?

$$V_{AB} = -(4\cdot 3) - 5 - 2\cdot 5 = -12 - 5 - 10 = \boxed{-27\ V}$$

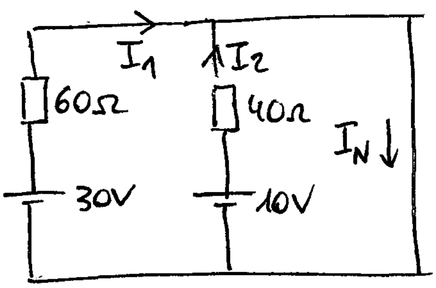
## EJERCICIO ADICIONAL




$$I = \frac{V_2 - V_1}{R_1 + R_2} = -0'2\ A$$

$$V_{AB} = 30 + 60(-0'2A) = 18V$$

$$V_{AB} = 10 - 40(-0'2A) = 18V$$

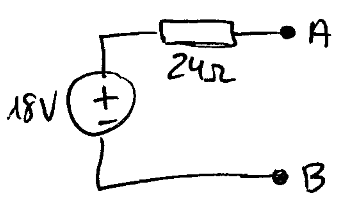


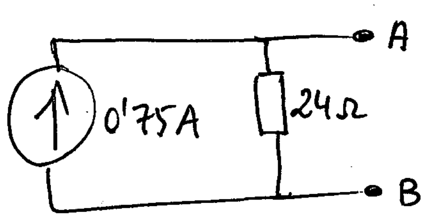

$30 - 60 I_1 = 0 \longrightarrow I_1 = 0'5A$

$10 - 40 I_2 = 0 \longrightarrow I_2 = 0'25A$

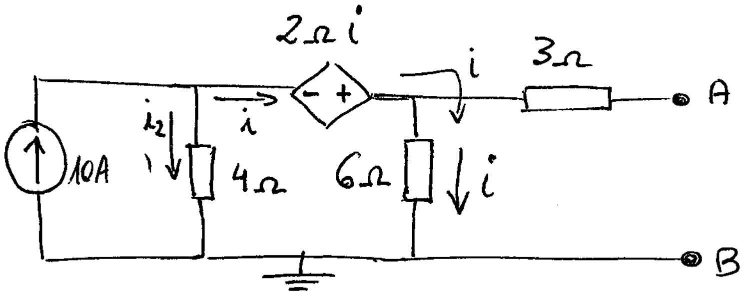
$I_N = I_1 + I_2 = 0'75A$

$$R_{eq} = \frac{18V}{0'75A} = 24\Omega$$



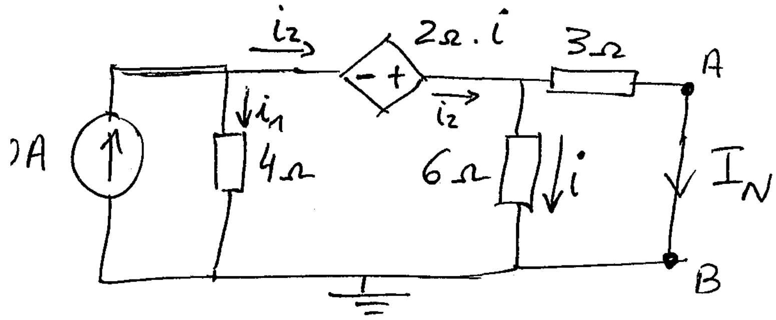
10.




$$\begin{cases} 10 = i + i_2 \\ 4i_2 + 2i - 6i = 0 \end{cases}$$

$$i = 5A$$

$$\boxed{V_{AB} = 6\Omega \cdot i = 5 \cdot 6 = \underline{30\ V} = V_{Th}}$$

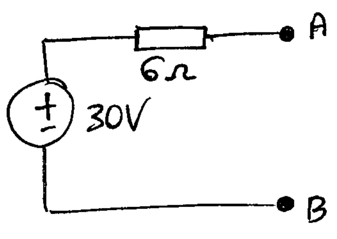



$$\left.\begin{array}{l} 10 = i_1 + i_2 \\ i_2 = i + I_N \end{array}\right\} \boxed{10 = i_1 + i + I_N}$$

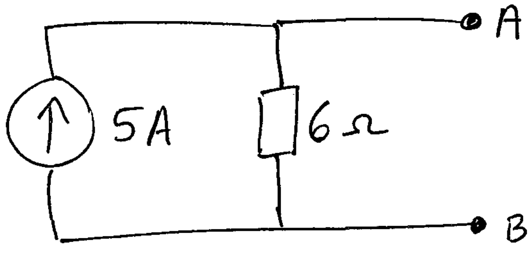
$$\left\{\begin{array}{l} 10 = i_1 + i + I_N \\ 6i - 3 \cdot I_N = 0 \\ 4i_1 + 2i - 3I_N = 0 \end{array}\right\}$$

3 incógnitas
3 ecuaciones

$$\boxed{I_N = 5A} \qquad \boxed{R_{eq} = \frac{V_{Th}}{I_N} = 6\,\Omega}$$

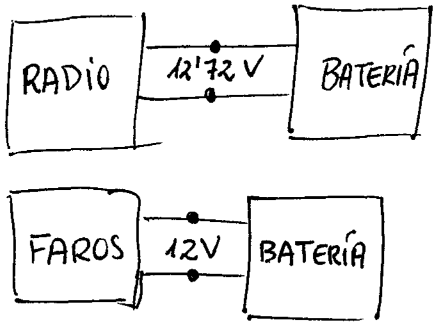



CIRCUITO
EQUIVALENTE
THÉVENIN




CIRCUITO
EQUIVALENTE
NORTON

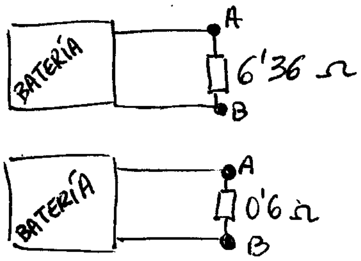
13.




radio $\equiv 6'36\ \Omega$

faros $\equiv 0'6\ \Omega$

1

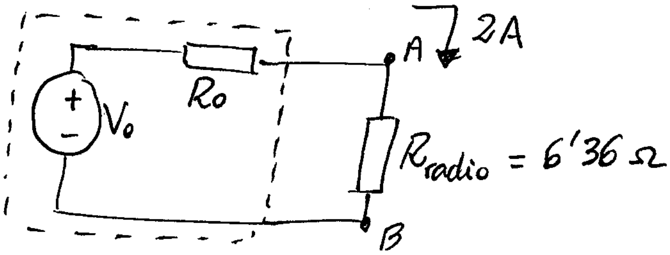



$V_{AB} = 12'72 V$

2

$V_{AB} = 12\ V$

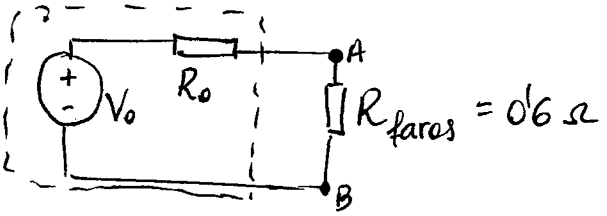
1




$V_{AB} = 12'72 V$

$\Rightarrow I_{radio} = \dfrac{12'72}{6'36} = 2A$

2



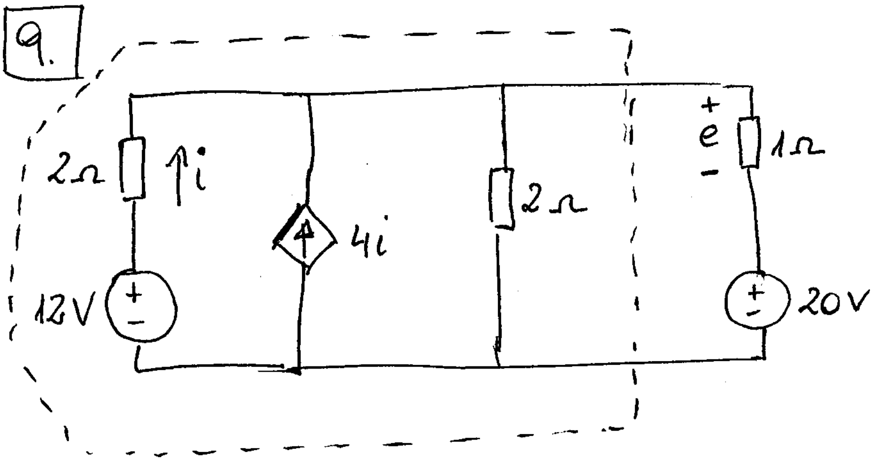

$V_{AB} = 12V$

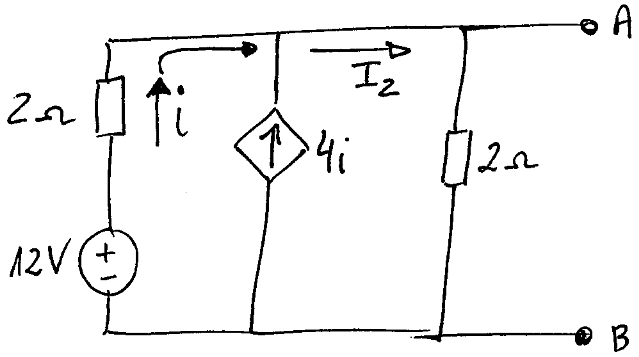
$\Rightarrow I_{faros} = \dfrac{12}{0'6} = 20\ A$

$$\begin{cases} V_0 - 2.R_0 \overbrace{-12'72}^{-I_{radio}.R_{radio} = -12'72} = 0 \\ V_0 - 20.R_0 - 12 = 0 \end{cases} \Rightarrow \begin{array}{l} V_0 = 12'8V \\ R_0 = 40\ m\Omega \end{array}$$

$$I_N = \frac{V_0}{R_0} = 320\ A$$

9.



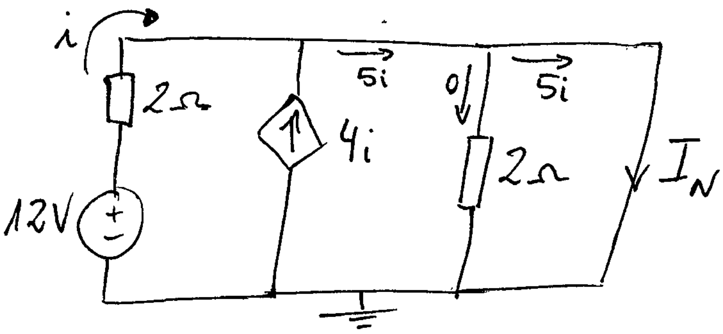

$$i + 4i = 5i = I_2$$

$$12 - 2i - 2.I_2 = 0 \Rightarrow$$

$$\Rightarrow 12 - 2i - 2.5i = 0 \Rightarrow$$

$$\Rightarrow 12 - 12i = 0 \Rightarrow \boxed{i = 1\,A}$$

$$V_{AB} = \boxed{V_{Th} = 2\Omega.\,5i = 10V}$$



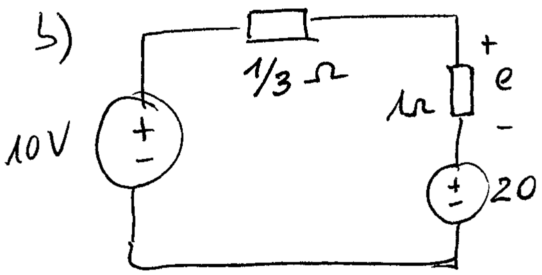

$$I_N = 5i$$

$$12 - 2\cdot i = 0 \Rightarrow \boxed{i = 6A}$$

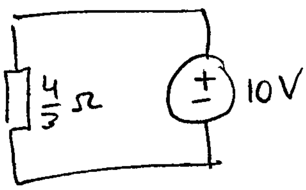
$$\boxed{I_N = 30A}$$

$$R_{eq} = \frac{V_{Th}}{I_N} = \frac{10V}{30A} = \frac{1}{3}\Omega$$

b)



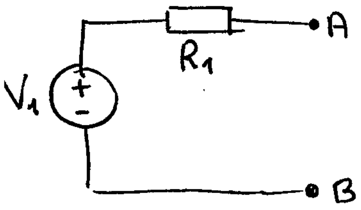

$\equiv$



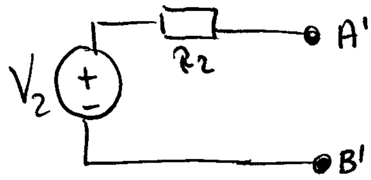

$$I = \frac{10}{4/3} = 7'5\,A$$

$$\boxed{e = -7'5A}$$

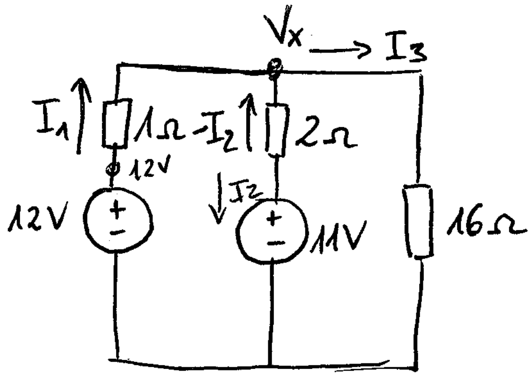
$\boxed{14.}$ pendiente $R$ = resistencia $= \frac{8}{0'5} = 16\ \Omega$




F1 $\begin{cases} V_1 = 12\text{ V (corte de F1 con el eje Y)} \\ R_1 = 1\,\Omega\text{ (pendiente cambiada de signo de F1)} \end{cases}$




F2 $\begin{cases} V_2 = 11V\ (\text{" " F2 " " " "}) \\ R_2 = 2\Omega\ (\text{" " " " " F2}) \end{cases}$




$I_1 + I_2 = I_3$

$$\frac{12 - V_x}{1\Omega} + \frac{11 - V_x}{2} = \frac{V_x}{16} \Rightarrow$$

$$\Rightarrow \boxed{V_x = 11'2\text{ V}}$$

$\begin{cases} I_1 = 0'8A \\ I_2 = -0'1A \\ I_3 = 0'7A \end{cases}$

$P_{F1} = 11'2 \cdot 0'8A = 8'96\text{ w}$

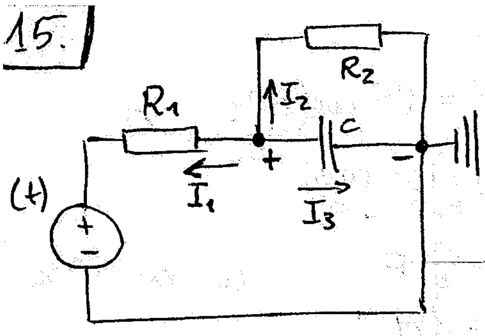
$P_{F2} = \underbrace{-1'12\text{ w}}$

negativo porque la intensidad entra por el terminal más positivo.

$P_{16\Omega} = 8'96\text{w} - 1'12\text{ w} = 7'84\text{ w}$

supusimos mal la direcció de $I_2$. $I_2$ baja con valor $0'1$ A.

**15.**




$R_1 = R_2 = 1\Omega$

$C = 0'01F$

$e(t) = 1V.\cos(10^2 t) \rightarrow$ fasor: $e = 1V.\, e^{j\varphi} = 1.e^{j0} = 1V.$

$e_c = e\,\frac{R_2 Z_c}{R_1R_2 + R_1Z_c + R_2Z_c}$ ?

¿e número e? ¿e = v(t)?

$$\begin{cases} I_1 = \dfrac{e_c - e}{R_1} \\ I_2 = \dfrac{e_c - 0}{R_2} = \dfrac{e_c}{R_2} \\ I_3 = \dfrac{e_c - 0}{Z_c} = \dfrac{e_c}{Z_c} \end{cases}$$

$I_1 + I_2 + I_3 = 0$

$Z_c = \frac{1}{j\omega c} = \frac{-j}{\omega c} = -j$

$$e_c = e.\frac{R_2.Z_c}{R_1R_2 + R_1Z_c + R_2Z_c} = e\,\frac{1}{1 + \frac{R_1}{R_2} + \frac{R_1}{Z_c}} = e\,\frac{1}{1+1+j} =$$

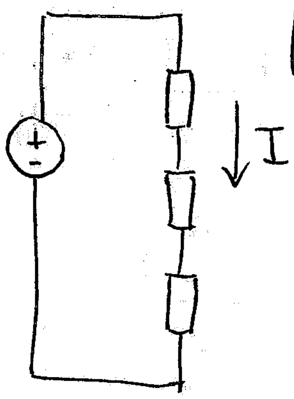
fasor

$$= e.\frac{1}{2+j} = e\,\frac{1}{\sqrt{5}}\cdot e^{j(0 - \operatorname{arctg}\frac{1}{2})} = \frac{1}{\sqrt{5}}\,e^{j(-0'46\,rad)}$$

$$e_c(t) = Re\left(e_c(\omega).\,e^{j\omega t}\right) = \frac{1}{\sqrt{5}}\cos(100t - 0'46)$$

---

**16.**




DATOS

$$\begin{cases} Z_L = j\omega L = j.16mH.400\,rad/s = j.6'4\Omega \\ I = 10\,\text{sen}(400t + 70^\circ) \xrightarrow{\text{fasor}} i(\omega) = 10A.\,e^{j70^\circ} \\ V = 50V.(400t + 15^\circ) \xrightarrow[\text{fasor}]{} v(\omega) = 50V.\,e^{j15^\circ} \end{cases}$$

$$Z_{eq} = \frac{v(\omega)}{i(\omega)} = \frac{50}{10}\cdot e^{j(15^\circ - 70^\circ)} = 5\Omega.\,e^{j(-55^\circ)} =$$

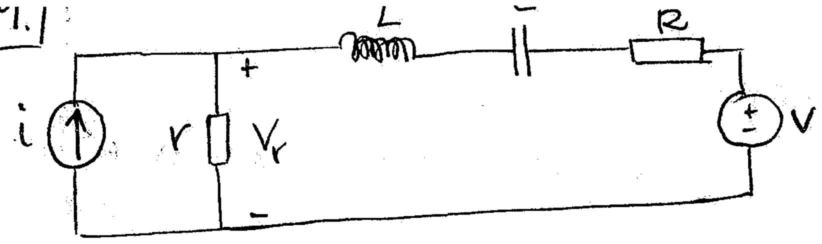
$$= 5\Omega.\cos(-55^\circ) + j\,5\Omega.\,\text{sen}(-55^\circ) = \underbrace{2'868\Omega}_{Re} - j.\underbrace{4'1\Omega}_{Im}$$

Ahora sabemes que hay una resistencia $R = 2'868\Omega$

$$Z_1 + Z_2 = j.(-4'1)\Omega = Z_L + Z_2 \Rightarrow Z_2 = -4'1j - 6'4j = \underbrace{-10'5j\,\Omega}_{\text{negativo } Z_2 = Z_C}$$

$$Z_C = -10'5j = \frac{1}{j.400.c} = \frac{-j}{400C} \Rightarrow C = 238\mu F$$

Nº 1



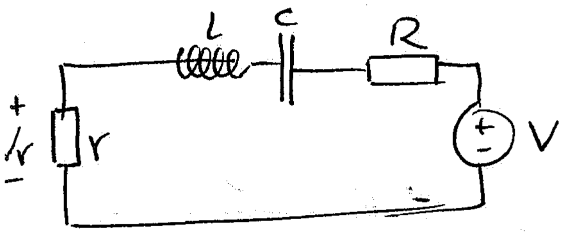

DATOS

$$\left\{\begin{array}{l} v(t) = 26\cos(3t+30^\circ) \\ i(t) = 3\cos(2t) \\ r = R = 2\,\Omega \\ C = \frac{1}{4}\,F \\ L = 1\,H \end{array}\right. \qquad \omega \text{ en rad/s}$$

asor : $v(\omega) = 26 \cdot e^{j30^\circ}$

sor : $i(\omega) = 3A \cdot e^{j \cdot 0} = 3A$

## PRINCIPIO DE SUPERPOSICIÓN (1)



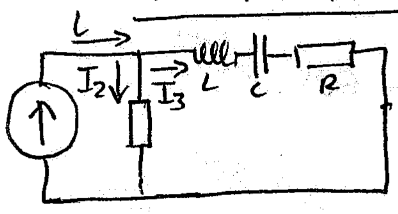

$$V_r = \frac{V \cdot r}{R + r + Z_L + Z_C} \qquad \omega = 3 \left\{\begin{array}{l} Z_L = 3j\,\Omega \\ Z_C = -\frac{4}{3}j\,\Omega \end{array}\right.$$

$$V_r = V \cdot \frac{2}{4 + 3j - \frac{4}{3}j} = V \cdot \frac{2}{4 + \frac{5}{3}j} = 26V \cdot e^{j30^\circ} \cdot 0'46 \cdot e^{j(-22^\circ)} =$$

$$= 12 \cdot e^{j(30^\circ - 22^\circ)}$$

$$\boxed{V_r^v(t) = 12 \cdot \cos(3t + 8^\circ)}$$

## PRINCIPIO DE SUPERPOSICIÓN (2)




$$i = I_2 + I_3 = \frac{V_r}{r} + \frac{V_r}{Z_L + Z_C} \qquad \omega = 2 \left\{\begin{array}{l} Z_L = 2j\,\Omega \\ Z_C = -2j\,\Omega \end{array}\right.$$

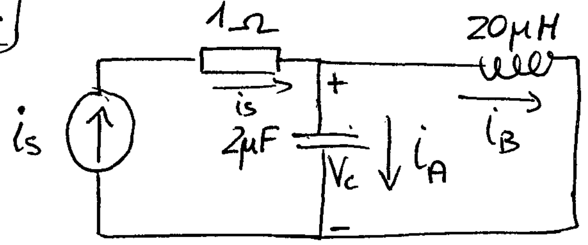
$$\Rightarrow V_r = \frac{r(R + Z_L + Z_C)}{r + R + Z_L + Z_C} \cdot i = \frac{4\Omega}{4\Omega} \cdot i = 1\Omega \cdot i$$

$$\Rightarrow V_r = 1\Omega \cdot 3A = 3V \quad ; \quad \Rightarrow \boxed{V_r^i(t) = 3V \cdot \cos(2t + 0) = 3V \cdot \cos(2t)}$$

## RESULTADO FINAL

$$\boxed{V_r(t) = V_r^v(t) + V_r^i(t) = 12V \cdot \cos(3t + 8^\circ) + 3V \cdot \cos(2t)}$$

20.




$$\begin{cases} i_s(t) = 10'5A \cdot \cos(10^5 t) \rightarrow i_s(\omega) = 10'5A \cdot \\ \omega = 10^5 \text{ rad/s} \end{cases}$$

$i_A$? $i_B$? $V_c$?

$$\begin{cases} i_s = i_A + i_B \\ i_A Z_C = i_B Z_L \end{cases} \Rightarrow \begin{cases} i_A = \dfrac{i_s \cdot Z_L}{Z_L + Z_C} = \dfrac{i_s}{1 + \dfrac{Z_C}{Z_L}} = \dfrac{i_s}{1 - \dfrac{1}{\omega^2 LC}} = \dfrac{-2}{3} i_s \\ i_B = \dfrac{i_s \cdot Z_C}{Z_L + Z_C} = \dfrac{i_s}{1 + \dfrac{Z_L}{Z_C}} = \dfrac{i_s}{1 - \omega^2 LC} = \dfrac{5}{3} i_s \end{cases}$$

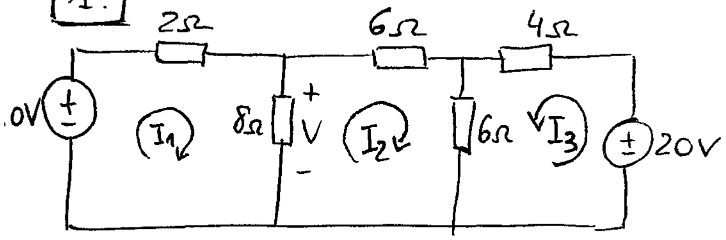
$$i_A = -\frac{2}{3} i_s = -7 e^{j0} \longrightarrow \boxed{i_A(t) = -7\cos(\omega t)}$$

$$i_B = 17'5A \cdot e^{j0} \longrightarrow \boxed{i_B(t) = 17'5 \cdot \cos(\omega t)}$$

$$V_c = Z_C \cdot i_A = \frac{-2}{3} i_s \cdot \frac{1}{j\omega C} = \frac{10}{3} j \cdot i_s \longrightarrow \boxed{V_c(t) = 35V \cdot \cos(\omega t + 90°)}$$

# HOJA 1 | TEORÍA DE REDES LINEALES

## 1.




$$\begin{cases} 40 - 2I_1 + 8(I_2 - I_1) = 0 \\ 8(I_1 - I_2) - 6I_2 - 6(I_2 + I_3) = 0 \\ 20 - 4I_3 - 6(I_2 + I_3) = 0 \end{cases}$$

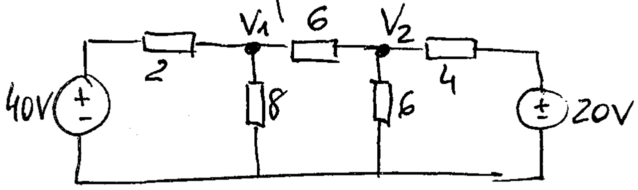
$$\begin{cases} 40 - 2I_1 + 8I_2 - 8I_1 = 0 \\ 8I_1 - 8I_2 - 6I_2 - 6I_2 - 6I_3 = 0 \\ 20 - 4I_3 - 6I_2 - 6I_3 = 0 \end{cases} \Rightarrow \begin{cases} 40 - 10I_1 + 8I_2 = 0 \\ 8I_1 - 20I_2 - 6I_3 = 0 \\ 20 - 6I_2 - 10I_3 = 0 \end{cases} \Rightarrow \begin{cases} 20 - 5I_1 + 4I_2 = 0 \\ 4I_1 - 10I_2 - 3I_3 = 0 \\ 10 - 3I_2 - 5I_3 = 0 \end{cases}$$

Calculadora $\Rightarrow$ $\begin{cases} I_1 = 5'6A \\ I_2 = 2A \\ I_3 = 0'8A \end{cases}$

Entonces: $V_{8\Omega} = 8I_1 - 8I_2 = 8(5'6 - 2) = \boxed{28'8\ V}$

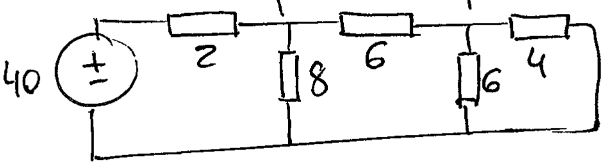
Observación:

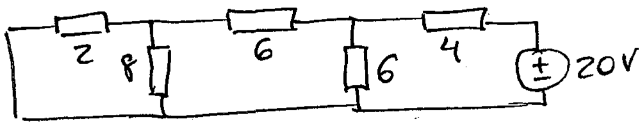
- También se podría haber hecho con ecuaciones de nodos:

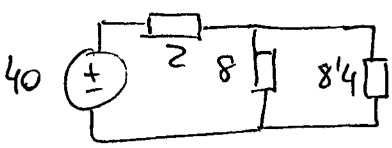


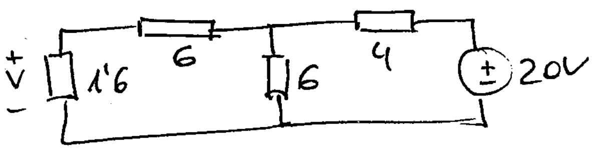

$$\begin{cases} \dfrac{40 - V_1}{2} + \dfrac{V_2 - V_1}{6} + \dfrac{-V_1}{8} = 0 \\ \dfrac{V_1 - V_2}{6} + \dfrac{20 - V_2}{4} + \dfrac{-V_2}{6} = 0 \end{cases}$$

- También por el Ppio. de superposición:

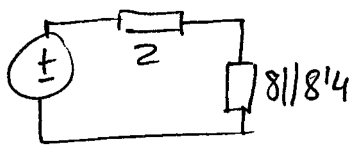



...




Resultado final

$V_T = V_{der} + V_{izq}$

$$I = \frac{40}{2(8||8'4)}$$

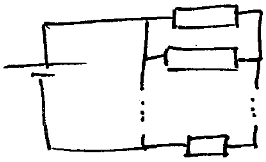
$$V_{izq.} = I\,(8||8'4) = 40 - 2I$$

## 2. DATOS: 15 resist ; P=50w ; V= 12V

$$P = V \cdot I \Rightarrow I = \frac{P}{V} = \frac{50w}{12V} = 4'1\widehat{6}\,A$$

$$Req = \frac{V}{I} = \frac{12V}{4'1\widehat{6}A} = 2'88\,\Omega$$

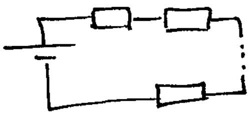
- Si colocamos las 15 resistencias en paralelo:



$$\frac{1}{Req} = \underbrace{\frac{1}{R} + \cdots + \frac{1}{R}}_{15 \text{ veces}} \Rightarrow \frac{1}{2'88} = \frac{15}{x} \Rightarrow x = 2'88 \cdot 15 = \boxed{43'2\,\Omega}$$

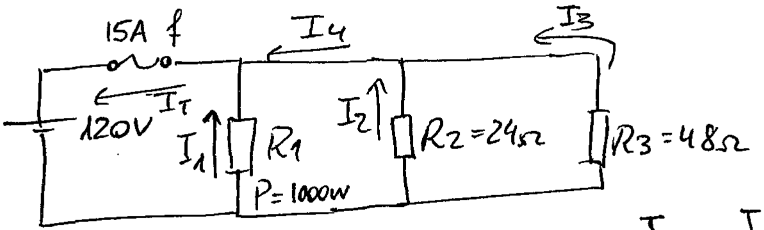
cada R

- Si colacamos las 15 resistencias en serie:



$$Req = 15R \Rightarrow R = \frac{2'88}{15} = \boxed{0'19\,\Omega} \text{ cada } R.$$

## 3.




$$P_1 = V \cdot I = \frac{V^2}{R_1} \Rightarrow R_1 = \frac{V^2}{P_1} = \frac{120^2}{1000} = \boxed{14'4\,\Omega}$$

$$I_T = I_1 + I_4 \;;\; I_4 = I_2 + I_3 \Rightarrow I_T = I_1 + I_2 + I_3$$

a)

$$\left.\begin{aligned} I_1 &= \frac{-120}{R_1} = -8'\widehat{3}A \\ I_2 &= \frac{-120}{R_2} = -5A \\ I_3 &= \frac{-120}{R_3} = -2'5A \end{aligned}\right\} \Rightarrow I_T = -15'83\,A$$

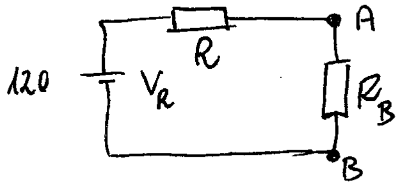
$|I_T| = \underline{\underline{15'83A}} \Rightarrow$ el fusible no aguantará la corriente.

b)

$$\left.\begin{aligned} |I_1| &= 8'\widehat{3}\,A \\ |I_2| &= 5A \\ |I_T| &= 15A \end{aligned}\right\} \Rightarrow |I_3| = 15 - 5 - 8'\widehat{3}\,A = 1'\widehat{6}\,A$$

$$\Rightarrow R_3 = \frac{V}{I_3} = \frac{120V}{1'\widehat{6}A} = \boxed{72\,\Omega}$$

4. DATOS: $V_B = 3V$ ; $I_B = 0'3A$ ; $V_R = 120V$

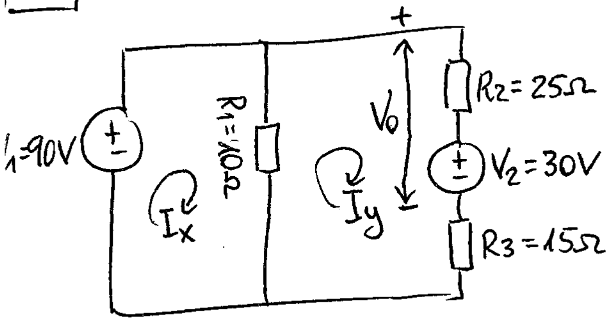



$V_{AB} = V_B = 3V$

$$R_B = \frac{3V}{0'3A} = 10\,\Omega$$

$$R_{eq} = \frac{120}{0'3} = 400\,\Omega \qquad R = R_{eq} - R_B = \boxed{390\,\Omega}$$

5.




$$\begin{cases} 90 + 10(I_y - I_x) = 0 \\ 30 + 25 I_y + 10(I_y - I_x) + 15 I_y = 0 \end{cases} \Rightarrow$$

$$\Rightarrow \begin{cases} 90 + 10 I_y - 10 I_x = 0 \\ 30 + 25 I_y + 10 I_y - 10 I_x + 15 I_y = 0 \end{cases} \Rightarrow$$

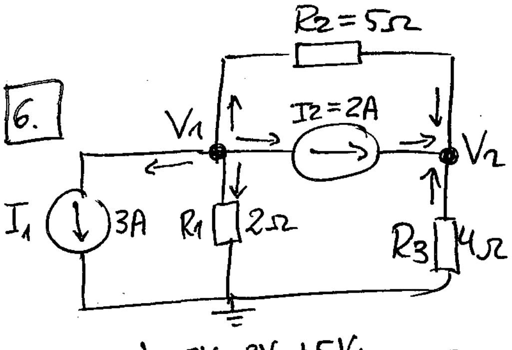
$$\Rightarrow \begin{cases} 9 + I_y - I_x = 0 \\ 30 + 50 I_y - 10 I_x = 0 \end{cases} \xrightarrow{\text{calculadora}} \boxed{\begin{matrix} I_x = 10'5A \\ I_y = 1'5A \end{matrix}}$$

$$I_1 = I_y - I_x = -9A \equiv |I_1| = |I_y - I_x| = 9A$$

$$I_2 = I_y = 1'5A$$

$$V_0 = 30 + 25 I_y = 30 + 25 \cdot 1'5 = \boxed{67'5\,V}$$

6.




$$\left.\begin{matrix} \text{Ecuación en } V_1:\ 3 + 2 + \dfrac{V_1 - V_2}{5} + \dfrac{V_1}{2} = 0 \\ \text{Ecuación en } V_2:\ 2 + \dfrac{V_1 - V_2}{5} + \dfrac{-V_2}{4} = 0 \end{matrix}\right\} \Rightarrow$$

$$\Rightarrow \begin{cases} \dfrac{2V_1 - 2V_2 + 5V_1}{10} = -5 \Rightarrow \\ \dfrac{4V_1 - 4V_2 - 5V_2}{20} = -2 \Rightarrow \end{cases} \begin{cases} 7V_1 - 2V_2 = -50 \\ 4V_1 - 9V_2 = -40 \end{cases} \xrightarrow{\text{calculadora}} \boxed{\begin{matrix} V_1 = -6'73V \\ V_2 = 1'45\,V \end{matrix}}$$

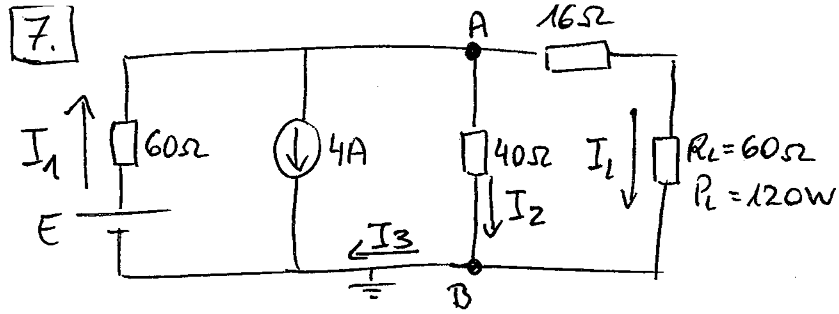
Corrientes:

$$I_{R_1} = \frac{V_1}{2} = \frac{-6'73}{2} = -3'37A$$

$$I_{R_2} = \frac{V_1 - V_2}{5} = -1'64A$$

$$I_{R_3} = \frac{-V_2}{4} = \frac{-1'45}{4} = -0'36A$$

**7.**

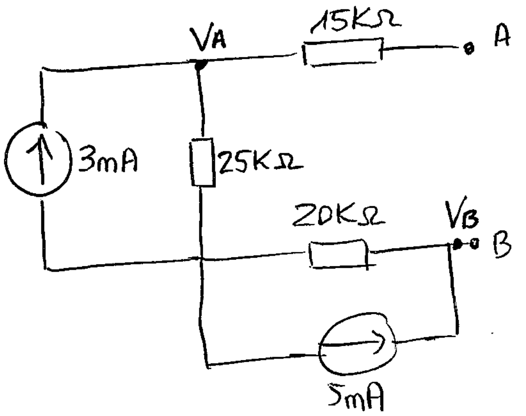



$$P = V.I = I^2.R \Rightarrow$$
$$\Rightarrow I_L = \sqrt{P_L / R_L} = \sqrt{2}\ A$$

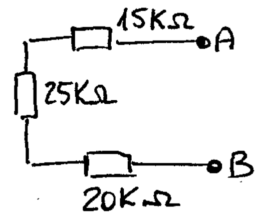
$$V_{AB} = I_L.(16+60) = 107'48V$$
$$I_2 = \frac{V_A - V_B}{40} = \frac{107'48}{40} = 2'69A$$
$$I_3 = I_L + I_2 = 2'69 + \sqrt{2} = 4'1\ A$$
$$I_1 = I_3 + 4 = 8'1A$$

$$E - 60I_1 - 40I_2 = 0 \Rightarrow$$
$$\Rightarrow E = 60I_1 + 40I_2 =$$
$$60.8'1 + 40.\ 2'69 = \boxed{593'6\ V}$$

**8.**




Req → no hay fuentes dependientes




$$\boxed{Req = 60K\Omega}$$

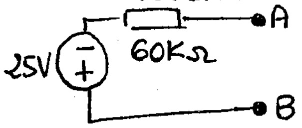
a)

$$V_{Th} = V_{AB} = -20K\Omega\ .\ 5.10^{-3}A\ +\ 25K\Omega\ .\ 3.10^{-3}A = -25V$$

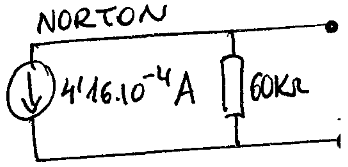
$$|V_{Th}| = 25V$$

$$\Rightarrow |I_N| = \frac{|V_{Th}|}{Req} = \frac{25}{60K} = 4'16.10^{-4}\ A$$

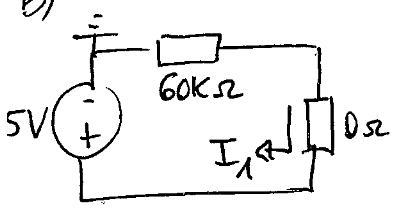
CIRCUITO EQUIVALENTE THEVENIN



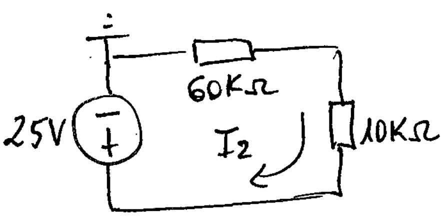

CIRCUITO EQUIVALENTE NORTON



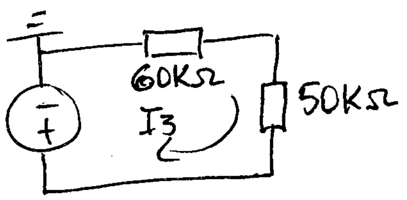

b)




$$I_1 = \frac{-25}{60K} = 4'16.10^{-4}A$$

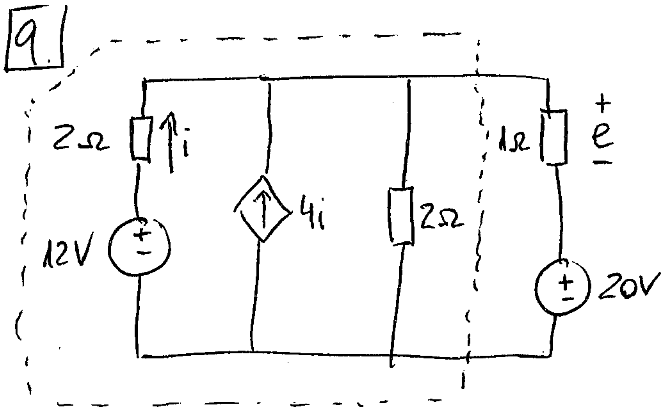


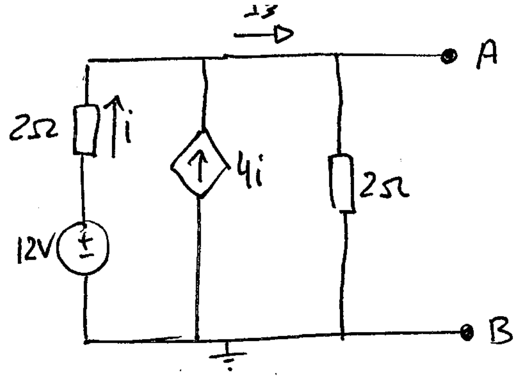

$$I_2 = \frac{-25}{70K} = -3'6.10^{-4}A$$




$$I_3 = \frac{-25}{110K} = -2'3.10^{-4}A$$

## 9.



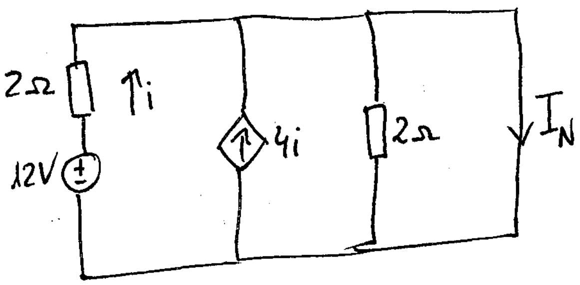




$I_3 = i + 4i = 5i$

$12 - 2i - 2I_3 = 0 \Rightarrow$

$\Rightarrow 12 - 2i - 2(5i) = 0 \Rightarrow 12 - 12i = 0 \Rightarrow \boxed{i = 1\,A} \Rightarrow \boxed{I_3 = 5\,A}$

$I_3 = \frac{V_A - V_B}{2} = \frac{V_A}{2} \Rightarrow V_A = 2I_3 = 10V \Rightarrow \boxed{V_{Th} = 10\,V}$



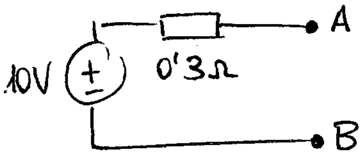

$I_N = i + 4i = 5i$

$12 - 2i = 0 \Rightarrow \boxed{i = 6A}$

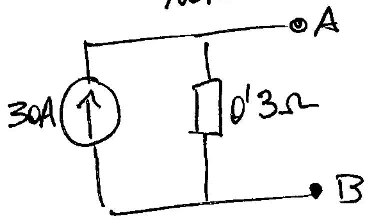
$\boxed{I_N = 30A}$

$\boxed{R_{eq} = \frac{V_{Th}}{I_N} = 0'3\,\Omega}$

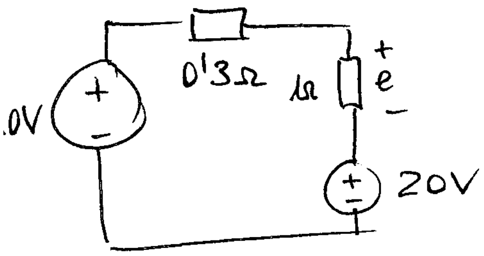
CIRCUITO EQUIVALENTE THEVENIN



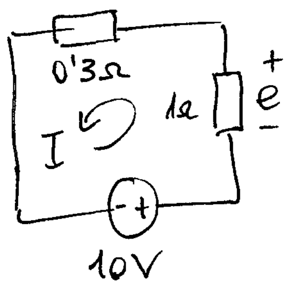

CIRCUITO EQUIVALENTE NORTON




b) ¿e?



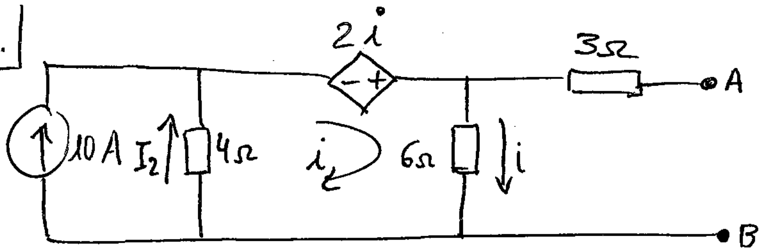

$\Rightarrow$




$I = \frac{10}{1'3} = 7'7\,A$

$\boxed{e = 7'7 \cdot 1 = 7'7\,V}$

**10.**

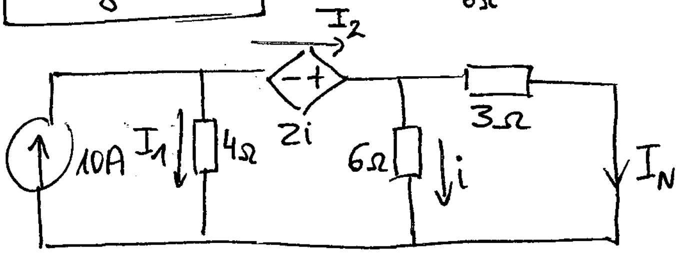



$$V_{Th} = V_{6\Omega}$$

$$I_2 = i - 10$$

$$-4I_2 + 2i - 6i = 0 \Rightarrow -4(i-10) + 2i - 6i = 0 \Rightarrow -4i + 40 + 2i - 6i = 0 \Rightarrow$$

$$\Rightarrow \boxed{i = \frac{40}{8} = 5\,A} \qquad V_{6\Omega} = 6 \cdot i = 6 \cdot 5 = 30\,V \Rightarrow \boxed{V_{Th} = 30V}$$




$$\left.\begin{array}{l} I_2 = I_N + i \\ 10 = I_1 + I_2 \end{array}\right\} \Rightarrow 10 - I_1 = I_N + i \Rightarrow I_N = 10 - I_1 - i$$

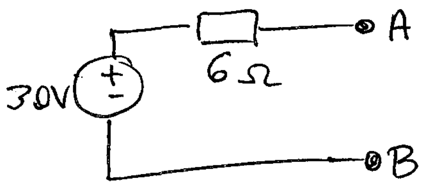
$$\left\{\begin{array}{l} 4I_1 + 2i - 6i = 0 \\ 4I_1 + 2i - 3I_N = 0 \end{array}\right. \Rightarrow \left\{\begin{array}{l} 4I_1 - 4i = 0 \rightarrow I_1 - i = 0 \\ 4I_1 + 2i - 3(10 - I_1 - i) = 0 \Rightarrow 4I_1 + 2i - 30 + 3I_1 + 3i = 0 \end{array}\right.$$

$$\Rightarrow \left\{\begin{array}{l} I_1 - i = 0 \\ 7I_1 + 5i = 30 \end{array}\right. \xRightarrow{\text{calculadora}} \boxed{\begin{array}{l} I_1 = 5/2\ A \\ i = 5/2\ A \end{array}}$$

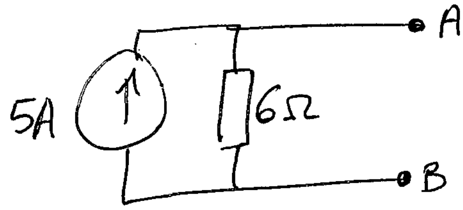
$$I_N = 10 - \frac{2 \cdot 5}{2} = 5 \Rightarrow \boxed{I_N = 5A}$$

$$\boxed{R_{eq} = \frac{30}{5} = 6\,\Omega}$$

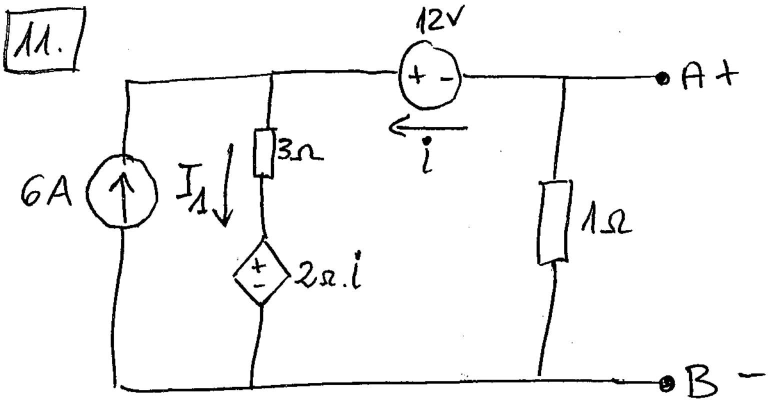
CIRCUITO EQUIVALENTE THEVENIN




CIRCUITO EQUIVALENTE NORTON



11.




$I_1 = i + 6$

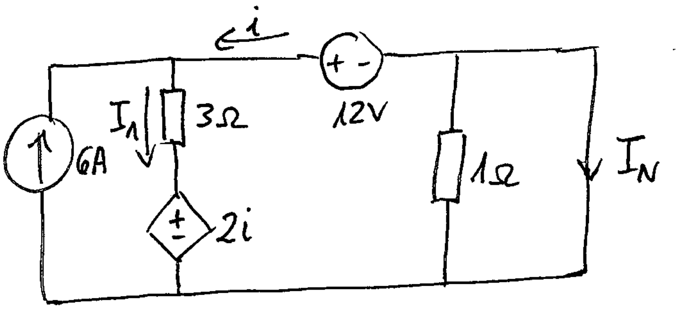
$2i + 3I_1 - 12 + i = 0 \Rightarrow$

$\Rightarrow 2i + 3(i+6) - 12 + i = 0 \Rightarrow$

$\Rightarrow 2i + 3i + 18 - 12 + i = 0 \Rightarrow$

$\Rightarrow 6i + 6 = 0 \Rightarrow \boxed{i = -1\text{ A}}$

$V_{AB} = -i \cdot 1\,\Omega = +1\text{V}$ $\qquad \boxed{V_{Th} = 1\text{V}}$




$I_N = -i$

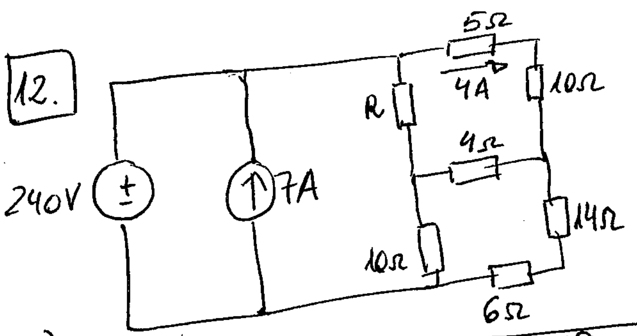
$I_1 = i + 6 = -I_N + 6$

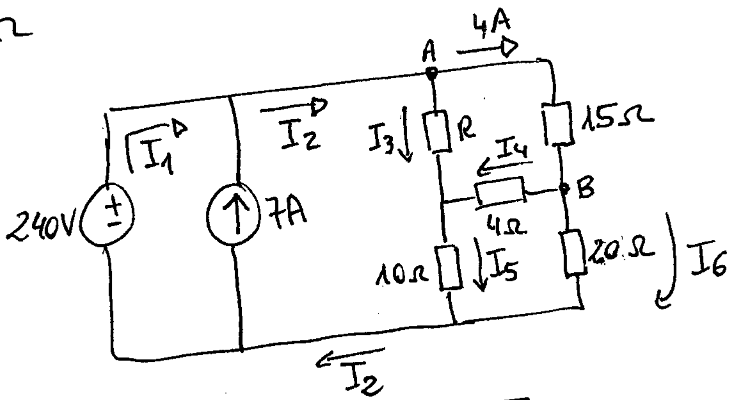
$2i + 3I_1 - 12 = 0 \rightarrow 2i + 3(i+6) - 12 = 0 \rightarrow 2i + 3i + 18 - 12 = 0 \Rightarrow$

$\Rightarrow 5i = -6 \quad \Rightarrow i = \frac{-6}{5} \quad \Rightarrow \boxed{I_N = 1'2\text{A}}$

$$R_{eq} = \frac{V_{Th}}{I_N} = \frac{1}{1'2} = 0'8\widehat{3}\,\Omega$$

12.




a)

$240 - 4.15 - I_6.20 = 0 \Rightarrow \boxed{I_6 = \frac{180}{20} = 9\text{A}}$ $\qquad \boxed{I_4 = 4 - I_6 = 4 - 9 = -5\text{ A}}$

$240 - 4.15 - 4.I_4 - 10I_5 = 0 \Rightarrow 180 + 20 - 10I_5 = 0 \Rightarrow \boxed{I_5 = \frac{200}{10} = 20\text{ A}}$

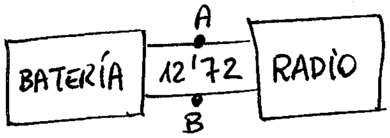
$I_3 = I_5 - I_4 = 20 - (-5) = \boxed{25\text{A} = I_3}$

$\left.\begin{array}{l} V_{AB} = 15.4 = 60 \\ V_{AB} = -4I_4 + I_3 R \end{array}\right\} \Rightarrow 60 = 20 + 25R \Rightarrow \boxed{R = \frac{40}{25} = 1'6\,\Omega}$

b) $I_2 = I_5 + I_6 = 20 + 9 = \boxed{29\text{A} = I_2}$ $\qquad \boxed{P = V.I = 240.22 = 5280\text{ W}}$

$I_1 = I_2 - 7 = \boxed{22\text{ A} = I_1}$

**13.**

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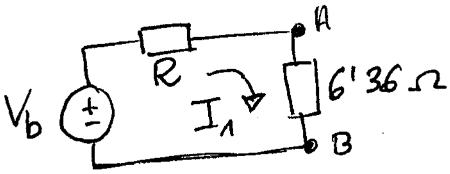
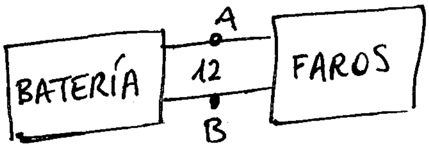



$V_{AB} = 12'72\,V$

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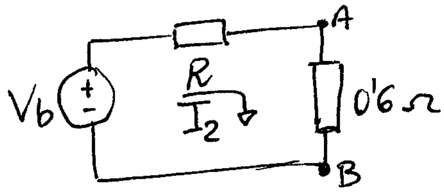


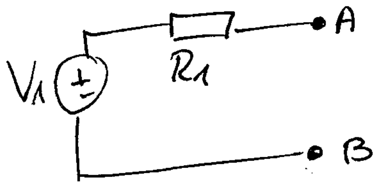

$V_{AB} = 12\,V$

$I_1 = \dfrac{12'72}{6'36} = 2\,A$ ; $I_2 = \dfrac{12}{0'6} = 20\,A$

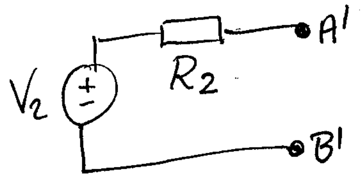
$$\left\{\begin{array}{l} V_b - 2R - 12'72 = 0 \\ V_b - 20R - 12 = 0 \end{array}\right. \xRightarrow{\text{calc.}} \boxed{\begin{array}{l} V_b = 12'8\,V \\ R = 0'04\,\Omega \end{array}}$$

**14.**

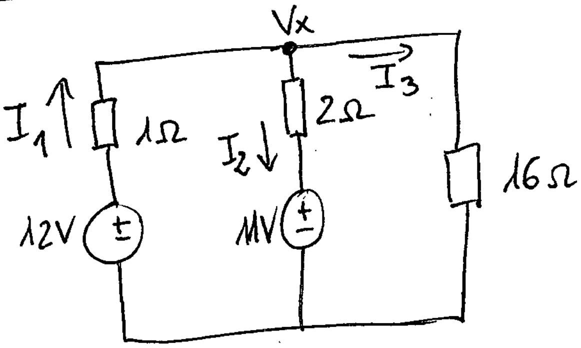
pendiente $R = \text{resist.} = \dfrac{8}{0'5} = 16\,\Omega$




F1 $\left\{\begin{array}{l} V_1 = 12\,V \text{ (corte de F1 con el eje Y)} \\ R_1 = 1\,\Omega \text{ (pendiente cambiada de signo de F1)} \end{array}\right.$




F2 $\left\{\begin{array}{l} V_2 = 11\,V \text{ (corte de F2 con el eje Y)} \\ R_2 = 2\,\Omega \text{ (pendiente cambiada de signo de F2)} \end{array}\right.$




$I_1 + I_2 = I_3$

$\dfrac{12 - V_x}{1} + \dfrac{11 - V_x}{2} = \dfrac{V_x}{16} \Rightarrow$

$\Rightarrow \boxed{V_x = 11'2\,V}$

$\left\{\begin{array}{l} I_1 = 0'8\,A \\ I_2 = -0'1\,A \\ I_3 = 0'7\,A \end{array}\right.$

$P_{F_1} = 11'2 \cdot 0'8 = 8'96\,W$

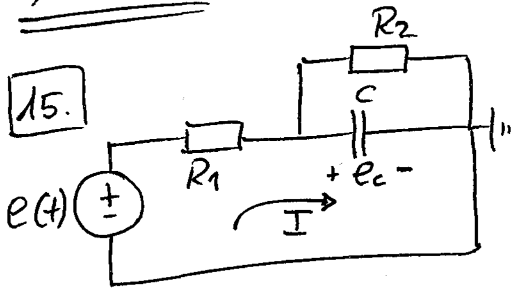
$P_{F_2} = \underbrace{-1'12\,W}$

$\Bigg\}\ P_{16\Omega} = 8'96 - 1'12 = 7'84\,W$

negativo porque la intensidad entra por el terminal positivo, por lo que la fuente consume energía.

# ALTERNA

**15.**




DATOS:

$R_1 = R_2 = 1\,\Omega$

$C = 0'01\,F \longrightarrow Z_C = \frac{-j}{\omega C} = -j$

$e(t) = 1\cos(100t) \qquad \omega = 100\,rad/s$

fasor $\rightarrow e = 1.\,e^{j0} = 1\,V$

$$I = \frac{e}{R_1 + (R_2 \| Z_C)}$$

$$R_2 \| Z_C = \frac{R_2 Z_C}{R_2 + Z_C} = \frac{-j}{1-j} = \frac{-j(1+j)}{1+1} = \frac{1}{2} - \frac{1}{2}j$$

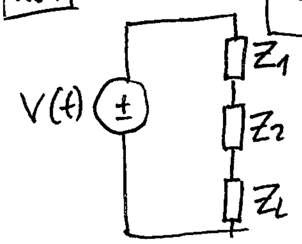
$$R_1 + \frac{1}{2} - \frac{1}{2}j = \frac{3}{2} - \frac{1}{2}j$$

$$I = \frac{1}{\frac{3}{2} - \frac{1}{2}j} = \frac{1}{1'58} \cdot e^{j(18'44)}$$

$$e_c = I\,(Z_C \| R_2) = \frac{1}{1'58} \cdot e^{j(18'43^\circ)} \cdot \frac{\sqrt{2}}{2} \cdot e^{j(-45^\circ)} = \frac{\sqrt{2}}{3'16} \cdot e^{j(-26'57^\circ)}$$

$$\boxed{e_c(t) = \frac{\sqrt{2}}{3'16} \cdot \cos(100t - 26'57^\circ)}$$

**16.** DATO $\rightarrow L = 16\,mH \quad Z_L = j\omega L = 6'4j$




$V(t) = 50\,\mathrm{sen}(400t + 15^\circ) \rightarrow V = 50.\,e^{15^\circ j}$

$I(t) = 10.\,\mathrm{sen}(400t + 70^\circ) \rightarrow I = 10.\,e^{70^\circ j}$

$$Z_{eq} = \frac{V}{I} = \frac{50.\,e^{15j}}{10.\,e^{70j}} = 5.\,e^{j(15-70)} = 5.\,e^{-55j} = 5\cos(-55) + j5\,\mathrm{sen}(-55) =$$
$$= 2'88 - 4'1j$$

$Z_1 + Z_2 + Z_L = 2'88 - 4'1j$

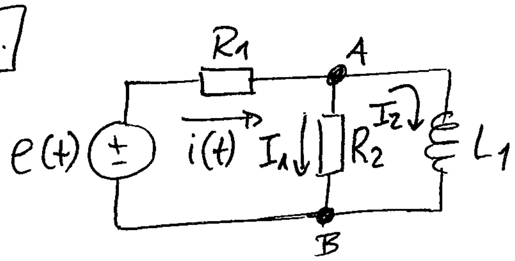
$\rightarrow Z_1 = \boxed{R = 2'88\,\Omega}$

$\rightarrow Z_2 = -4'1j - Z_L = -4'1j - 6'4j = -10'5j$

$\boxed{Z_2 = -10'5j}$ negativo por lo que $Z_2 = Z_C = \frac{1}{j\omega C} = \frac{-j}{\omega C}$

$$-10'5j = \frac{-j}{\omega C} \Rightarrow C = \frac{-j}{\omega.(-10'5j)} = 2'38.\,10^{-4}\,F$$

17.




DATOS:

$R_1 = 2\Omega$

$R_2 = 1\Omega$

$L_1 = 0'2H$

$e(t) = 3\cos(10t) \qquad \omega = 10 \frac{rad}{s}$

¿ $i(t)$ ?

$Z_L = j\omega L = 10 . 0'2j = 2j$

$e = 3 . e^{j0} = 3V$

$V_A = V_{Th}$

$$\frac{e - V_{Th}}{R_1} = \frac{V_{Th}}{R_2} + \frac{V_{Th}}{Z_L} \Rightarrow \frac{3 - V_{Th}}{2} = \frac{V_{Th}}{1} + \frac{V_{Th}}{2j} \Rightarrow$$

$$\Rightarrow 3 - V_{Th} = 2V_{Th} - V_{Th}j \Rightarrow 3 = 3V_{Th} - V_{Th}j \Rightarrow 3 = V_{Th}(3-j) \Rightarrow$$

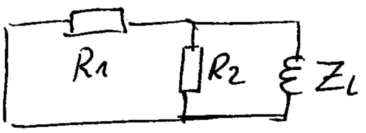
$$\Rightarrow V_{Th} = \frac{3}{3-j} = \frac{3(3+j)}{9+1} = \frac{9+3j}{10} \Rightarrow \boxed{V_{Th} = \frac{9}{10} + \frac{3}{10}j}$$

$$i = \frac{e - V_{Th}}{R_1} = \frac{3 - \left(\frac{9}{10} + \frac{3}{10}j\right)}{2} = \frac{2'1 - 0'3j}{2} = 1'05 - 0'15j$$

$$\boxed{V_{Th}(t) = 0'95 . \cos(10t + 18'43^\circ)}$$

$$\boxed{i(t) = 1'06 . \cos(10t - 8'13^\circ)}$$

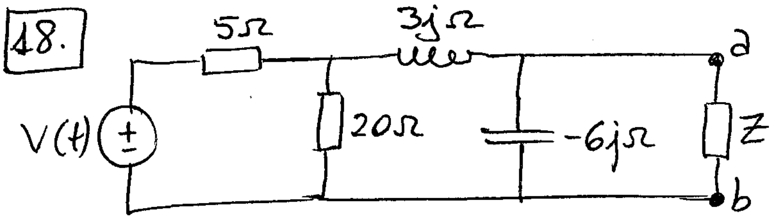
$Zeq =$



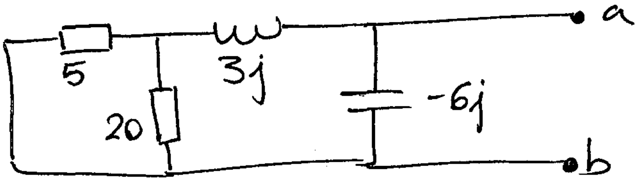

$$Zeq = R_1 + \frac{R_2 Z_L}{R_2 + Z_L}$$

$$I_N = \frac{V_{Th}}{Zeq}$$

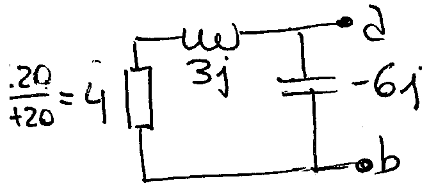
**18.**




Potencia máxima cuando $Z = Zeq$.




No hay fuentes dependientes, por lo que anulamos las independientes.



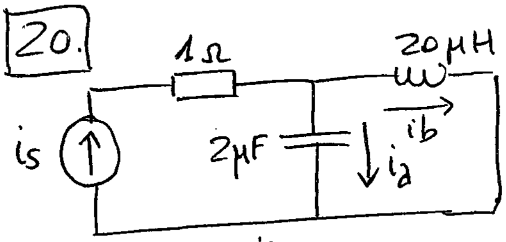

$(4+3j)\,||\,-6j$

$$Zeq = \frac{-6j(4+3j)}{4-3j} = \frac{-24j+18}{4-3j} = \frac{(18-24j)(4+3j)}{25} =$$

$$= \frac{144}{25} - \frac{42}{25}j = \boxed{5'76 - 1'68j = Zeq}$$

(19 en el reverso)

**20.**




$i_s(t) = 10'5\cos(10^5 t)$ $\quad \omega = 10^5 \frac{rad}{s}$

$i_s = i_a + i_b$

$i_a Z_c = i_b \cdot Z_L$

$i_s = 10'5 \cdot e^{j0} = 10'5 A$

$Z_c = \frac{-j}{\omega C} = -5j$

$Z_L = j\omega L = 2j$

$$i_a = \frac{i_b \cdot Z_L}{Z_c}$$

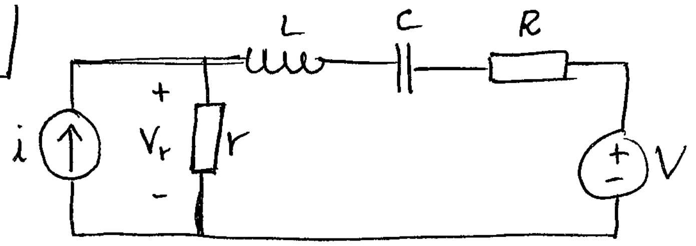
$$i_s = \frac{i_b \cdot Z_L}{Z_c} + i_b \Rightarrow i_s = i_b\left(\frac{Z_L}{Z_c} + 1\right)$$

$$\Rightarrow i_b = \frac{10'5}{\frac{2j}{-5j} + 1} = 17'5 \Rightarrow \boxed{i_b(t) = 17'5\cos(10^5 t)}$$

$$\Rightarrow i_a = \frac{17'5 \cdot 2j}{-5j} = -7 \Rightarrow \boxed{i_a(t) = -7\cos(10^5 t)}$$

$$V_c = i_a \cdot Z_c = -7 \cdot -5j = 35j \Rightarrow \boxed{V_c(t) = 35\cos\left(10^5 t + \frac{\pi}{2}\right)}$$

19.




DATOS:

$V(t) = 26 \cdot \cos(3t + 30°) \rightarrow V = 26 \cdot e^{30j}$ A

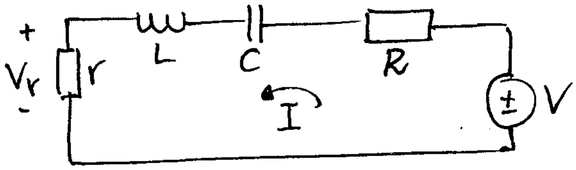
$i(t) = 3\cos(2t) \rightarrow i = 3 \cdot e^{0j} = 3$ A

$r = R = 2\,\Omega$

$C = 1/4$ F

$L = 1$ H $\qquad \omega = \frac{rad}{s}$

Anulamos $i$



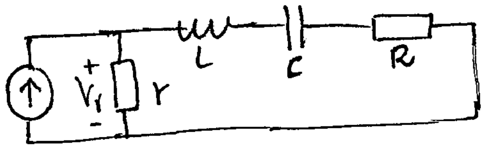

$V_{r_1} = I \cdot r \quad ; \quad I = \frac{V}{r + Z_L + Z_C + R}$

$r + Z_L + Z_C + R = 4 + \frac{1}{j\omega C} + j\omega L = 4 - 1'\widehat{3}j + 3j = 4 + 1'\widehat{6}j$

$I = \frac{26\cos(30°) + 26j\,\mathrm{sen}(30°)}{4 + 1'\widehat{6}j} = \frac{22'52 + 13j}{4 + 1'\widehat{6}j} = 5'95 + 0'77j$

$V_{r_1} = I \cdot r = 12 + 1'54j \longrightarrow \boxed{V_{r_1}(t) = 12\cos(3t + 7'32°)}$

Anulamos $V$




$V_{r_2} = i \cdot Z_{eq}$

$Z_{eq} = r \,||\, (Z_L + Z_C + R) \quad ; \quad Z_L + Z_C + R = 2 + \frac{1}{j\omega C} + j\omega L = 2 - \cancel{2j} + \cancel{2j} = 2$

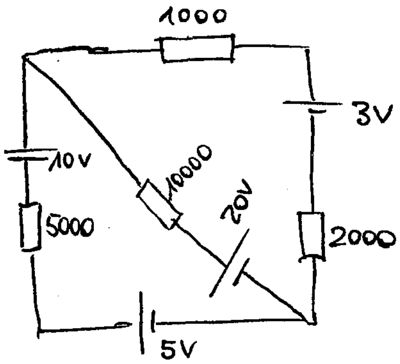
$Z_{eq} = \frac{2 \cdot 2}{2+2} = \frac{4}{4} = 1$

$V_{r_2} = i \cdot 1 = i \Rightarrow \boxed{V_{r_2}(t) = 3\cos(2t)}$

Resultado FINAL: Sumamos componentes del Ppio. de superposición.

$$\boxed{V_{r_T}(t) = V_{r_1}(t) + V_{r_2}(t) = 12\cos(3t + 7'32°) + 3\cos(2t) \quad V}$$

## CALCULAR LAS CORRIENTES DE RAMA

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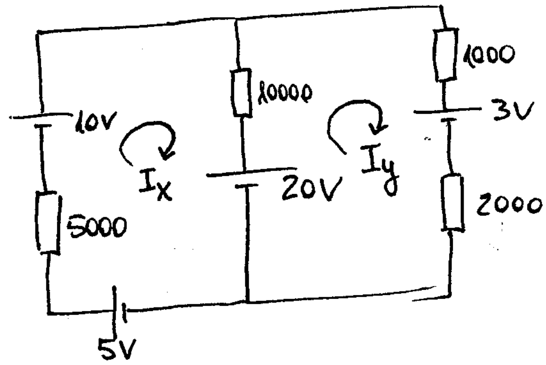


$$-5000I_x + 10 + 10000(I_y - I_x) - 20 + 5 = 0 \longrightarrow -5000I_x - 5 + 10000I_y - 10000I_x = 0$$

$$20 + 10000(I_x - I_y) - 1000I_y - 3 - 2000I_y = 0 \longrightarrow 17 - 3000I_y + 10000I_x - 10000I_y = 0$$

$$\Rightarrow \begin{cases} -15000I_x + 10000I_y = 5 \\ 10000I_x - 13000I_y = -17 \end{cases} \overset{\text{calc.}}{\Longrightarrow} \boxed{\begin{array}{l} I_x = 1'1 \cdot 10^{-3} A \\ I_y = 2'2 \cdot 10^{-3} A \end{array}}$$

$$\boxed{\begin{array}{l} I_{rama\_izq.} = I_x = 1'1 \cdot 10^{-3} A \\ I_{rama\_der} = I_y = 2'2 \cdot 10^{-3} A \\ I_{rama\_central} = I_y - I_x = 1'1 \cdot 10^{-3} A \end{array}}$$

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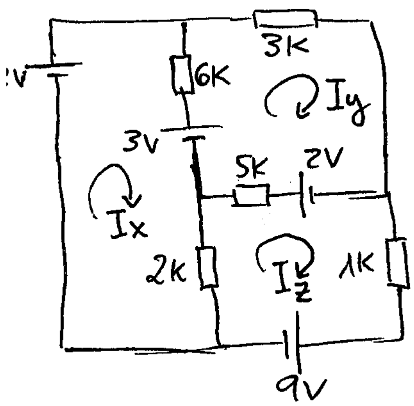
## CALCULAR LAS CORRIENTES DE MALLA

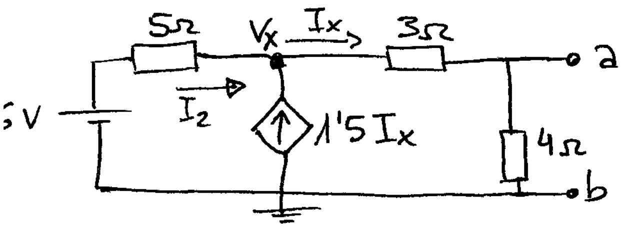



$$\begin{cases} 12 + 6K(I_y - I_x) + 2K(I_z - I_x) = 0 \\ 3 + 6K(I_x - I_y) - 3K \cdot I_y + 2 + 5K(I_z - I_y) = 0 \\ 2K(I_x - I_z) + 5K(I_y - I_z) - 2 - 1K I_z - 9 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 12 + 6KI_y - 6KI_x + 2KI_z - 2KI_x = 0 \\ 5 + 6KI_x - 6KI_y - 3KI_y + 5KI_z - 5KI_y = 0 \\ -11 + 2KI_x - 2KI_z + 5KI_y - 5KI_z - 1KI_z = 0 \end{cases}$$

$$\Rightarrow \begin{cases} -8KI_x + 6KI_y + 2KI_z = -12 \\ 6KI_x - 14KI_y + 5KI_z = -5 \\ 2KI_x + 5KI_y - 8KI_z = 11 \end{cases} \overset{\text{calc.}}{\Longrightarrow} \boxed{\begin{array}{l} I_x = 3mA = 3 \cdot 10^{-3} A \\ I_y = 1'83mA = 1'83 \cdot 10^{-3} A \\ I_z = 0'52mA = 0'52 \cdot 10^{-3} A \end{array}}$$

CALCULAR EL EQUIVALENTE DE THEVENIN




$$V_{Th} = V_{ab} = V_a - \cancel{V_b}^{0} = V_a$$

$$V_a = I_x \cdot 4$$

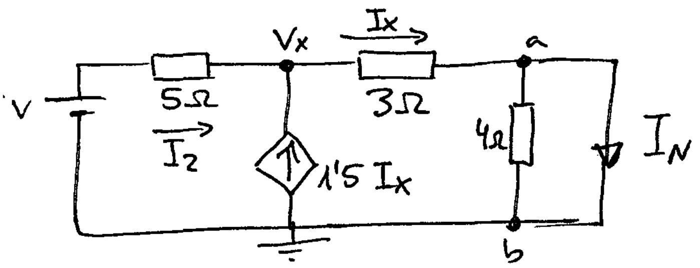
$$I_x = \frac{V_x}{3+4}$$

Ecuación de nodo: $\frac{6-V_x}{5} + \frac{1'5V_x}{7} = \frac{V_x}{7} \Rightarrow \frac{42-7V_x+7'5V_x}{35} = \frac{5V_x}{35}$

$\Rightarrow 42 + 0'5V_x = 5V_x \Rightarrow \boxed{V_x = \frac{42}{4'5} = \frac{28}{3}\,V}$

$$I_x = \frac{9'\widehat{3}}{7} = 1'\widehat{3}\,A$$

$$\boxed{V_{Th} = 4 \cdot 1'\widehat{3} = 5'\widehat{3}\,V}$$




$$I_N = I_x$$

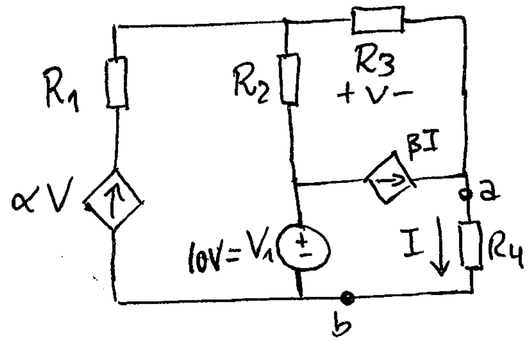
$$I_x = \frac{V_x}{3}$$

Ecuación de nodo: $\frac{6-V_x}{5} + \frac{1'5V_x}{3} = \frac{V_x}{3} \Rightarrow \frac{18-3V_x+7'5V_x}{15} = \frac{5V_x}{15} \Rightarrow$

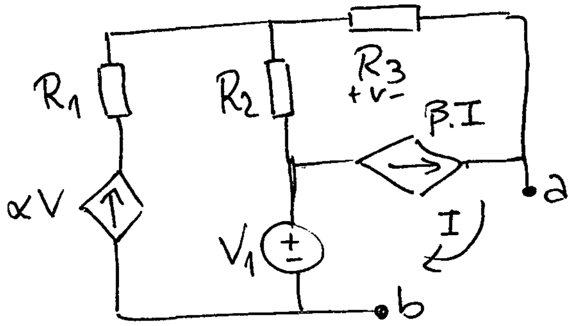
$\Rightarrow 18 + 4'5V_x = 5V_x \Rightarrow \boxed{V_x = \frac{18}{0'5} = 36V}$

$I_x = \boxed{I_N = \frac{36}{3} = 12A}$ $\qquad \boxed{R_{eq} = \frac{V_{Th}}{I_N} = \frac{5'\widehat{3}\,V}{12} = 0'\widehat{4}\,\Omega}$

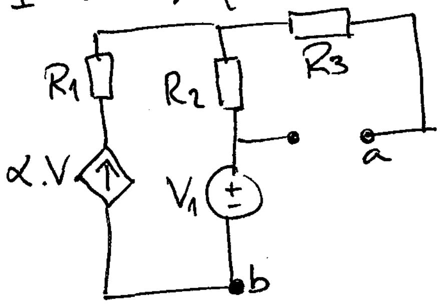
Calcular el valor de la resistencia $R_4$ para que la transferencia de potencia en sus extremos sea máxima. Determina el valor de esa potencia.



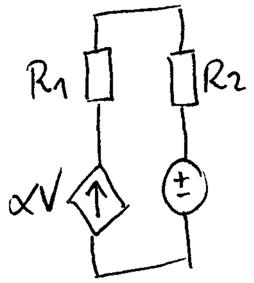

Para que la transferencia de potencia sea máxima en $R_4$, esta tiene que ser igual a la resistencia equivalente del resto del circuito. $R_4 = R_{eq}$.



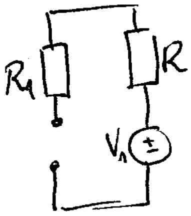

$I = 0 \Rightarrow \beta . I = 0$



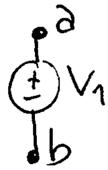

$R_3$ se anula porque está en circuito abierto.




Como $V = 0 \Rightarrow \alpha V = 0$

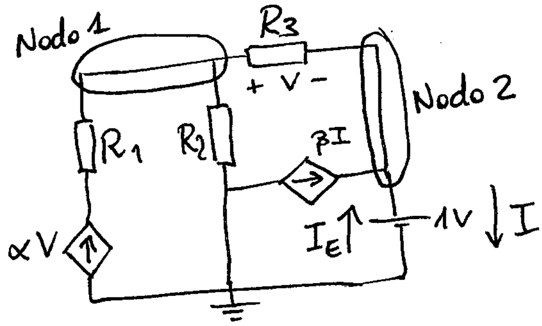



Por lo tanto: $\boxed{V_{Th} = V_1 = 10V}$




**Resistencia equivalente**

1. Circuito abierto en a y b
2. Anulamos las fuentes indep.
3. Si hay f. dep.:
   - 3.1. Pila 1V en a y b
   - 3.2. Calculamos $I_E$
   - 3.3. $R_{eq} = \frac{1}{I_E}$




Nodo 2

$\beta I + I_3 + I_E = 0$ ; $3(-I_E) + I_E + I_3 = 0$

$\beta = 3 \quad I = -I_E$

$-2I_3 + \frac{1}{3} = 0$

$\boxed{\frac{1}{6} mA = I_E}$

$$\boxed{R_{eq} = \frac{1}{\frac{1}{6} \cdot 10^{-3}} = 6K\Omega}$$

Nodo 1

$3 \cdot 10^{-3} V = I_2 + I_3 \rightarrow 3 \cdot 10^{-3} V = \frac{1+V}{2K} + \frac{V}{1K}$

$I_2 = \frac{1+V}{R_2} = \frac{1+V}{2K}$

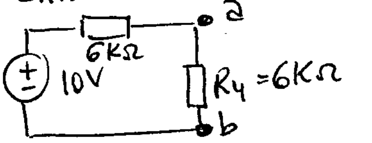
$I_3 = \frac{(1+V) - 1}{R_3} = \frac{V}{R_3} = \frac{V}{1K} = \frac{1}{3} mA$

$\frac{3}{1K} V = \frac{1+V}{2K} + \frac{V}{1K}$

$3V = 1 + 3V$

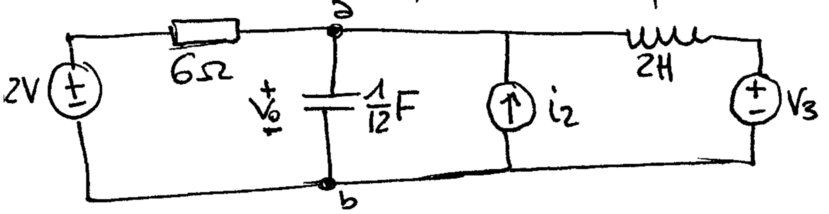
$3V = 1 \Rightarrow V = \frac{1}{3}$ voltios

Entonces:




$P_{ab} = V_{ab} . I = I^2 . R =$
$= \left(\frac{10}{12K}\right)^2 . 6K = 4'16 . 10^{-3}$ W

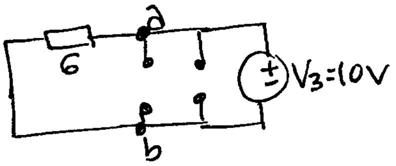
Encontrar la diferencia de potencial $V_0(t)$ entre los terminales de C.




$$\begin{cases} i_2(t) = 4\,\mathrm{sen}(2t) \ \ A \\ V_1(t) = 12\cos(3t) \ \ V \\ V_3 = 10V \end{cases}$$

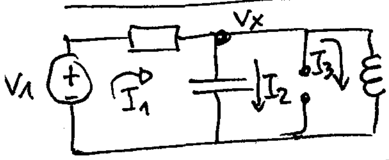
Hay una fuente c.c. y dos de C.A a distinta frecuencia. Hay que aplicar el Ppio. de Superposición: $V_0(t) = V_{01}(t) + V_{02}(t) + V_{03}(t)$

- <u>GENERADOR 3</u> (continua) : anulamos generadores 1 y 2.




$$\boxed{V_{03}(t) = 10V}$$

- <u>GENERADOR 1</u> (alterna) : anulamos los generadores 2 y 3.



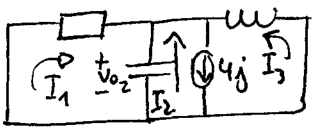

$V_1 = 12 \cdot e^{0j} = 12V$ ; $Z_C = \frac{1}{j\omega C} = -4j$ ; $Z_L = j\omega L = 6j$

$I_1 = I_2 + I_3 \Rightarrow \frac{12 - V_x}{6} = \frac{V_x}{-4j} + \frac{V_x}{6j} \Rightarrow 24j - 2V_xj = -3V_x + 2V_x$

$\Rightarrow V_x = \frac{-24j + 48}{5}$. Calculamos módulo y fase:

$|V_x| = \frac{24}{5}\sqrt{5}$ ; $\varphi(V_x) = \mathrm{arctg}\left(\frac{-1}{2}\right) = -26'57°$ ; $\boxed{V_{01}(t) = \frac{24}{5}\sqrt{5}\cos(3t - 26'57°)}$

- <u>GENERADOR 2</u> (alterna): anulamos los generadores 1 y 3.




$i_2(t) = 4\,\mathrm{sen}(2t) = 4\cos\left(2t - \frac{\pi}{2}\right)$ ; $Z_C = \frac{1}{j\omega C} = -6j$

$i_2 = 4e^{-\frac{\pi}{2}j} = -4j$ ; $Z_L = j\omega L = 4j$

Resolvemos por nodos:

$$I_1 + I_3 + I_2 = 4j \longrightarrow \frac{-V_{02}}{6} + \frac{V_{02}}{6j} - \frac{V_{02}}{4j} = 4j \Rightarrow$$

$$\Rightarrow -2jV_{02} + 2V_{02} - 3V_{02} = -48 \Rightarrow -2jV_{02} - V_{02} = -48 \Rightarrow V_{02} = \frac{48}{1+2j} \Rightarrow$$

$\Rightarrow V_{02} = \frac{48}{5}(1-2j)$ $\quad |V_{02}| = \frac{48}{5}\sqrt{5}$ $\quad \varphi(V_{02}) = \mathrm{arctg}(-2) = -63'44°$

$$\boxed{V_{02}(t) = \frac{48}{5}\sqrt{5}\cos(2t - 63'44°)}$$

Finalmente, sumamos los tres resultados.