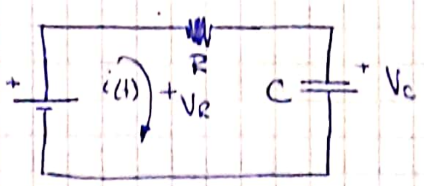
Francisco Gabriel Rainero.

Carpeta de Trabajos Prácticos.
Teoría de Circuitos II.

1) Mediante T [L] determinar y graficar $i(t)$.

$e(t) = E$



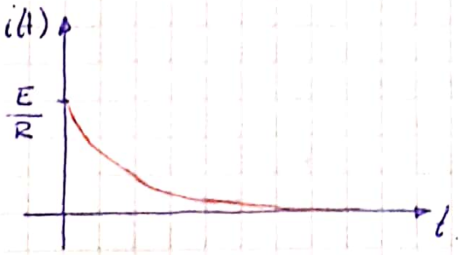
$$E = V_R(t) + V_c(t)$$

$$\frac{E}{P} = V_R(P) + V_c(P)$$

$$\frac{E}{P} = I(P) \cdot R + \frac{I(P)}{C \cdot P}$$

$$I(P) = \frac{E}{P\left(R + \frac{1}{CP}\right)} = \frac{E}{P \cdot R + \frac{1}{C}} = \frac{E/R}{P + \frac{1}{RC}}$$

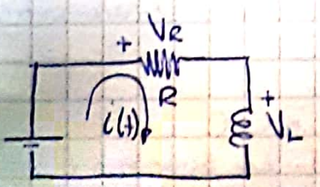
$$i(t) = L^{-1}\left[I(P)\right] = \frac{E}{R} \cdot e^{-\frac{1}{RC}t}$$



$$\boxed{i(t) = \frac{E}{R} \cdot e^{-\frac{t}{RC}}}$$

2) Mediante T [L] determinar y graficar $i(t)$.

$e(t) = E$



$$E = V_R(t) + V_L(t)$$

$$\frac{E}{P} = V_R(P) + V_L(P)$$

$$\frac{E}{P} = I(P) \cdot R + I(P) \cdot LP$$

$$I(P) = \frac{E}{P(LP + R)} = \frac{E/L}{P(P + R/L)}$$

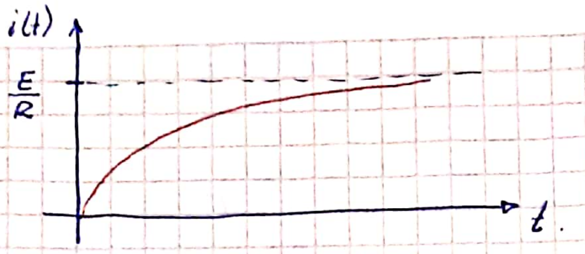
$$I(P) = \frac{A}{P} + \frac{B}{P + R/L}$$

$$A = \lim_{P \to 0} \frac{E/L}{P + R/L} = E/R$$

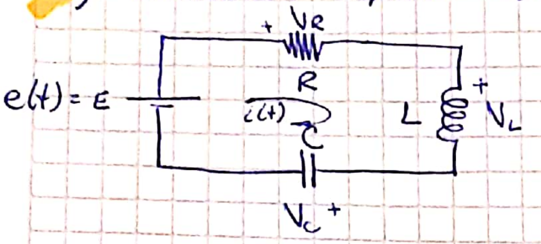
$$B = \lim_{P \to -\frac{R}{L}} \frac{E/L}{P} = -E/R$$

$$I(P) = \frac{E/R}{P} - \frac{E/R}{P + R/L}$$

$$\boxed{i(t) = \frac{E}{R} - \frac{E}{R} \cdot e^{-\frac{R}{L}t}}$$



3) *Mediante Laplace determinar y graficar i(t).*



$$E = V_R(t) + V_L(t) + V_C(t)$$

$$\frac{E}{P} = V_R(P) + V_L(P) + V_C(P)$$

$$\frac{E}{P} = R \cdot I(P) + LP \cdot I(P) + \frac{I(P)}{CP}$$

$$I(P) = \frac{E}{P\left(R + LP + \frac{1}{CP}\right)}$$

$$I(P) = \frac{E}{L \cdot P^2 + R \cdot P + \frac{1}{C}}$$

$$I(P) = \frac{E/L}{P^2 + \frac{R}{L} \cdot P + \frac{1}{LC}}$$

$$I(P) = \frac{A}{P + P_1} + \frac{B}{P + P_2}$$

Donde P_1 y P_2 son raíces de:

$$P^2 + \frac{R}{L} \cdot P + \frac{1}{LC} = 0$$

$$P_1, P_2 = \frac{-R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$$

Pueden ser:

- Raíces Reales Distintas.
- Raíces Reales iguales
- Raíces Complejas conjugadas.
- Raíces imaginarias puras.

Lo que define las raíces es el término de la raíz.

$$\frac{R^2}{4L^2} - \frac{1}{LC} = 0$$

$$\boxed{R_C = 2\sqrt{\frac{L}{C}}}$$ Resistencia crítica.

ζ = zita = Factor de amortiguamiento.

$$\boxed{\zeta = \frac{R}{R_C}}$$

Tenemos que:

- $\zeta = 1$: R.R.I.
  ↳ Amortiguamiento crítico.
- $\zeta > 1$: R.R.D
  ↳ Sobreamortiguamiento
- $\zeta < 1$: R.C.C.
  ↳ Subamortiguamiento.
- $\zeta = 0$: R.I.P.
  ↳ Oscilatorio
  ↓
  Caso teórico.

- $\alpha = \frac{-R}{2L}$.
- $\omega_n = \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$.

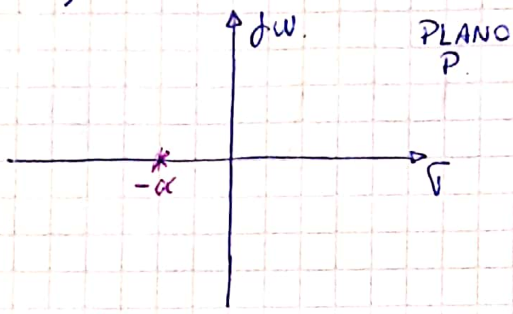
Casos

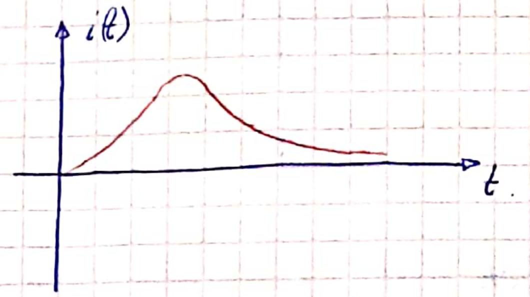
- Amortiguamiento crítico.

  * $R = R_C \rightarrow P_1 = P_2 = -\frac{R}{2L}$

  * $\xi = 1$.

$$\boxed{i(t) = \frac{E}{L}\, t \cdot e^{-\alpha t}}$$

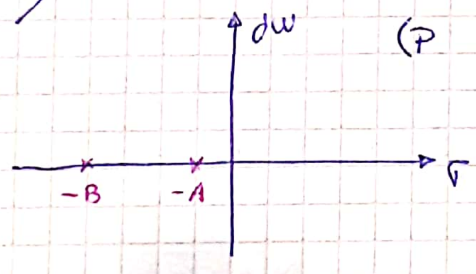


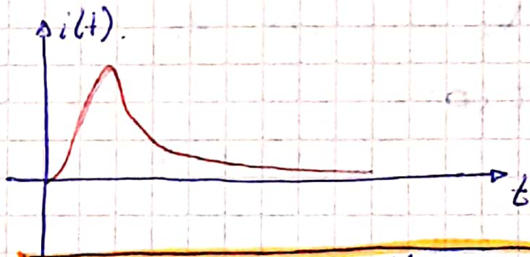


- Sobreamortiguamiento.

  * $R > R_C \rightarrow P_1$ y $P_2 = -\frac{R}{2L} \pm \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}$ } 2 reales ↳ A y B.

  * $\xi > 1$.



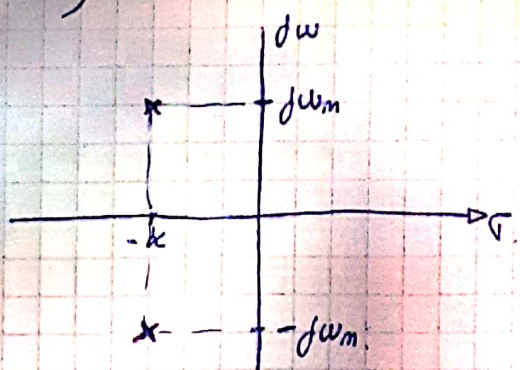


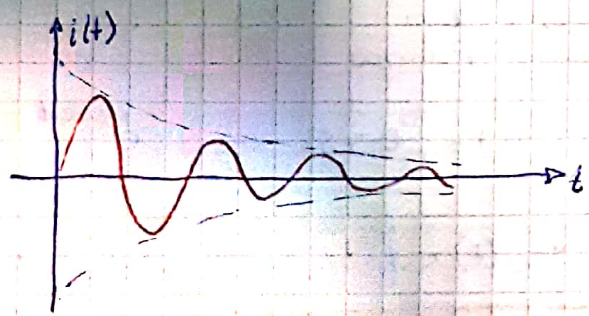
$$\boxed{i(t) = \frac{E}{L(A-B)} \left(e^{-At} - e^{-Bt} \right)}$$

- Subamortiguamiento.

  * $R < R_C \rightarrow P_1$ y $P_2 = \alpha \pm j\omega_m$.

  * $\xi < 1$.



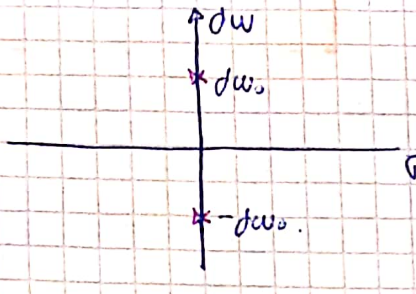


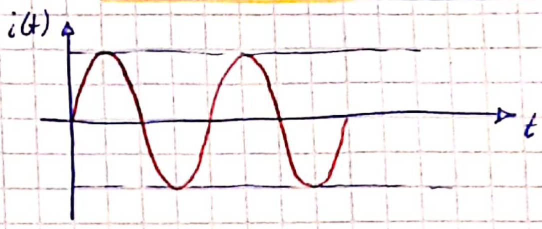
$$\boxed{i(t) = \frac{E}{\omega_m \cdot L} \left(e^{-\alpha t} \cdot \operatorname{sen} \omega_m t \right)}$$

o Oscilatorio.

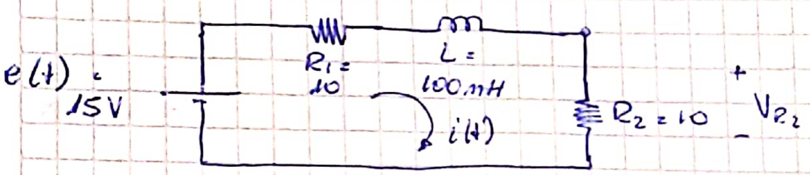
* $R = 0$ $\quad P_1$ y $P_2 = \pm j\omega_n = \pm j\omega_0$; $\omega_0 = \dfrac{1}{\sqrt{LC}}$.
* $\zeta = 0$
* Caso teórico (siempre hay R).

$$\boxed{i(t) = \frac{E}{\omega_0 L}\,\text{sen}(\omega_0 t)}$$





4) Determinar y graficar V_{R_2}



$$V_{R_2}(t) = i(t)\cdot R_2.$$

$$I(p) = \frac{E}{p\cdot(R_1 + R_2 + p\cdot L)} = \frac{E/L}{p\cdot\left(p + \frac{R_1+R_2}{L}\right)} = \frac{150}{p\cdot(p+200)}$$

$$I(p) = \frac{A}{p} + \frac{B}{p+200}.$$

$$A = \lim_{p\to 0} \frac{150}{p+200} = 0{,}75$$

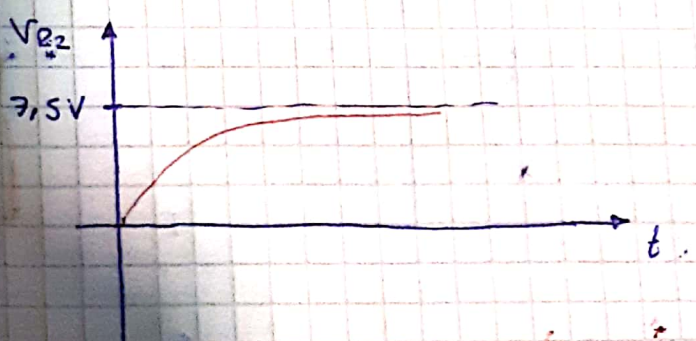
$$B = \lim_{p\to -200} \frac{150}{p} = -0{,}75$$

$$I(p) = \frac{0{,}75}{p} + \frac{(-0{,}75)}{p+200}.$$

$$i(t) = 0{,}75 - 0{,}75\cdot e^{-200t}.$$

$$V_{R_2}(t) = i(t)\cdot R_2 = 7{,}5 - 7{,}5\cdot e^{-200t}$$

$$\boxed{V_{R_2}(t) = 7{,}5 - 7{,}5\cdot e^{-200t}\ [V]}$$



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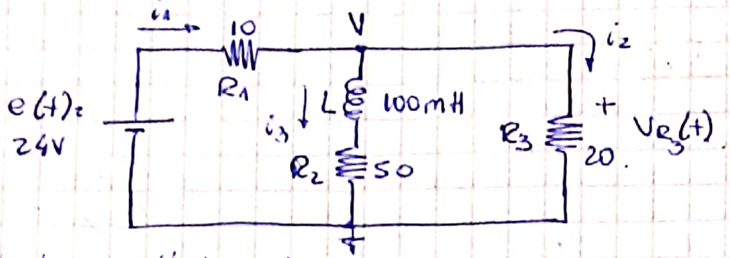
5) Determinar y graficar $v_{R_3}(t)$.



Aplicando método de nudos:

$$Y_{(s)} V_{(s)} = I(s)$$

$$Y(s) = \frac{1}{R_1} + \frac{1}{R_2 + PL} + \frac{1}{R_3} = \frac{1}{10} + \frac{1}{20} + \frac{1}{0{,}1P + 50}$$

$$I(s) = \frac{E/P}{10} = \frac{24}{10} \cdot \frac{1}{P} = \frac{2{,}4}{P}$$

$$Y(s) = 0{,}15 + \frac{10}{P+500} = \frac{10 + 75 + 0{,}15P}{P+500} = \frac{0{,}15P + 85}{P+500}$$

$$V(s) = \frac{I(s)}{Y(s)} = \frac{2{,}4}{P} \cdot \frac{P+500}{0{,}15(P+566{,}667)}$$

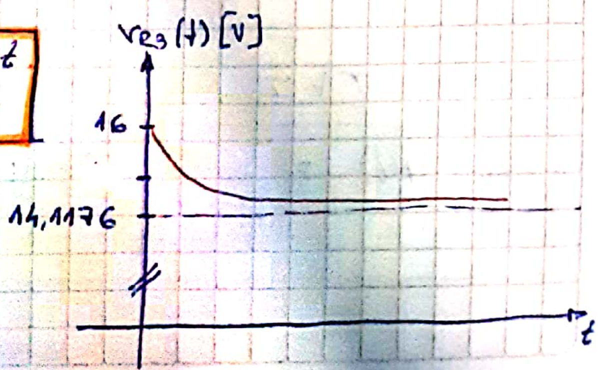
$$V(s) = \frac{16 \cdot (P+500)}{P \cdot (P+566{,}667)} = \frac{A}{P} + \frac{B}{P+566{,}667}$$

$$* A = \lim_{P \to 0} 16 \cdot \frac{(P+500)}{(P+566{,}667)} = 14{,}1176$$

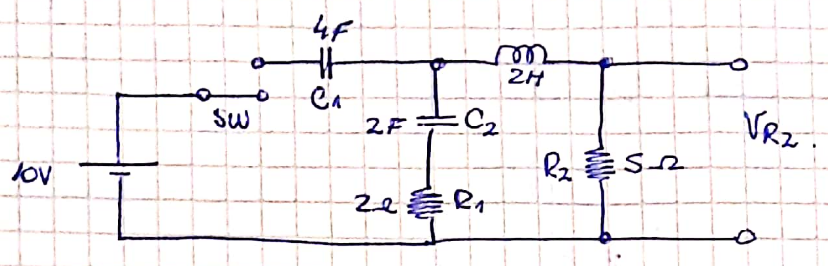
$$* B = \lim_{P \to -566{,}67} \frac{16 \cdot (P+500)}{P} = 1{,}8824.$$

$$V(s) = \frac{14{,}1176}{P} + \frac{1{,}8824}{P+566{,}67} = V_{R_3}(s).$$

$$\boxed{V_{R_3}(t) = 14{,}1176 + 1{,}8824 \cdot e^{-566{,}67t}}$$



6) Cuando se cierra la llave ($t=0$). Determinar V_{R_2} p/ $t=0$, $t=\infty$

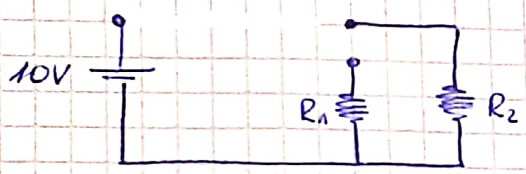


Para $t=0$, y teniendo en cuenta que los C y L están descargados, los capacitores se comportan como C.C y las bobinas como C.A., en el primer instante. Quedándonos el circuito:

Al no circular corriente por R_2,

$$V_{R_2}(0)=0$$

Para $t=\infty$, los capacitores e inductores están completamente cargados. Los C. se comportan como C.A y los L como C.C. Circuito p/ $t=\infty$:

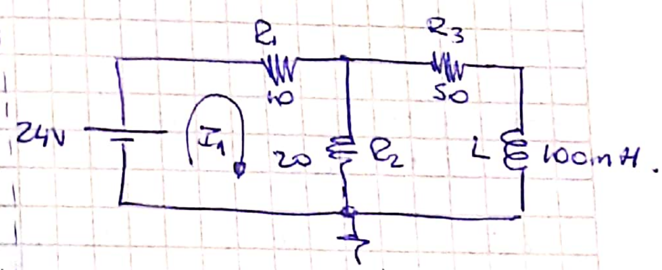


Al tampoco circular corriente por R_2:

$$V_{R_2}(\infty)=0.$$

Lo anterior se cumple siempre y cuando las fuentes sean de continua (constantes)

7) Aplicar TVI y TVF a las funciones del tiempo y transformada que corresponden a I_1.



$$I_1(P)=\frac{0{,}8\cdot(P+700)}{P\cdot(P+566{,}66)}$$

$$i_1(t)=0{,}988-0{,}188\cdot e^{-566{,}66t}$$

T.V.I

$$\boxed{\lim_{t\to 0} f(t)=\lim_{p\to\infty} pF(p)}$$

T.V.F

$$\boxed{\lim_{t\to\infty} f(t)=\lim_{p\to 0} pF(p)}$$

* **TVI**

$$\lim_{t \to 0} i_1(t) = \lim_{p \to \infty} p \cdot I_1(s)$$

$$\lim_{t \to 0} \left(0{,}988 - 0{,}188\, e^{-566{,}66t}\right) = \lim_{p \to \infty} \cancel{p} \cdot \frac{0{,}8\,(p+700)}{\cancel{p}\,(p+566{,}66)}$$

$$0{,}8 = 0{,}8 \quad \checkmark$$

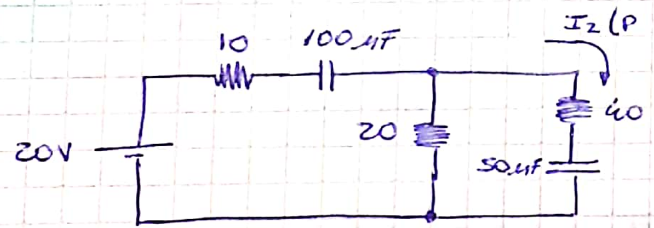
* **TVF**

$$\lim_{t \to \infty} i_1(t) = \lim_{p \to 0} p \cdot I_1(s)$$

$$\lim_{t \to \infty} \left(0{,}988 - 0{,}188\, e^{-566{,}66t}\right) = \lim_{p \to 0} \frac{0{,}8 \cdot (p+700)}{p+566{,}66} =$$

$$0{,}988 = 0{,}988 \quad \checkmark$$

8) Dada $I_2(P)$, obtener $i_2(t)$ y aplicar TVI y TVF.



$$I_2(P) = \frac{0{,}285\,P}{P^2 + 857{,}14P + 142{,}8 \times 10^3}$$

$$I_2(P) = \frac{0{,}285\,P}{(P+226{,}4011)(P+630{,}7388)} = \frac{A}{(P+226{,}4011)} + \frac{B}{(P+630{,}7388)}$$

$$+ A = \lim_{P \to -226{,}4011} \frac{0{,}285P}{P+630{,}7388} = -0{,}1596.$$

$$+ B = \lim_{P \to -630{,}7388} \frac{0{,}285P}{P+226{,}4011} = 0{,}4446.$$

$$I_2(P) = \frac{-0{,}1596}{P+226{,}4011} + \frac{0{,}4446}{P+630{,}7388}$$

$$\boxed{i_2(t) = -0{,}1596 \cdot e^{-226{,}4011\,t} + 0{,}4446 \cdot e^{-630{,}7388\,t}}$$

T.V.I.

$$\lim_{t \to 0} i_2(t) = -0{,}1596 + 0{,}4446 = 0{,}285$$

$$\lim_{P \to \infty} P \cdot I_2(P) = 0{,}285 \quad \checkmark$$

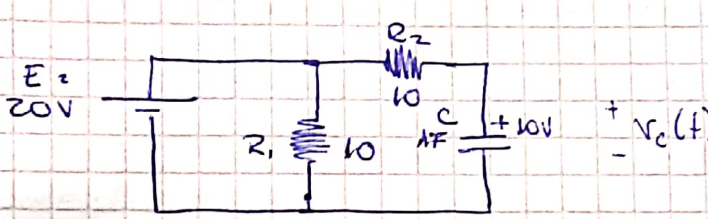
T.V.F

$$\lim_{t \to \infty} i_2(t) = 0$$

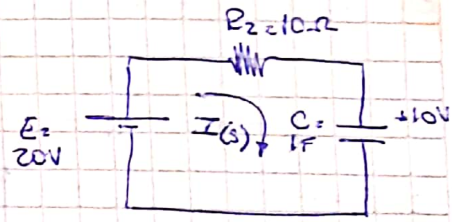
$$\lim_{P \to 0} P \cdot I_2(P) = 0 \quad \checkmark$$

9) Determinar y graficar $V_c(t)$, sabiendo que contiene una carga inicial de 10 Coulomb.

$$V = \frac{Q}{C} = \frac{10C}{1F} = 10V$$



$\Rightarrow$



$$\frac{E}{P} = V_{R_2}(P) + V_c(P) + \frac{V_0}{P}$$

$$\frac{E}{P} = R_2 \cdot I(P) + \frac{I(P)}{CP} + \frac{V_0}{P}$$

$$\frac{E - V_0}{P\left(R_2 + \frac{1}{CP}\right)} = I(P) \quad \Rightarrow \quad I(P) = \frac{10}{10P + 1} = \frac{1}{P + 0{,}1}$$

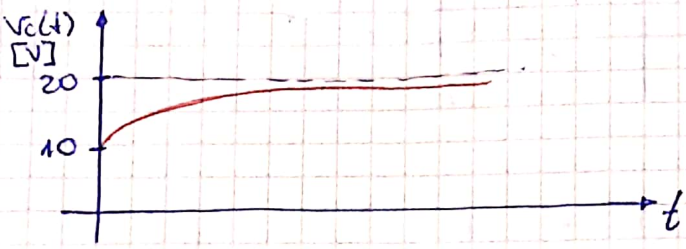
$$V_c(P) = \frac{I(P)}{CP} + \frac{V_0}{P} = \frac{1}{(P + 0{,}1)} \cdot \frac{1}{P} + \frac{10}{P} = \frac{A}{P} + \frac{B}{P + 0{,}1} + \frac{10}{P}$$

$$* \; A = \lim_{P \to 0} \frac{1}{P + 0{,}1} = 10$$

$$* \; B = \lim_{P \to -0{,}1} \frac{1}{P} = -10$$

$$V_c(P) = \frac{10}{P} + \frac{10}{P} - \frac{10}{P + 0{,}1} = \frac{20}{P} - \frac{10}{P + 0{,}1}.$$

$$V_c(t) = 20 - 10 \cdot e^{-0,1t}$$



10) Dada $F(P)$, obtener $f(t)$, empleando método gráfico p/ residuos.
Aplicar TVI y TVF.

$$F(P) = \frac{6,5\times10^{3}\,P + 10^{6}}{7,5\,P^{3} + 21000\,P^{2} + 3\times10^{6}\,P}$$

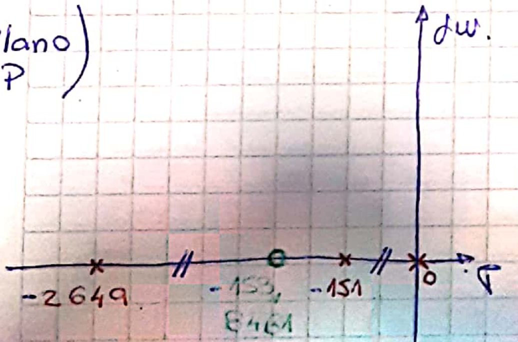
$$F(P) = \frac{6,5\times10^{3}\,(P + 153,8461)}{7,5\,(P + 151,0004)(P + 2648,9996)(P)}$$

$$F(P) = \frac{866,6667\,(P + 153,8461)}{P\,(P + 151,0004)(P + 2648,9996)}$$

$$F(P) = \frac{A}{P} + \frac{B}{P+151} + \frac{C}{2649}$$

$$Res = \frac{k \cdot \pi\,(\text{Dist. ceros})}{\pi\,(\text{Dist. polos})}$$

Plano P



$$* A = \frac{866,6667\,(0 + 153,8461)}{(0 + 151,0004)(0 + 2648,9996)}$$

$$* \boxed{A = 0,3333}$$

$$* B = \frac{866,6667\,(2,8461)}{(-151)(2498)} = \boxed{-6,54\times10^{-3}}$$

$$* C = \frac{866,667\,(-2513,1539)}{(-2649)(-2498)} = \boxed{-0,3291}$$

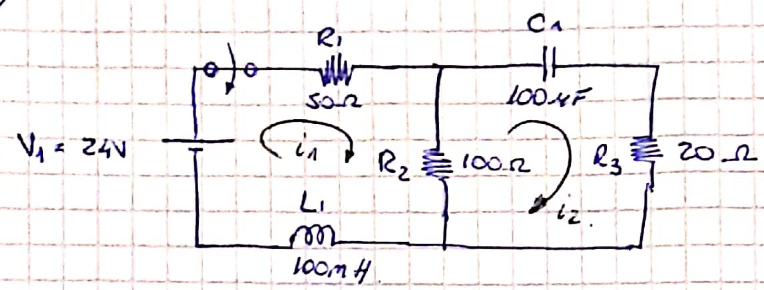
$$F(P) = \frac{0,3333}{P} + \frac{(-6,54\times10^{-3})}{P+151} + \frac{(-0,3291)}{P+2649}$$

$$\boxed{f(t) = 0,3333 - 6,54\times10^{-3}\,e^{-151t} - 0,3291\,e^{-2649t}}$$

TVI: $\cdot \lim_{t\to 0} f(t) = 0 = \lim_{P\to\infty} P \cdot F(P) = 0$ ✓

TVF: $\cdot \lim_{t\to\infty} f(t) = 0,3333 = \lim_{P\to 0} P \cdot F(P) = 0,3333$ ✓

12) Mediante método de mallas determinar $i_1(t)$ e $i_2(t)$.



$$\left.\begin{array}{l} Z_{11(P)} = R_1 + R_2 + P \cdot L_1 = 150 + 0{,}1P \\ Z_{12(P)} = Z_{21(P)} = -R_2 = -100 \\ Z_{22(P)} = R_2 + R_3 + \dfrac{1}{C_1 P} = 120 + \dfrac{10.000}{P} \end{array}\right\} [Z] = \begin{bmatrix} 150 + 0{,}1P & -100 \\ -100 & 120 + \dfrac{10000}{P} \end{bmatrix}$$

$$\left.\begin{array}{l} V_1(P) \quad V_1 = \dfrac{24}{P} \\ V_2(P) = 0 \end{array}\right\} [V] = \begin{bmatrix} \dfrac{24}{P} \\ 0 \end{bmatrix}$$

$$[I] \cdot [Z] = [V]$$

$$\begin{bmatrix} 150 + 0{,}1P & -100 \\ -100 & 120 + \dfrac{10000}{P} \end{bmatrix} \begin{bmatrix} I_1(P) \\ I_2(P) \end{bmatrix} = \begin{bmatrix} \dfrac{24}{P} \\ 0 \end{bmatrix}$$

$$I_1(P) = \frac{\Delta_{11}}{\Delta p} \quad ; \quad I_2(P) = \frac{\Delta_{22}}{\Delta p}$$

- $\Delta p = (150 + 0{,}1P)\left(120 + \dfrac{10000}{P}\right) - (-100)(-100)$

$\Delta p = 18.000 + \dfrac{1{,}5\times10^6}{P} + 12P + 1000 - 10000 = \dfrac{12}{P}\left(P^2 + 750P + 125000\right)$

- $\Delta_{11} = \left(120 + \dfrac{10000}{P}\right)\left(\dfrac{24}{P}\right) = \dfrac{2880}{P} + \dfrac{240000}{P^2} = \dfrac{2880}{P^2}(P + 83{,}333)$

- $\Delta_{22} = -(-100)\,\dfrac{24}{P} = \dfrac{2400}{P}$

$$I_1(P) = \frac{2880}{P^2}(P+83{,}333) \cdot \frac{P}{12} \cdot \frac{1}{(P+250)(P+500)}$$

$$I_1(P) = \frac{240\,(P+83{,}333)}{P(P+250)(P+500)} = \frac{A}{P} + \frac{B}{P+250} + \frac{C}{P+500}$$

$$I_2(P) = \frac{2400}{P} \cdot \frac{P}{12} \cdot \frac{1}{(P+250)(P+500)} =$$

$$I_2(P) = \frac{200}{(P+250)(P+500)} = \frac{D}{P+250} + \frac{E}{P+500}$$

- $A = \lim_{P \to 0} \frac{240(P+83{,}333)}{(P+250)(P+500)} = 0{,}16$
- $B = \lim_{P \to -250} \frac{240(P+83{,}333)}{P \cdot (P+500)} = 0{,}64$
- $C = \lim_{P \to -500} \frac{240(P+83{,}333)}{P(P+250)} = -0{,}8$
- $D = \lim_{P \to -250} \frac{200}{P+500} = 0{,}8$
- $E = \lim_{E \to -500} \frac{200}{P+250} = -0{,}8$

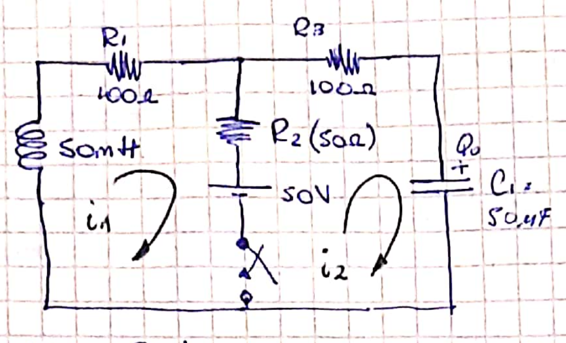
$$I_1(P) = \frac{0{,}16}{P} + \frac{0{,}64}{P+250} - \frac{0{,}8}{P+500}$$

$$\boxed{i_1(t) = 0{,}16 + 0{,}64\,e^{-250t} - 0{,}8\,e^{-500t}}$$

$$I_2(P) = \frac{0{,}8}{P+250} - \frac{0{,}8}{P+500}$$

$$\boxed{i_2(t) = 0{,}8 \cdot e^{-250t} - 0{,}8 \cdot e^{-500t}}$$

13) Mediante método de mallas determinar $i_1(t)$ e $i_2(t)$, sabiendo que $Q_0 = 0{,}0015C$.



$$V_0 = \frac{Q_0}{C} = \frac{0{,}0015}{50\mu F} = 30V.$$

$$Z_{11(P)} = R_1 + R_2 + P.L_1 = 150 + 0{,}05P$$

$$Z_{12(P)} = -R_2 = -50$$

$$Z_{22(P)} = R_2 + R_3 + \frac{1}{C_1 P} = 150 + \frac{20000}{P}$$

$$[Z] = \begin{bmatrix} 150+0{,}05P & -50 \\ -50 & 150+\frac{20000}{P} \end{bmatrix}$$

$$V_{1(P)} = -\frac{50}{P}$$

$$V_2(P) = \frac{50}{P} - \frac{30}{P} = \frac{20}{P}$$

$$[V] = \begin{bmatrix} -\frac{50}{P} \\ \frac{20}{P} \end{bmatrix}$$

$$\begin{bmatrix} 150+0{,}05P & -50 \\ -50 & 150+\frac{20000}{P} \end{bmatrix} \begin{bmatrix} I_1(P) \\ I_2(P) \end{bmatrix} = \begin{bmatrix} -\frac{50}{P} \\ \frac{20}{P} \end{bmatrix}$$

$$I_1(P) = \frac{\Delta_{11}}{\Delta_P} \quad ; \quad I_2(P) = \frac{\Delta_{22}}{\Delta_P}$$

- $\Delta_P = \left(150 + \frac{20000}{P}\right)\left(150 + 0{,}05P\right) - (-50)(-50)$

$$\Delta_P = 22500 + \frac{3\times10^6}{P} + 7{,}5P + 1000 - 2500 = \frac{7{,}5}{P}\left(P^2 + 2800P + 4\times10^5\right)$$

$$\Delta_P = \frac{7{,}5}{P}\left(P + 151\right)\left(P + 2649\right)$$

- $\Delta_{11} = \left(150 + \frac{20000}{P}\right)\left(-\frac{50}{P}\right) - (-50)\,\frac{20}{P} = -\frac{7500}{P} - \frac{1\times10^6}{P^2} + \frac{1000}{P}$

$$\Delta_{11} = -6500\,\frac{1}{P^2}\left(P + 153{,}85\right)$$

- $\Delta_{22} = \left(150 + 0{,}05P\right)\cdot\frac{20}{P} - (-50)\cdot\left(-\frac{50}{P}\right) = \frac{3000}{P} + 1 - \frac{2500}{P} = \frac{500}{P} + 1$

$$\Delta_{22} = \frac{1}{P}\left(P + 500\right)$$

$$I_1(p) = \frac{-6500}{p^{\cancel{2}}}(p+153{,}85)\cdot\frac{\cancel{p}}{7{,}5}\cdot\frac{1}{(p+151)(p+2649)}$$

$$I_1(p) = \frac{-866{,}667\cdot(p+153{,}85)}{p(p+151)(p+2649)} = \frac{A}{p} + \frac{B}{p+151} + \frac{C}{p+2649}$$

$$I_2(p) = \frac{p+500}{\cancel{p}}\cdot\frac{\cancel{p}}{7{,}5}\cdot\frac{1}{(p+151)(p+2649)}$$

$$I_2(p) = \frac{0{,}1333\,(p+500)}{(p+151)(p+2649)} = \frac{D}{p+151} + \frac{E}{p+2649}$$

- $A = \lim_{p\to 0} \frac{-866{,}667\,(p+153{,}85)}{(p+151)(p+2649)} = -0{,}3333$

- $B = \lim_{p\to -151} \frac{-866{,}667\cdot(p+153{,}85)}{p\cdot(p+2649)} = 0{,}00654$

- $C = \lim_{p\to -2649} \frac{-866{,}667\,(p+153{,}85)}{p\cdot(p+151)} = 0{,}3268$

- $D = \lim_{p\to -151} \frac{0{,}1333\,(p+500)}{p+2649} = 0{,}0186$

- $E = \lim_{p\to -2649} \frac{0{,}1333\,(p+500)}{p+151} = 0{,}1147$

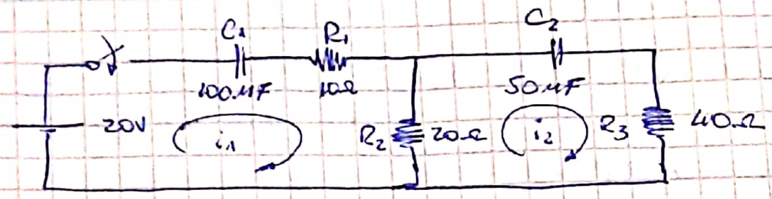
$$I_1(p) = \frac{-0{,}3333}{p} + \frac{0{,}00654}{p+151} + \frac{0{,}3268}{p+2649}$$

$$\boxed{i_1(t) = -0{,}3333 + 0{,}00654\cdot e^{-151t} + 0{,}3268\cdot e^{-2649t}}$$

$$I_2(p) = \frac{0{,}0186}{p+151} + \frac{0{,}1147}{p+2649}$$

$$\boxed{i_2(t) = 0{,}0186\cdot e^{-151t} + 0{,}1147\cdot e^{-2649t}}$$

14) Mediante método de mallas determinar $i_1(t)$ e $i_2(t)$.



$$Z_{11} = \frac{1}{C_1 P} + R_1 + R_2 = 30 + \frac{10000}{P}$$

$$Z_{12} = Z_{21} = -R_2 = -20$$

$$Z_{22} = R_2 + R_3 + \frac{1}{C_2 P} = 60 + \frac{20000}{P}$$

$$\begin{bmatrix} 30 + \frac{10000}{P} & -20 \\ -20 & 60 + \frac{20000}{P} \end{bmatrix}$$

$$V_1(P) = \frac{20}{P} \quad ; \quad V_2(P) = 0. \qquad \begin{bmatrix} \frac{20}{P} \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 30 + \frac{10000}{P} & -20 \\ -20 & 60 + \frac{20000}{P} \end{bmatrix} \begin{bmatrix} I_1(P) \\ I_2(P) \end{bmatrix} = \begin{bmatrix} \frac{20}{P} \\ 0 \end{bmatrix}$$

$$I_1(P) = \frac{\Delta_{11}}{\Delta P} \quad ; \quad I_2(P) = \frac{\Delta_{22}}{\Delta P}$$

- $$\Delta P = \left(60 + \frac{20000}{P}\right)\left(30 + \frac{10000}{P}\right) - 400 = 1800 + \frac{6 \times 10^5}{P} + \frac{6 \times 10^5}{P} + \frac{2 \times 10^8}{P^2} - 400.$$

$$\Delta P = \frac{1400}{P^2}\left(P^2 + 857{,}1428\,P + 142857{,}1429\right) = \frac{1400}{P^2}(P + 226{,}54)(P + 630{,}6)$$

- $$\Delta_{11} = \frac{20}{P} \cdot \left(60 + \frac{20000}{P}\right) = \frac{1200}{P} + \frac{400\,000}{P^2} = \frac{1200}{P^2}\left(P + 333{,}33\right).$$

- $$\Delta_{22} = -(-20) \cdot \frac{20}{P} = \frac{400}{P}.$$

$$I_1(P) = \frac{1200}{P^2}(P + 333{,}33) \cdot \frac{P^2}{1400} \cdot \frac{1}{(P + 226{,}54)(P + 630{,}6)}$$

$$I_1(P) = \frac{0{,}8571\,(P + 333{,}33)}{(P + 226{,}54)(P + 630{,}6)} = \frac{A}{P + 226{,}54} + \frac{B}{P + 630{,}6}$$

$$I_2(P) = \frac{400}{P} \cdot \frac{P^2}{1400} \cdot \frac{1}{(P + 226{,}54)(P + 630{,}6)} =$$

$$I_2(P) = \frac{0{,}2857 \cdot P}{(P + 226{,}54)(P + 630{,}6)} = \frac{C}{P + 226{,}54} + \frac{D}{P + 630{,}6}.$$

$$A = \lim_{P \to -226,54} \frac{0,8571 \cdot (P + 333,33)}{P + 630,6} = 0,226$$

$$B = \lim_{P \to -630,6} \frac{0,8571 \, (P + 333,33)}{P + 226,54} = 0,63$$

$$C = \lim_{P \to -226,54} \frac{0,2857 \, P}{P + 630,6} = -0,16$$

$$D = \lim_{P \to -630,6} \frac{0,2857 P}{P + 226,54} = 0,446$$

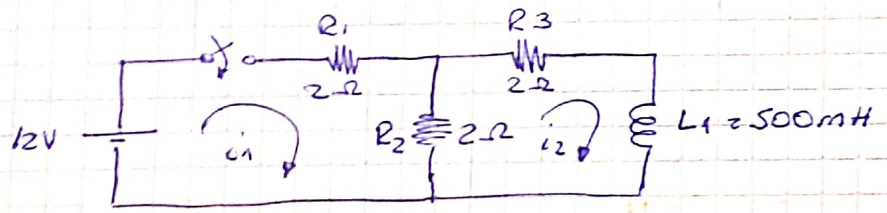
$$I_1(P) = \frac{0,63}{P + 630,6} + \frac{0,226}{P + 226,54}$$

$$\boxed{i_1(t) = 0,63 \, e^{-630,6 t} + 0,226 \, e^{-226,54 t}}$$

$$I_2(P) = \frac{-0,16}{P + 226,54} + \frac{0,446}{P + 630,6}$$

$$\boxed{i_2(t) = -0,16 \, e^{-226,54 t} + 0,446 \, e^{-630,6 t}}$$

15) Mediante método de mallas determinar $i_1(t)$ e $i_2(t)$.



$$\left.\begin{aligned} Z_{11} &= R_1 + R_2 = 4 \\ Z_{22} &= Z_{22} = R_2 + R_3 + L_1 P = 4 + 0,5P \\ Z_{12} &= Z_{21} = R_2 = -2 \end{aligned}\right\} \begin{bmatrix} 4 & -2 \\ -2 & 4+0,5P \end{bmatrix}$$

$$V_1 = \frac{12}{P} \; ; \; V_2 = 0$$

$$\begin{bmatrix} 4 & -2 \\ -2 & 4+0,5P \end{bmatrix} \begin{bmatrix} I_1(P) \\ I_2(P) \end{bmatrix} = \begin{bmatrix} \frac{12}{P} \\ 0 \end{bmatrix}$$

$$I_1(P) = \frac{\Delta_{11}}{\Delta P} \; ; \; I_2(P) = \frac{\Delta_{22}}{\Delta P}$$

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$\circ\ \Delta_p = (4+0{,}5p)\,4 - (-2)(-2) = 16 + 2p - 4 = 2(p+6)$

$\bullet\ \Delta_1 = (4+0{,}5p)\cdot\frac{12}{p} = \frac{6}{p}(p+8)$

$\circ\ \Delta_2 = \frac{24}{p}$

$I_1(p) = \frac{6}{p}(p+8)\frac{1}{2\cdot(p+6)} = \frac{3\cdot(p+8)}{p\,(p+6)} = \frac{A}{p} + \frac{B}{p+6}$

$I_2(p) = \frac{24}{p}\cdot\frac{1}{2\cdot(p+6)} = \frac{12}{p(p+6)} = \frac{C}{p} + \frac{D}{p+6}$

$\circ\ A = \lim_{p\to 0} \frac{3\cdot(p+8)}{p+6} = 4$

$\bullet\ B = \lim_{p\to -6} \frac{3\cdot(p+8)}{p} = -1$

$\circ\ C = \lim_{p\to 0} \frac{12}{p+6} = 2$

$\circ\ D = \lim_{p\to -6} \frac{12}{p} = -2$

$I_1(p) = \frac{4}{p} \quad \frac{-1}{p+6}$

$\boxed{i_1(t) = 4 - e^{-6t}}$

$I_2(p) = \frac{2}{p} - \frac{2}{p+6}$

$\boxed{i_2(t) = 2 - 2\cdot e^{-6t}}$

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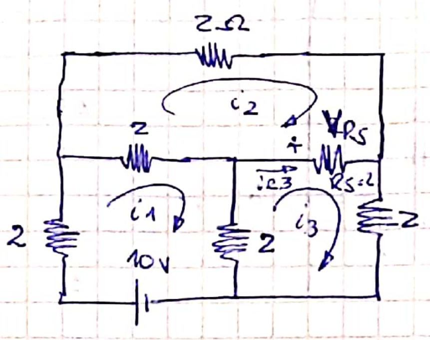
16) Mediante método de mallas determinar $i_1(t)$ y $i_2(t)$ e $i_3(t)$
(¿Porqué $V_{Rs} = 0V$?)



$R_{11} = 6$
$R_{12} = R_{21} = -2$
$R_{13} = R_{31} = -2$
$R_{22} = 6$
$R_{23} = R_{32} = -2$
$R_{33} = 6$

$$\begin{bmatrix} 6 & -2 & -2 \\ -2 & 6 & -2 \\ -2 & -2 & 6 \end{bmatrix} \cdot \begin{bmatrix} i_1(t) \\ i_2(t) \\ i_3(t) \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}$$

$i_1(t) = \frac{\Delta_1}{\Delta p}$; $i_2(t) = \frac{\Delta_2}{\Delta p}$; $i_3(t) = \frac{\Delta_3}{\Delta p}$

$\Delta p = 6 \cdot (36 - 4) - (-2)(-12 - 4) + (-2) \cdot (4 + 12) = 128$

$$\Delta_1 = \begin{vmatrix} 10 & -2 & -2 \\ 0 & 6 & -2 \\ 0 & -2 & 6 \end{vmatrix} = 10\,(36 - 4) = 320$$

$\Delta_2 = -10\,(-12 - 4) = 160$

$\Delta_3 = 10\,(4 + 12) = 160$

$\boxed{i_1(t) = \frac{320}{128} = 2{,}5\,A}$ $\boxed{i_2(t) = \frac{160}{128} = 1{,}25\,A}$ $\boxed{i_3(t) = \frac{160}{128} = 1{,}25\,A}$

* $V_{R3} = i_{R3} \cdot R_3$

$i_{R3} = i_3 - i_2 = 1{,}25A - 1{,}25A = 0A$

$\boxed{V_{R3} = 0V}$

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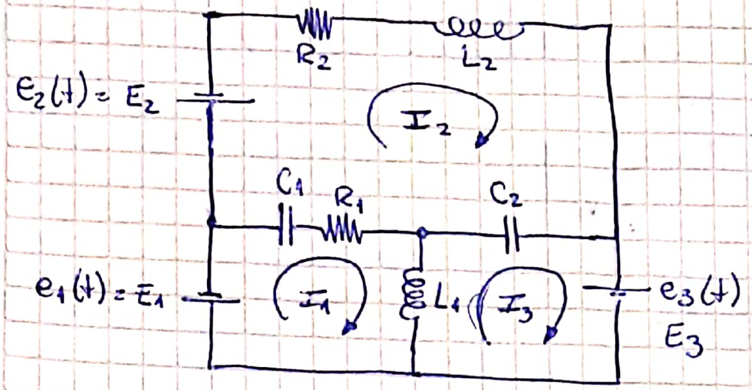
17) Escribir las ecuaciones de malla, identificando las impedancias.



Impedancias $(Z(P))$:

- $Z_{11} = R_1 + P \cdot L_1 + \dfrac{1}{C_1 P}$
- $Z_{12} = -\left(R_1 + \dfrac{1}{C_1 P}\right) = Z_{21}$
- $Z_{13} = -L_1 \cdot P = Z_{31}$
- $Z_{22} = R_1 + R_2 + L_2 \cdot P + \dfrac{1}{P(C_1 + C_2)}$
- $Z_{23} = Z_{32} = -\dfrac{1}{P \cdot C_2}$
- $Z_{33} = L_1 \cdot P + \dfrac{1}{C_2 \cdot P}$

Tensiones $(V(P))$:

- $V_1(P) = -\dfrac{E_1}{P}$
- $V_3(P) = -\dfrac{E_3}{P}$
- $V_2(P) = -\dfrac{E_2}{P}$

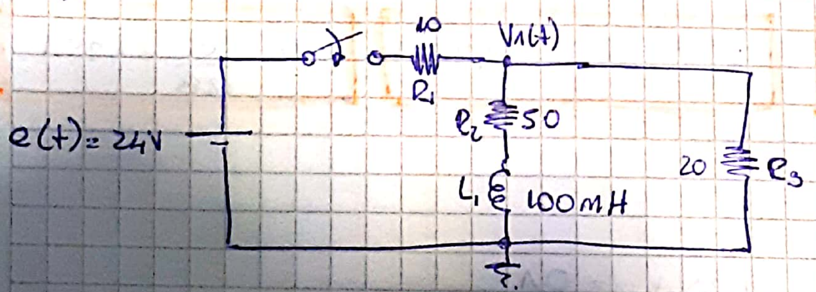
Ecuaciones:

(1) $I_1(P)\left[R_1 + PL_1 + \dfrac{1}{C_1 P}\right] - I_2(P)\left[R_1 + \dfrac{1}{C_1 P}\right] - I_3(P)\left[L_1 P\right] = -\dfrac{E_1}{P}$

(2) $I_2(P)\left[R_1 + R_2 + L_2 P + \dfrac{1}{P(C_1+C_2)}\right] - I_1(P)\left[R_1 + \dfrac{1}{C_1 P}\right] - I_3(P)\left[\dfrac{1}{PC_2}\right] = -\dfrac{E_2}{P}$

(3) $I_3(P)\left[L_1 P + \dfrac{1}{C_2 P}\right] - I_1(P)\left[L_1 P\right] - I_2(P)\left[\dfrac{1}{PC_2}\right] = -\dfrac{E_3}{P}$

18) Mediante método nodal determinar la tensión $V_1(t)$.



$$Y_1(P) = \frac{1}{R_1} + \frac{1}{R_2 + P \cdot L_1} + \frac{1}{R_3} = 0{,}15 + \frac{1}{50 + 0{,}1P} = \frac{10}{P + 500} + 0{,}15$$

$$Y_1(P) = \frac{10 + 0{,}15P + 75}{P + 500} = \frac{0{,}15\,(P + 566{,}667)}{P + 500}$$

$$I_1(P) = \frac{24}{S} \cdot \frac{1}{10} = \frac{2{,}4}{S}$$

$$Y_1(P)\cdot V_1(P) = I_1(P) \Rightarrow V_1(P) = \frac{I_1(P)}{Y_1(P)}$$

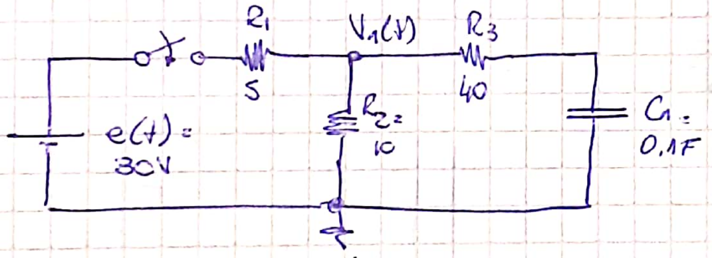
$$V_1(P) = \frac{2,4}{P}\cdot\frac{(P+500)}{0,15(P+566,67)} = \frac{16(P+500)}{P(P+566,67)} = \frac{A}{P}+\frac{B}{P+566,67}$$

- $A = \lim_{P\to 0} \frac{16(P+500)}{P+566,67} = 14,1176$
- $B = \lim_{P\to -566,67} \frac{16(P+500)}{P} = 1,8824$

$$V_1(P) = \frac{14,1176}{P} + \frac{1,8824}{P+566,67}$$

$$\boxed{v_1(t) = 14,1176 + 1,8824\cdot e^{-566,67t} \quad [V]}$$

19) Mediante método nodal determinar $V_1(t)$.



$$Y_1(P) = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3+\frac{1}{C_1P}} = 0,3 + \frac{1}{\frac{10}{P}+40} = 0,3 + \frac{P}{10+40P}$$

$$Y_1(P) = \frac{3+12P+P}{10+40P} = \frac{13(P+0,2308)}{40(P+0,25)} = \frac{0,325(P+0,2308)}{(P+0,25)}$$

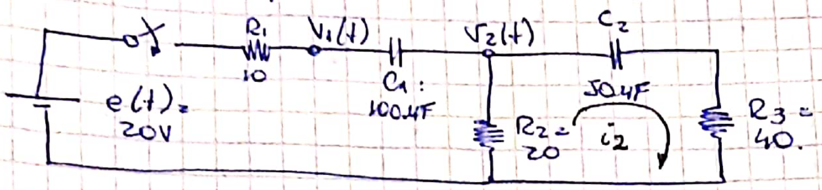
$$I_1(P) = \frac{30}{P}\cdot\frac{1}{5} = \frac{6}{P}$$

$$V_1(P) = \frac{I_1(P)}{Y_1(P)} = \frac{6}{P}\cdot\frac{(P+0,25)}{0,325(P+0,2308)} = \frac{18,4615\,(P+0,25)}{P(P+0,2308)}$$

$$V_1(P) = \frac{A}{P} + \frac{B}{P+0,2308} = \frac{20}{P} + \frac{(-1,5358)}{P+0,2308}$$

$$\boxed{v_1(t) = 20 - 1,5358\cdot e^{-0,2308t}}$$

20) Mediante método nodal, determinar las tensiones en los nudos $V_1(t)$ y $V_2(t)$. Calcular $i_2(t)$.



- $Y_{11}(P) = \dfrac{1}{R_1} + C_1 \cdot P = 0{,}1 + 1\times10^{-4} \cdot P = 1\times10^{-4} \cdot (P + 1000)$

- $Y_{12} = Y_{21} = -1\times10^{-4} P$

- $Y_{22} = 1\times10^{-4} P + 0{,}05 + \dfrac{1}{40 + \dfrac{20000}{P}} = 1\times10^{-4} P + 0{,}05 + \dfrac{P}{40P + 20000}$

$$Y_{22} = \frac{(1\times10^{-4} P + 0{,}05)(40P + 20000) + P}{40(P+500)} = \frac{4\times10^{-3} P^2 + 2P + 2P + P + 1000}{40(P+500)}$$

$$Y_{22} = \frac{4\times10^{-3}}{40} \frac{(P^2 + 1250P + 250.000)}{P+500} = \frac{1\times10^{-4} \cdot (P+250)(P+1000)}{P+500}$$

- $I_1(P) = \dfrac{20}{P} \cdot \dfrac{1}{10} = \dfrac{2}{P}$; $I_2(P) = 0$

$$\begin{bmatrix} 1\times10^{-4}(P+1000) & -1\times10^{-4} P \\ -1\times10^{-4} P & \dfrac{1\times10^{-4}(P+250)(P+1000)}{P+500} \end{bmatrix} \begin{bmatrix} V_1(P) \\ V_2(P) \end{bmatrix} = \begin{bmatrix} \dfrac{2}{P} \\ 0 \end{bmatrix}$$

$$\Delta p = \frac{(1\times10^{-4})^2 \cdot (P+250)(P+1000)^2}{P+500} - (1\times10^{-4})^2 \cdot P^2$$

$$\Delta p = \frac{1\times10^{-8} \left[(P^2 + 1250P + 250000) \cdot (P+1000) - P^2(P+500)\right]}{P+500}$$

$$\Delta p = \frac{1\times10^{-8} \left[\cancel{P^3} + \underline{1250P^2} + \underline{1000P^2} + 1{,}25\times10^6 P + 250000P + 250\times10^6 - \cancel{P^3} \underline{-500P^2}\right]}{P+500}$$

$$\Delta p = \frac{1\times10^{-8} \left[1750 P^2 + 1{,}5\times10^6 P + 250\times10^6\right]}{P+500}$$

$$\Delta p = \frac{1{,}75\times10^{-5} (P + 226{,}54)(P + 630{,}6)}{P+500}$$

$$\Delta_1 = \frac{1\times10^{-4}(P+250)(P+1000)}{P+500}\cdot\frac{2}{P} = \frac{2\times10^{-4}(P+250)(P+1000)}{P(P+500)}$$

$$\Delta_2 = 1\times10^{-4}\cancel{P}\cdot\frac{2}{\cancel{P}} = 2\times10^{-4}$$

$$V_1(P) = \frac{\Delta_1}{\Delta_P} = \frac{2\times10^{-4}(P+250)(P+1000)}{P\cancel{(P+500)}\cdot(P+630{,}6)}\cdot\frac{\cancel{(P+500)}}{1{,}75\times10^{-5}(P+226{,}54)}$$

$$V_1(P) = \frac{11{,}4286\cdot(P+250)(P+1000)}{P\cdot(P+226{,}54)(P+630{,}6)} = \frac{A}{P} + \frac{B}{P+226{,}54} + \frac{C}{P+630{,}6}$$

$$V_2(P) = \frac{\Delta_2}{\Delta_P} = \frac{2\times10^{-4}\cdot(P+500)}{1{,}75\times10^{-5}(P+226{,}54)(P+630{,}6)} = \frac{11{,}4286(P+500)}{(P+226{,}54)(P+630{,}6)}$$

$$V_2(P) = \frac{D}{P+226{,}54} + \frac{E}{P+630{,}6}$$

- $A = \lim_{P\to 0} \frac{11{,}4286\cdot(P+250)(P+1000)}{(P+226{,}54)(P+630{,}6)} = 20$
- $B = \lim_{P\to -226{,}54} \frac{11{,}4286\,(P+250)(P+1000)}{P(P+630{,}6)} = -2{,}26$
- $C = \lim_{P\to -630{,}6} \frac{11{,}4286\,(P+250)(P+1000)}{P(P+226{,}54)} = -6{,}31$
- $D = \lim_{P\to -226{,}54} \frac{11{,}4286\,(P+500)}{P+630{,}6} = 7{,}73$
- $E = \lim_{P\to -630{,}6} \frac{11{,}4286\,(P+500)}{P+226{,}54} = 3{,}69$

$$\boxed{V_1(t) = 20 - 2{,}26\cdot e^{-226{,}54t} - 6{,}31\cdot e^{-630{,}6t}}$$

$$\boxed{V_2(t) = 7{,}73\cdot e^{-226{,}54t} + 3{,}69\cdot e^{-630{,}6t}}$$

$$I_2(p) = \frac{V_2(p)}{R_3 + \frac{1}{C_2 P}} = \frac{\frac{11,4286 \cdot \cancel{(P+500)}}{(P+226,24)(P+630,6)}}{\frac{40\cancel{(P+500)}}{P}}$$

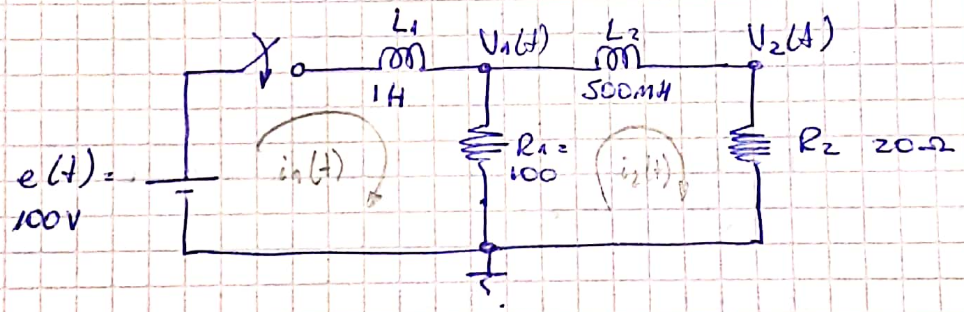
$$I_2(p) = \frac{0,2857 \cdot P}{(P+226,24)(P+630,6)} = \frac{A}{P+226,24} + \frac{B}{P+630,6}$$

- $A = \lim_{P \to -226,24} \frac{0,2857\, P}{P+630,6} = -0,1598$

- $B = \lim_{P \to -630,6} \frac{0,2857\, P}{P+226,24} = 0,4455$

$$\boxed{i_2(t) = -0,1598\, e^{-226,24\, t} + 0,4455\, e^{-630,6\, t}}$$

21) Mediante método nodal determinar $V_1(t)$ y $V_2(t)$. Calcular $i_1(t)$ e $i_2(t)$.



- $Y_{11}(P) = \frac{1}{P} + \frac{1}{100} + \frac{1}{0,5\,P} = \frac{3}{P} + 0,01 = \frac{0,01(P+300)}{P}$

- $Y_{12} = Y_{21} = -\frac{2}{P}$

- $Y_{22} = \frac{2}{P} + \frac{1}{20} = \frac{0,05(P+40)}{P}$

$I_1(p) = \frac{100}{P} \cdot \frac{P}{P} = \frac{100}{P^2}$

$I_2(p) = 0$

$$\begin{bmatrix} \frac{0,01(P+300)}{P} & -2/P \\ -\frac{2}{P} & \frac{0,05(P+40)}{P} \end{bmatrix} \begin{bmatrix} V_1(p) \\ V_2(p) \end{bmatrix} = \begin{bmatrix} \frac{100}{P^2} \\ 0 \end{bmatrix}$$

$$\Delta p = \frac{0,05\ (P+40)}{P} \cdot \frac{0,01\ (P+300)}{P} - \frac{4}{P^2} = \frac{5\times10^{-4}\left[P^2+300P+40P+1200\right.}{P^2}$$

$$\Delta p = \frac{5\times10^{-4}\left(P^2+340P+12000-8000\right)}{P^2} = \frac{5\times10^{-4}(P+12,2)(P+327,8)}{P^2}$$

$$\Delta_1 = \frac{0,05\ (P+40)}{P} \cdot \frac{100}{P^2} = \frac{5\ (P+40)}{P^3}$$

$$\Delta_2 = \frac{200}{P^3}$$

$$V_1(P) = \frac{\Delta_1}{\Delta p} = \frac{5\ (P+40)}{P^3} \cdot \frac{P^2}{5\times10^{-4}(P+12,2)(P+327,8)}$$

$$V_1(P) = \frac{10000\ (P+40)}{P(P+12,2)(P+327,8)} = \frac{A}{P} + \frac{B}{P+12,2} + \frac{C}{P+327,8}$$

$$V_2(P) = \frac{\Delta_2}{\Delta p} = \frac{200}{P^3} \cdot \frac{P^2}{5\times10^{-4}(P+12,2)(P+327,8)} = \frac{400\times10^3}{P(P+12,2)(P+327,8)}$$

$$V_2(P) = \frac{D}{P} + \frac{E}{P+12,2} + \frac{F}{P+327,8}$$

- $A = \lim_{P\to 0} \frac{10000\ (P+40)}{(P+12,2)(P+327,8)} = 100$

- $B = \lim_{P\to -12,2} \frac{10000\ (P+40)}{P\ (P+327,8)} = -72,18$

- $C = \lim_{P\to -327,8} \frac{10000\ (P+40)}{P\ (P+12,2)} = -27,82$

- $D = \lim_{P\to 0} \frac{400\times10^3}{(P+12,2)(P+327,8)} = 100$

- $E = \lim_{P\to -12,2} \frac{400\times10^3}{P\ (P+327,8)} = -103,89$

- $D = \lim_{P\to -327,8} \frac{400\times10^3}{P\ (P+12,2)} = 3,89$

$$V_1(p) = \frac{100}{p} - \frac{72,18}{p+12,2} - \frac{27,82}{p+327,8}$$

$$\boxed{v_1(t) = 100 - 72,18 \cdot e^{-12,2t} - 27,82 \cdot e^{-327,8} \quad [V]}$$

$$V_2(p) = \frac{100}{p} - \frac{103,89}{p+12,2} + \frac{3,89}{p+327,8}$$

$$\boxed{v_2(t) = 100 - 103,89\, e^{-12,2t} + 3,89 \cdot e^{-327,8t} \quad [V]}$$

$$I_1(p) = \frac{E(p) - V_1(p)}{p \cdot L_1} = \frac{100}{p^2} - \frac{10000\,(p+40)}{p^2(p+12,2)(p+327,8)}$$

$$I_1(p) = \frac{100\,(p+12,2)(p+327,8) - 10000\,(p+40)}{p^2\,(p+12,2)(p+327,8)}$$

$$I_1(p) = \frac{100p^2 + 3400\cancel{0p} + \cancel{400000} - 1000\cancel{0p} - \cancel{400000}}{p^2\,(p+12,2)(p+327,8)}$$

$$I_1(p) = \frac{100\,(p+240)}{p(p+12,2)(p+327,8)} = \frac{A}{p} + \frac{B}{p+12,2} + \frac{C}{p+327,8}$$

- $A = \lim\limits_{p \to 0} \dfrac{100\,(p+240)}{(p+12,2)(p+327,8)} = 6$
- $B = \lim\limits_{p \to -12,2} \dfrac{100\,(p+240)}{p(p+327,8)} = -5,92$
- $C = \lim\limits_{p \to -327,8} \dfrac{100\,(p+240)}{p(p+12,2)} = -0,0849$

$$\boxed{i_1(t) = 6 - 5,92 \cdot e^{-12,2t} - 0,0849 \cdot e^{-327,8t} \quad [A]}$$

$$i_2(t) = \frac{v_2(t)}{R_2} = \frac{100 - 103,89\, e^{-12,2t} + 3,89\, e^{-327,8t}}{20}$$

$$\boxed{i_2(t) = 5 - 5,1945\, e^{-12,2t} + 0,194\, e^{-327,8t} \quad [A]}$$

22) Mediante método de mallas, verificar $i_1(t)$ e $i_2(t)$ del ej. 21.

$$Z_{11} = L_1 \cdot P + R_1 = P + 100$$
$$Z_{12} = -R_1 = -100$$
$$Z_{22} = R_1 + R_2 + L_2 P = 0{,}5P + 120$$
$$V_1(P) = \frac{100}{P} \; ; \; V_2(P) = 0$$

$$\begin{bmatrix} P+100 & -100 \\ -100 & 0{,}5P+120 \end{bmatrix} \begin{bmatrix} I_1(P) \\ I_2(P) \end{bmatrix} = \begin{bmatrix} \frac{100}{P} \\ 0 \end{bmatrix}$$

$$\Delta p = (0{,}5P+120)(P+100) - 10000 = 0{,}5P^2 + 50P + 120P + 12000 - 10000$$

$$\Delta p = 0{,}5\,(P+12{,}2)(P+327{,}8)$$

$$\Delta_1 = (0{,}5P+120)\cdot\frac{100}{P} = \frac{50}{P}(P+240)$$

$$\Delta_2 = 100 \times \frac{100}{P} = \frac{10000}{P}$$

- $I_1(P) = \dfrac{\Delta_1}{\Delta p} = \dfrac{50}{P}(P+240)\cdot\dfrac{1}{0{,}5(P+12{,}2)(P+327{,}8)}$

$I_1(P) = \dfrac{100\,(P+240)}{P\,(P+12{,}2)(P+327{,}8)}$, igual a $I_1(P)$ que el ej. anterior

Destranformando =

$$\boxed{i_1(t) = 6 - 5{,}92\, e^{-12{,}2t} - 0{,}0849 \cdot e^{-327{,}8t} \quad [A]}$$

- $I_2(P) = \dfrac{\Delta_2}{\Delta p} = \dfrac{10000}{P}\cdot\dfrac{1}{0{,}5(P+12{,}2)(P+327{,}8)} = \dfrac{20.000}{P(P+12{,}2)(P+327{,}8)}$

$I_2(P) = \dfrac{A}{P} + \dfrac{B}{P+12{,}2} + \dfrac{C}{P+327{,}8}$

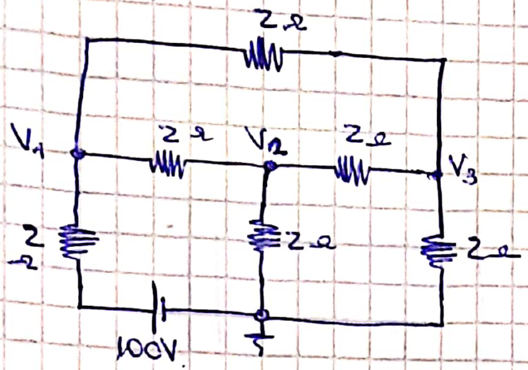
- $A = \lim\limits_{P\to 0} \dfrac{20000}{(P+12{,}2)(P+327{,}8)} = 5.$

- $B = \lim\limits_{P\to -12{,}2} \dfrac{20000}{P(P+327{,}8)} = -5{,}19.$

- $C = \lim\limits_{P\to -327{,}8} \dfrac{20000}{P(P+12{,}2)} = 0{,}19.$

$$\boxed{i_2(t) = 5 - 5{,}19 \cdot e^{-12{,}2t} + 0{,}19 \cdot e^{-327{,}8t}}$$

23) Mediante método de nudos, determinar $V_1(t)$, $V_2(t)$ y $V_3(t)$



$R_{11} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 1,5$

$R_{12} = -\frac{1}{2} = R_{21}$

$R_{13} = -\frac{1}{2} = R_{31}$

$R_{22} = 1,5$

$R_{23} = -\frac{1}{2} = R_{32}$

$R_{33} = 1,5$

$i_1 = \frac{100}{2} = 50$

$i_2 = 0$

$i_3 = 0$

$$\begin{bmatrix} 1,5 & -0,5 & -0,5 \\ -0,5 & 1,5 & -0,5 \\ -0,5 & -0,5 & 1,5 \end{bmatrix} \begin{bmatrix} V_1(t) \\ V_2(t) \\ V_3(t) \end{bmatrix} = \begin{bmatrix} 50 \\ 0 \\ 0 \end{bmatrix}$$

$V_1 = \frac{\Delta_1}{\Delta p}$; $V_2 = \frac{\Delta_2}{\Delta p}$; $V_3 = \frac{\Delta_3}{\Delta p}$

- $\Delta p = 1,5\left(1,5 \times 1,5 - (0,5)^2\right) + 0,5\left(1,5(-0,5) - (0,5)^2\right) - 0,5\left((0,5)^2 + 0,5 \times 1,5\right)$

$\Delta p = 3 - 0,5 - 0,5 = 2$

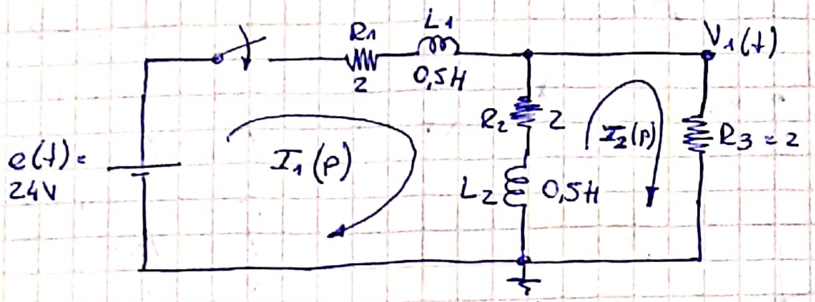
- $\Delta_1 = 50\left(1,5^2 - (0,5)^2\right) = 100$
- $\Delta_2 = -50\left(1,5 \times (-0,5) - 0,5^2\right) = 50$
- $\Delta_3 = 50\left(0,5^2 + 0,5 \times 1,5\right) = 50$

$$\boxed{V_1(t) = \frac{100}{2} = 50V}$$

$$\boxed{V_2(t) = \frac{50}{2} = 25V}$$

$$\boxed{V_3(t) = \frac{50}{2} = 25V}$$

24) Mediante método nodal, determinar $V_1(t)$ y las corrientes $I_1(p)$, $I_2(p)$.



$$Y_1(p) = \frac{1}{2+0{,}5p} + \frac{1}{2+0{,}5p} + \frac{1}{2} = \frac{2}{2+0{,}5p} + 0{,}5$$

$$Y_1(p) = \frac{2 + 0{,}5 \times 2 + 0{,}5 \times 0{,}5p}{2+0{,}5p} = \frac{0{,}25}{0{,}5} \frac{(p+12)}{(p+4)} = \frac{p+12}{2(p+4)}$$

$$I(p) = \frac{24}{p} \cdot \frac{1}{2+0{,}5p} = \frac{24}{0{,}5p(p+4)} = \frac{48}{p(p+4)}$$

$$Y_1(p) \cdot V_1(p) = I(p) \quad \therefore \quad V_1(p) = \frac{I(p)}{Y_1(p)}$$

$$V_1(p) = \frac{48}{p\cancel{(p+4)}} \cdot \frac{2\cancel{(p+4)}}{(p+12)} = \frac{96}{p(p+12)} = \frac{A}{p} + \frac{B}{p+12}$$

$$A = \lim_{p \to 0} \frac{96}{p+12} = 8$$

$$B = \lim_{p \to -12} \frac{96}{p} = -8$$

$$V_1(p) = \frac{8}{p} - \frac{8}{p+12}$$

$$\boxed{V_1(t) = 8 - 8 \cdot e^{-12t}}$$

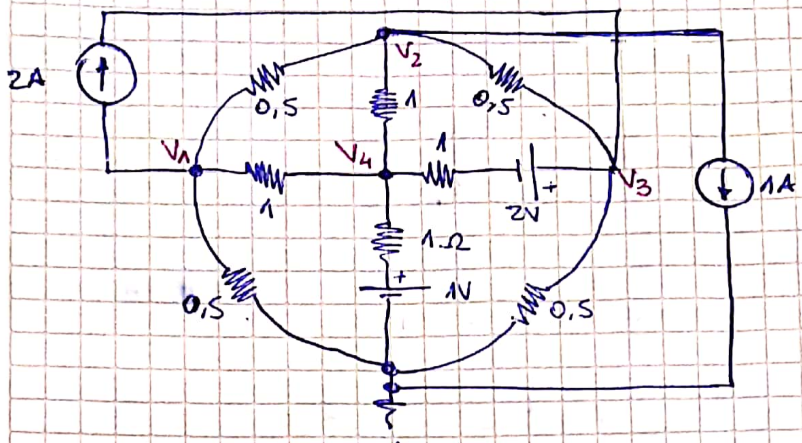
$$I_1(p) = \frac{24/p - V_1(p)}{0{,}5p + 2} = \frac{48}{p(p+4)} - \frac{192}{p(p+12)(p+4)}$$

$$I_1(p) = \frac{48(p+12) - 192}{p(p+4)(p+12)} = \frac{48p + 384}{p(p+4)(p+12)} = \frac{48(p+8)}{p(p+4)(p+12)}$$

$$\boxed{I_1(p) = \frac{48(p+8)}{p(p+4)(p+12)}}$$

$$I_2(p) = \frac{V_1(p)}{R_3} = \frac{96}{p(p+12)} \cdot \frac{1}{2} \rightarrow \boxed{I_2(p) = \frac{48}{p(p+12)}}$$

25) Mediante método nodal, determinar $v_1(t)$, $v_2(t)$, $v_3(t)$ y $v_4(t)$



$Y_{11} = \frac{1}{1} + 2 + 2 = 5$

$Y_{12} = Y_{21} = -2$

$Y_{13} = Y_{31} = 0$

$Y_{14} = Y_{41} = -1$

$Y_{22} = 2 + 1 + 2 = 5$

$Y_{23} = Y_{32} = -2$

$Y_{24} = Y_{42} = -1$

$Y_{33} = 2 + 1 + 2 = 5$

$Y_{34} = Y_{43} = -1$

$Y_{44} = 1 + 1 + 1 + 1 = 4$

$I_1 = -2$; $I_2 = -1$; $I_3 = 2+2 = 4$; $I_4 = 1 - 2 = -1$

$$\begin{bmatrix} 5 & -2 & 0 & -1 \\ -2 & 5 & -2 & -1 \\ 0 & -2 & 5 & -1 \\ -1 & -1 & -1 & 4 \end{bmatrix} \begin{bmatrix} V_1(t) \\ V_2(t) \\ V_3(t) \\ V_4(t) \end{bmatrix} = \begin{bmatrix} -2 \\ -1 \\ 4 \\ -1 \end{bmatrix}$$

- $\Delta p = 225$
- $\Delta_1 = -120$
- $\Delta_2 = -45$
- $\Delta_3 = 150$
- $\Delta_4 = -60$

Calculados por calculadora.

$V_1(t) = \frac{\Delta_1}{\Delta p} = \frac{-120}{225} = -0{,}533$ $\boxed{V_1(t) = -0{,}533V}$

$V_2(t) = \frac{\Delta_2}{\Delta p} = \frac{-45}{225} = -0{,}2$ $\boxed{V_2(t) = -0{,}2V}$

$V_3(t) = \frac{\Delta_3}{\Delta p} = \frac{150}{225} = 0{,}667$ $\boxed{V_3(t) = 0{,}667V}$

$V_4(t) = \frac{\Delta_4}{\Delta p} = \frac{-60}{225} = -0{,}267$ $\boxed{V_4(t) = -0{,}267}$

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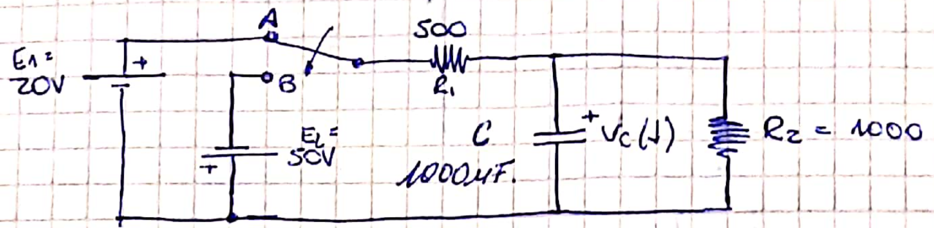
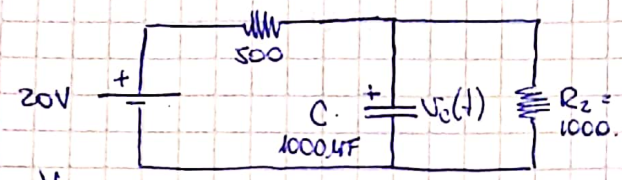
26) Determinar $v_c(t)$ cuando la llave S pasa de "A" a "B".



Suponiendo que la llave cambia en $t = 0$:

* Circuito p/ $t<0$:

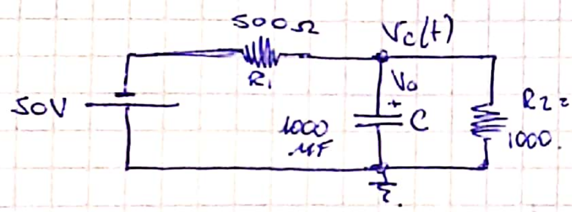


$V_{c0} = 13,333V.$

Se lo considera al circuito en régimen y la tensión del capacitor será:

$$V_c(0^-) = \frac{20}{1500} \times 1000 = 13,333.$$

* Circuito p/ $t>0$:



Aplicando nodos: $Y_c(p) \cdot V_c(p) = I_c(p).$

$$Y_c(p) = \frac{1}{500} + 1000 \times 10^{-6} p + \frac{1}{1000} = 1 \times 10^{-3}(p+3)$$

$$I_c(p) = -\frac{50}{p} \cdot \frac{1}{500} + \frac{13,333}{\cancel{p}} \cdot 1 \times 10^{-3} \cancel{p} = -\frac{0,1}{p} + 13,333 \times 10^{-3}$$

$$I_c(p) = \frac{13,333 \times 10^{-3}(p-7,5)}{p}$$

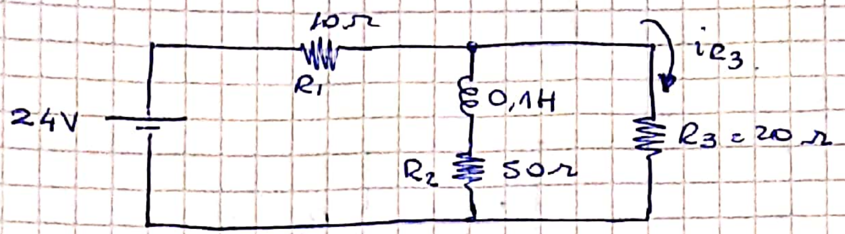
$$V_c(p) = \frac{I_c(p)}{Y_c(p)} = \frac{13,333 \times 10^{-3}}{1 \times 10^{-3}} \cdot \frac{(p-7,5)}{p(p+3)} = 13,333 \frac{(p-7,5)}{p(p+3)} = \frac{A}{p} + \frac{B}{p+3}$$

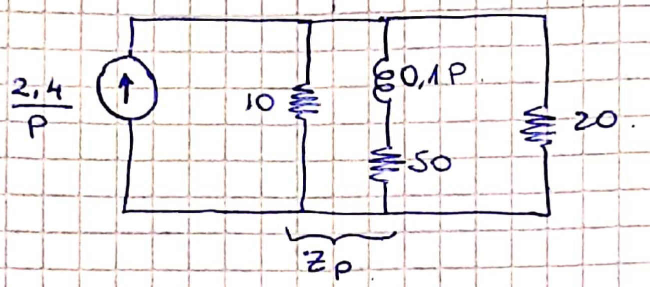
$$\bullet\ A = \lim_{p \to 0} \frac{13,333(p-7,5)}{p+3} = -33,332.$$

$$\bullet\ B = \lim_{p \to -3} \frac{13,333(p-7,5)}{p} = 46,665.$$

$$\boxed{V_c(t) = -33,332 + 46,665 \cdot e^{-3t}}$$

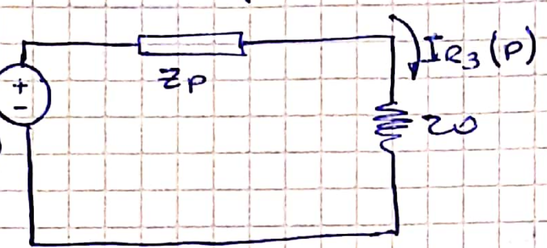
27) Aplicando Thevenin y Norton sucesivo, encontrar $i_{R_3}(t)$ que circula por R_3.





$$Z_P = \frac{10\,(0{,}1P+50)}{10+0{,}1P+50}$$

$$Z_P = \frac{P+500}{0{,}1\,(P+600)}$$



$$\frac{2{,}4}{P}\cdot\frac{P+500}{0{,}1\,(P+600)} = \frac{24\,(P+500)}{P\,(P+600)}$$

$$I_{R_3}(P) = \frac{24\,(P+500)}{P\,(P+600)}\;\frac{1}{\frac{P+500}{0{,}1\,(P+600)}+20}$$

$$\left(\frac{10\,(P+500)}{P+600}+20 = \frac{10P+5000+20P+12000}{P+600} = \frac{30\,(P+566{,}67)}{P+600}\right)$$

$$I_{R_3}(P) = \frac{24\,(P+500)}{P\,\cancel{(P+600)}}\;\frac{\cancel{(P+600)}}{30\,(P+566{,}67)} = \frac{0{,}8\,(P+500)}{P\,(P+566{,}67)} = \frac{A}{P}+\frac{B}{P+566{,}67}$$

- $A = \lim\limits_{P\to 0} \dfrac{0{,}8\,(P+500)}{P+566{,}67} = 0{,}706$

- $B = \lim\limits_{P\to -566{,}67} \dfrac{0{,}8\,(P+500)}{P} = 0{,}094$

$$\boxed{i_{R_3}(t) = 0{,}706 + 0{,}094\cdot e^{-566{,}67t}\ [A]}$$

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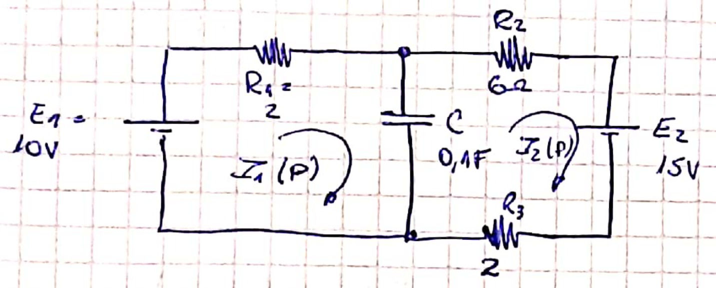
28) Aplicar método de mallas y superposición para encontrar $I_1(p)$ e $I_2(p)$, comprobar aplicando TVI y TVF.



$$Z_{11} = R_1 + \frac{1}{CP} = \frac{2(P+5)}{P}$$

$$Z_{12} = Z_{21} = -\frac{1}{CP} = -\frac{10}{P}$$

$$Z_{22} = R_2 + R_3 + \frac{1}{CP} = \frac{8(P+1,25)}{P}$$

– Pasivando E_2:

$$\left.\begin{array}{l} V_1 = 10/P \\ V_2 = 0 \end{array}\right\} \quad \begin{bmatrix} \frac{2(P+5)}{P} & -\frac{10}{P} \\ -\frac{10}{P} & \frac{8(P+1,25)}{P} \end{bmatrix} \begin{bmatrix} I_{11}(P) \\ I_{21}(P) \end{bmatrix} = \begin{bmatrix} \frac{10}{P} \\ 0 \end{bmatrix}$$

- $\Delta p = \frac{8(P+1,25)}{P} \cdot \frac{2(P+5)}{P} - \frac{100}{P^2} = \frac{16(P^2+1,25P+5P+6,25)-100}{P^2}$

$$\Delta p = \frac{16\cancel{P}(P+6,25)}{P^{\cancel{2}}} = \frac{16(P+6,25)}{P}$$

- $\Delta_{11} = \frac{80(P+1,25)}{P^2}$

- $\Delta_{21} = \frac{100}{P^2}$

* $I_{11}(P) = \frac{\Delta_{11}}{\Delta p} = \frac{80(P+1,25)}{P^2} \cdot \frac{P}{16(P+6,25)} = \frac{5(P+1,25)}{P(P+6,25)}$

* $I_{21}(P) = \frac{\Delta_{21}}{\Delta p} = \frac{100}{P^2} \cdot \frac{P}{16(P+6,25)} = \frac{6,25}{P(P+6,25)}$

– Pasivando E_1:

$$\left.\begin{array}{l} V_1 = 0 \\ V_2 = -\frac{15}{P} \end{array}\right\} \quad \begin{bmatrix} \frac{2(P+5)}{P} & -\frac{10}{P} \\ -\frac{10}{P} & \frac{8(P+1,25)}{P} \end{bmatrix} \begin{bmatrix} I_{12}(P) \\ I_{22}(P) \end{bmatrix} = \begin{bmatrix} 0 \\ -\frac{15}{P} \end{bmatrix}$$

- $\Delta_{12} = -\frac{150}{P^2}$

- $\Delta_{22} = -\frac{30(P+5)}{P^2}$

$$* \ I_{12}(p) = \frac{\Delta_{12}}{\Delta p} = \frac{-150}{p^2}\cdot\frac{\cancel{p}}{16(p+6,25)} = \frac{-9,375}{p(p+6,25)}$$

$$* \ I_{22}(p) = \frac{\Delta_{22}}{\Delta p} = \frac{-30(p+5)}{p^2}\cdot\frac{\cancel{p}}{16(p+6,25)} = \frac{-1,875(p+5)}{p(p+6,25)}$$

<u>Sumamos</u> =

- $I_1(p) = I_{11}(p) + I_{12}(p)$

$$= \frac{5(p+1,25)}{p(p+6,25)} - \frac{9,375}{p(p+6,25)} = \frac{5(p-0,625)}{p(p+6,25)}$$

$$\boxed{I_1(p) = \frac{5(p-0,625)}{p(p+6,25)}}$$

- $\lim_{p\to\infty} p\cdot I_1(p) = 5A \longrightarrow$ Valor inicial.
- $\lim_{p\to 0} p\, I_1(p) = -0,5A \longrightarrow$ Valor final.

- $I_2(p) = I_{21}(p) + I_{12}(p)$

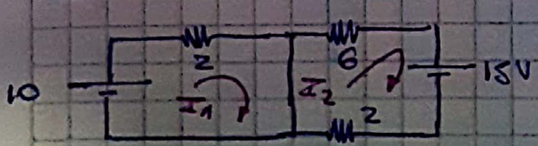
$$= \frac{6,25 - 1,875(p+5)}{p(p+6,25)} = \frac{-1,875(p+1,667)}{p(p+6,25)}$$

$$\boxed{I_2(p) = \frac{-1,875(p+1,667)}{p(p+6,25)}}$$

- $\lim_{p\to\infty} p\, I_2(p) = -1,875A \longrightarrow$ Valor inicial.
- $\lim_{p\to 0} p\, I_2(p) = -0,5A \longrightarrow$ Valor final.

<u>Comprobación</u>:

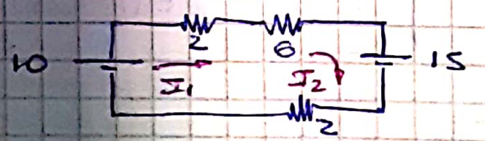
- <u>Valor inicial</u> $(t=0)$



$I_1 = 10/2 = 5A$ ✓

$I_2 = \frac{-15}{8} = -1,875A$ ✓

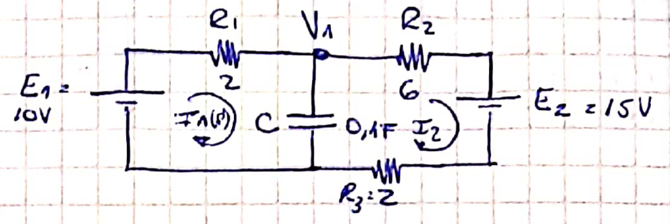
- <u>Valor final</u> $(t=\infty)$



$I_1 = I_2 = \frac{10-15}{10} = -0,5A$ ✓

29) Comprobar el resultado anterior empleando método ... :

$$Y_1(p) \cdot V_1(p) = I(p)$$



$$Y_1(p) = \frac{1}{2} + 0{,}1\,P + \frac{1}{8} = 0{,}1\,(p + 6{,}25)$$

$$I(p) = \frac{10}{p} \cdot \frac{1}{2} + \frac{15}{P} \cdot \frac{1}{8} = \frac{5}{P} + \frac{1{,}875}{P} = \frac{6{,}875}{P}$$

$$V_1(p) = \frac{6{,}875}{P} \cdot \frac{1}{0{,}1\,(p+6{,}25)} = \frac{68{,}75}{p\,(p+6{,}25)}$$

Corrientes =

$$* \ I_1(P) = \frac{E_1(p) - V_1(p)}{R_1} = \frac{10/p - \frac{68{,}75}{p(p+6{,}25)}}{2} = \frac{5}{P} - \frac{34{,}375}{P(P+6{,}25)}$$

$$I_1(P) = \frac{5P + 31{,}25 - 34{,}375}{P(P+6{,}25)} \Rightarrow \boxed{I_1(p) = \frac{5(P - 0{,}625)}{P(P+6{,}25)}}$$

$$* \ I_2(P) = \frac{V_1(p) - E_2(p)}{R_2 + R_3} = \frac{\frac{68{,}75}{P(P+6{,}25)} - \frac{15}{P}}{8} = \frac{8{,}59375}{P(P+6{,}25)} - \frac{1{,}875}{P}$$

$$I_2(P) = \frac{8{,}59375 - 1{,}875P - 11{,}71875}{P\,(P+6{,}25)}$$

$$\boxed{I_2(P) = \frac{-1{,}875\,(P + 1{,}667)}{P\,(P+6{,}25)}}$$

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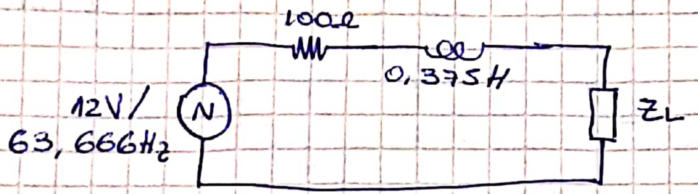
30) Aplicar teorema de máxima transferencia de potencia y calcular el valor de impedancia de carga Z_L que hace máx. la potencia transferida. Calcular el valor de P.



$Z_{th} = 100 + j\,63{,}666 \times 0{,}375 = 100 + j\,150.$

$Z_L\,(\text{MÁX. T. P}) = 100 - j150 = Z_{th}^*$

$P_{MAX} = I^2 \cdot R_L$

$I = \dfrac{12V}{200} = 0{,}06\,A.$

$P_{MAX} = (0{,}06)^2 \times 100 = 360\,mW$

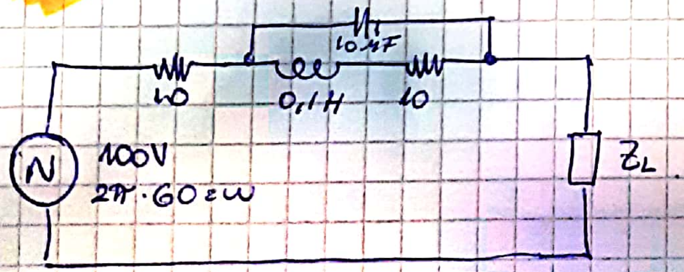
31) Calcular el valor de R_L que hace máxima la pot. transferida para el caso anterior

$R_L\,(M.T.P) = |Z_{th}| = \sqrt{100^2 + 150^2} = 180{,}2776\,\Omega.$

$I = \dfrac{12}{100 - j150 + 180{,}2776} = 0{,}03775\,\angle 28{,}15^\circ$

$P_{R_L} = R_L\,|I|^2 = 180{,}2776 \times 0{,}03775^2 = 256{,}91\,mW.$

32) Calcular el valor de Z_L para máx. transf. de Pot. y calcular P.



$Z_{th} = 10 + \dfrac{(10 + j12\pi)\cdot(-j265{,}258)}{10 + j12\pi - j265{,}258.}$

$Z_{th} = 49{,}42\,\angle 61{,}47^\circ$

$Z_{th} = 23{,}56 + j\,43{,}35.$

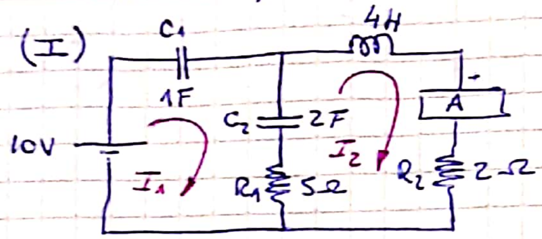
$Z_L\,(MTP) = Z_{th}^* = 23{,}56 - j\,43{,}35.$

$I = \dfrac{100}{2 \times 23{,}56} = 2{,}122\,A.$

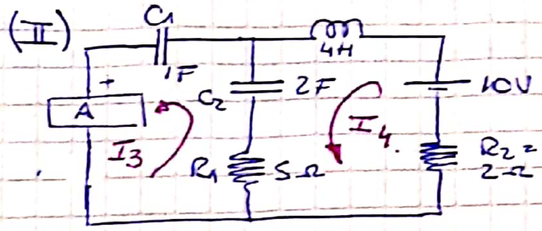
$P = I^2 R_L = (2{,}122)^2 \times 23{,}56 = 106{,}11\,W.$

33) Verificar Teorema de reciprocidad obteniendo la corriente indicada por el amperímetro A en ambos circuitos.

(I)



(II)



Misma [z] p/ los 2 circuitos:

$$\begin{cases} z_{11} = \dfrac{1}{p} + \dfrac{0,5}{p} + 5 = \dfrac{5(p+0,3)}{p} \\ z_{12} = z_{21} = -5 - \dfrac{0,5}{p} = -\dfrac{5(p+0,1)}{p} \\ z_{22} = 7 + 4p + \dfrac{0,5}{p} = \dfrac{4(p^2+1,75p+0,125)}{p} \end{cases}$$

Circuito (I)

$$\begin{bmatrix} \dfrac{5(p+0,3)}{p} & -\dfrac{5(p+0,1)}{p} \\ -\dfrac{5(p+0,1)}{p} & \dfrac{4(p^2+1,75p+0,125)}{p} \end{bmatrix} \times \begin{bmatrix} I_1(p) \\ I_2(p) \end{bmatrix} = \begin{bmatrix} 10/p \\ 0 \end{bmatrix}$$

Circuito (II)

$$[z] \cdot \begin{bmatrix} I_3(p) \\ I_4(p) \end{bmatrix} = \begin{bmatrix} 0 \\ \dfrac{10}{p} \end{bmatrix}$$

$$\Delta p = \frac{20p^3 + 41p^2 + 13p + 0,75 - 25p^2 - 5p - 0,25}{p^2} = \frac{20p^3 + 16p^2 + 8p + 0,5}{p^2}$$

$$\Delta p = 20(p^3 + 0,8p^2 + 0,4p + 0,025) \longrightarrow \text{común p/ los 2 circuitos}$$

$$\Delta_2(\text{circ I}) = \frac{5(p+0,1)}{p} \times \frac{10}{p}$$

$$\Delta_2(\text{circ I}) = \frac{50(p+0,1)}{p^2}$$

$$\Delta_1(\text{circ II}) = \frac{5(p+0,1)}{p} \times \frac{10}{p}$$

$$\Delta_{1\,II} = \frac{50(p+0,1)}{p^2}$$

$$I_2(p) = \frac{\Delta_{2I}}{\Delta p} = \frac{50(p+0,1) \cdot p^2}{20 \cdot p^2 (p^3+0,8p^2+0,4p+0,025)}$$

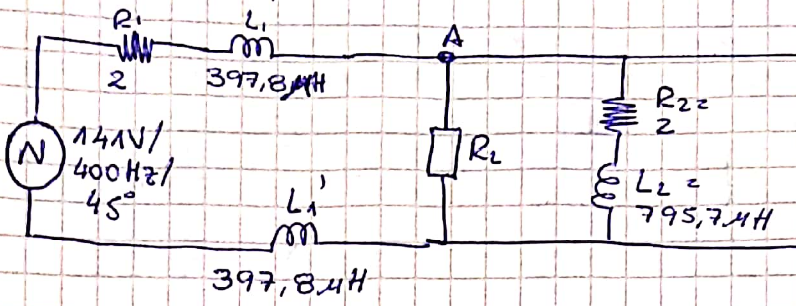
$$I_3(p) = \frac{\Delta_{1II}}{\Delta p}$$

$$\boxed{I_2(p) = \frac{2,5(p+0,1)}{p^3+0,8p^2+0,4p+0,025}}$$

$$\boxed{I_3(p) = \frac{2,5(p+0,1)}{p^3+0,8p^2+0,4p+0,025}}$$

$I_2(p) = I_3(p) \Rightarrow$ Se cumple el Teorema.

34) Aplicar Thevenin - Norton sucesivo, reemplazar ambas fuentes por una única de tensión con su Z asociada.



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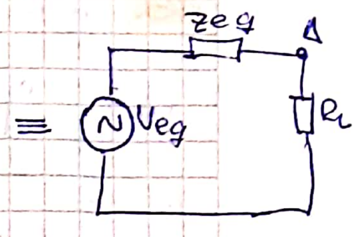
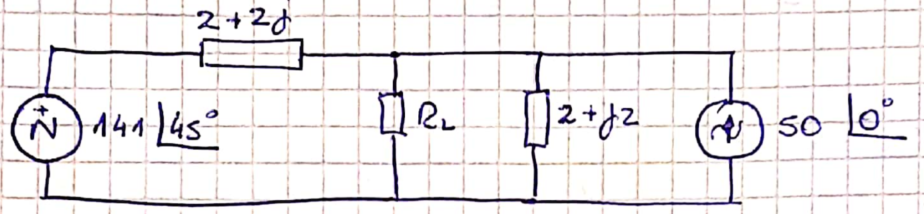
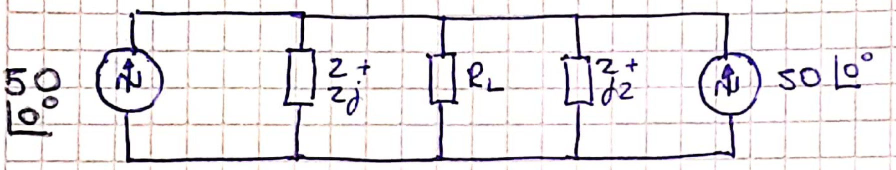
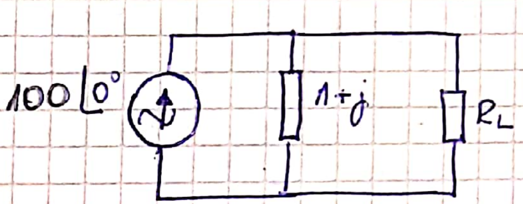


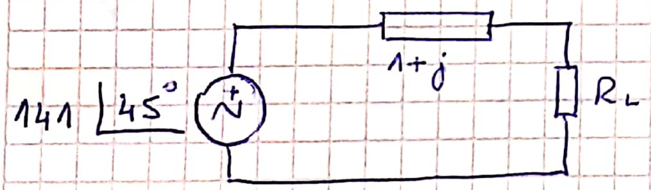
$$j\omega L_1 = j\omega L_1' = j\,2\pi \times 400 \times 397{,}8\,\mu H = j$$

$$j\omega L_2 = j\,2\pi \times 400 \times 795{,}7\,\mu H = j2$$



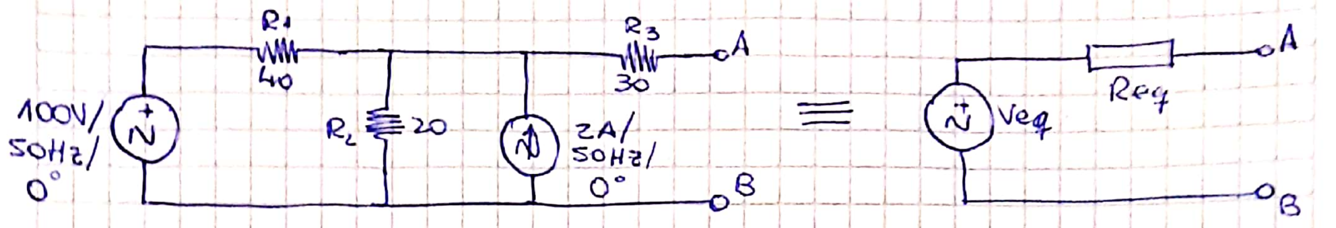


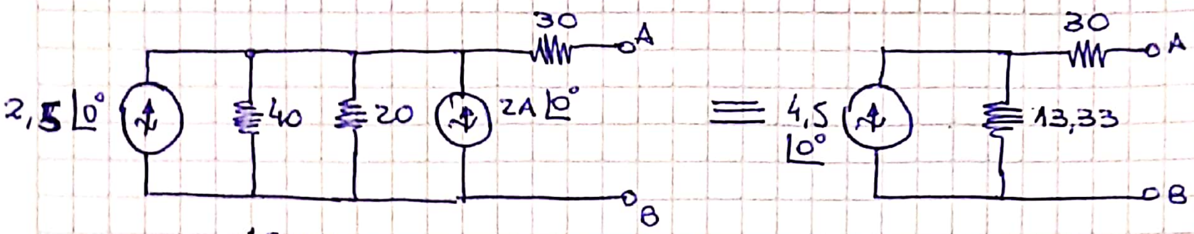


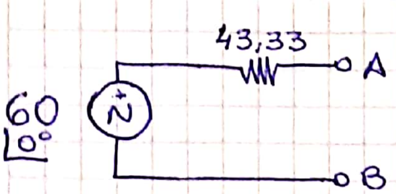


$$\boxed{\begin{aligned} V_{eq} &= 141\,V\ \angle 45^\circ \\ Z_{eq} &= 1+j \end{aligned}}$$

35) Encontrar los valores de Veq y Req para hacer eq. los circuitos

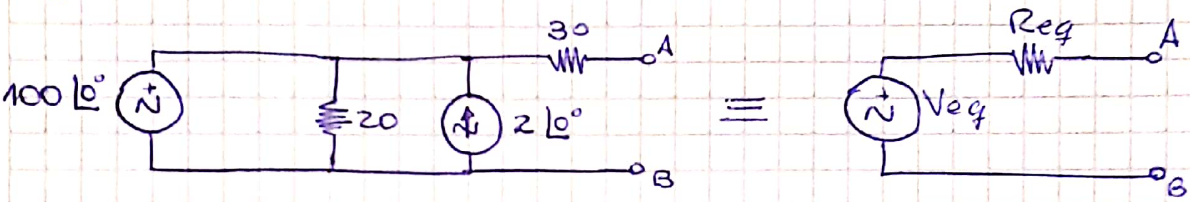






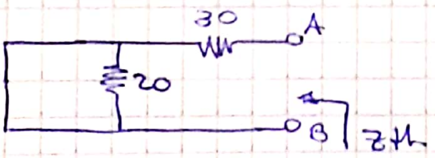
$$\boxed{\begin{array}{l} V_{eq} = 60\,V \angle 0° \\ R_{eq} = 43,33\,\Omega \end{array}}$$

36) Repetir 35 considerando $R_1 = 0$.

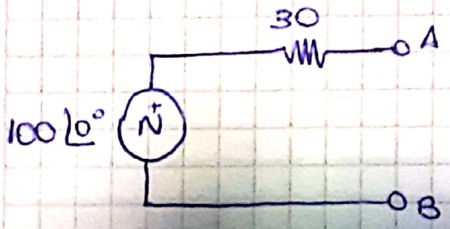


$$V_{AB}(CA) = 100 \angle 0°$$

P/ Rth, pasivamos fuentes:

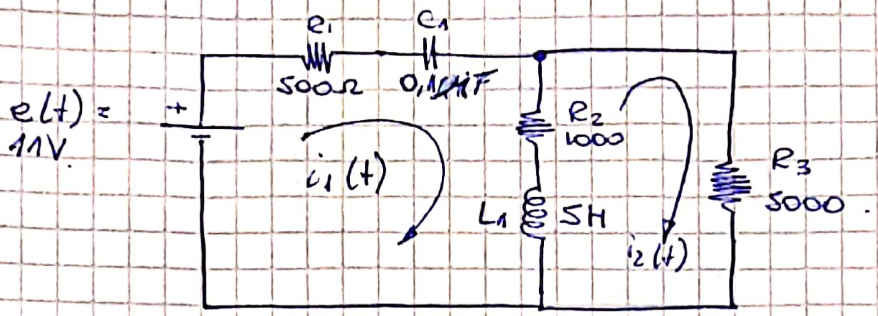


$Z_{th} = 30\,\Omega$



$$\boxed{\begin{array}{l} V_{eq} = 100\,V \angle 0° \\ R_{eq} = 30\,\Omega \end{array}}$$

37) Determinar el valor de la impedancia de excitación (Z_{exit}) y de la impedancia de transferencia ($Z_{transf.}$), en forma transformada.



$$\begin{cases} Z_i = \dfrac{\Delta Z}{\Delta_{11}} \\ Z_{tr} = \dfrac{\Delta Z}{\Delta_{12}} = \dfrac{\Delta Z}{\Delta_{21}} \\ Z_o = \dfrac{\Delta Z}{\Delta_{22}} \end{cases}$$

$$Z_{11} = 500 + \frac{10\times10^6}{P} + 1000 + 5P = \frac{5P^2 + 1500P + 10\times10^6}{P}$$

$$Z_{22} = 5P + 1000 + 5000 = 5P + 6000$$

$$Z_{12} = Z_{21} = -1000 - 5P$$

$$[Z] = \begin{bmatrix} \dfrac{5P^2+1500P+10\times10^6}{P} & -1000-5P \\ -1000-5P & 5P+6000 \end{bmatrix}$$

$$\Delta Z = \frac{(5P+6000)\cdot(5P^2+1500P+10\times10^6) - P(1000+5P)^2}{P}$$

$$\Delta Z = \frac{\cancel{25P^3} + 30000P^2 + 7500P^2 + 9\times10^6P + 5\times10^7P + 6\times10^{10} - \cancel{25P^3} - 10000P^2 - 1\times10^6P}{P}$$

$$\Delta Z = \frac{27500P^2 + 58\times10^6P + 6\times10^{10}}{P}$$

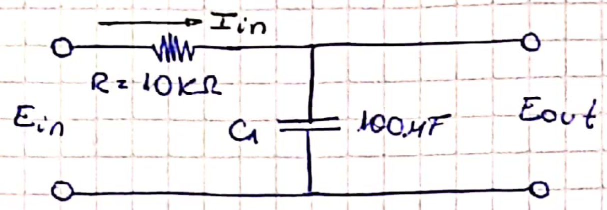
$$\Delta_{11} = 5P + 6000$$

$$\Delta_{12} = -(5P + 1000)$$

$$\boxed{Z_{exit} = \frac{\Delta Z}{\Delta_{11}} = \frac{27{,}5\times10^3P^2 + 58\times10^6P + 6\times10^{10}}{P(5P+6000)}}$$

$$\boxed{Z_{tr} = \frac{\Delta Z}{\Delta_{12}} = \frac{-(27{,}5\times10^3P^2 + 58\times10^6P + 6\times10^{10})}{P(5P+1000)}}$$

38) Encontrar la func. de transf. y trazar diagrama polar.



$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}} \cdot 1/C_1P}{\cancel{I_{in}}\left(R + \frac{1}{C_1P}\right)} = \frac{1}{C_1P\left(R + \frac{1}{C_1P}\right)} = \frac{1}{C_1RP + 1}.$$

$$F(P) = \frac{1}{100\times10^{-6} \cdot 10\times10^{3}\, P + 1} = \frac{1}{P+1}.$$

$$\boxed{F(P) = \frac{1}{P+1}.}$$

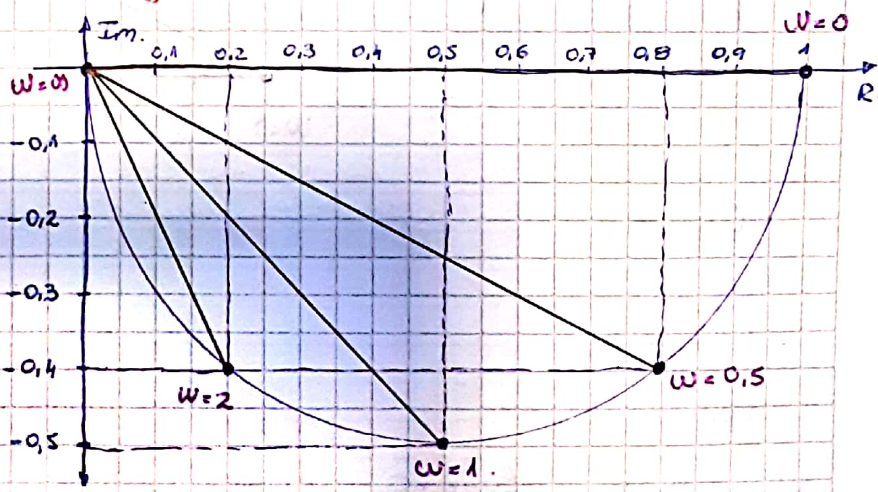
$P \rightarrow j\omega \quad \therefore \quad F(P) \rightarrow F(j\omega)$

$$F(j\omega) = \frac{1}{1+j\omega} \cdot \frac{1-j\omega}{1-j\omega} = \frac{1}{1+\omega^2} + j\,\frac{(-\omega)}{1+\omega^2}.$$

$$\boxed{F(j\omega) = \underbrace{\frac{1}{1+\omega^2}}_{Re} + j\,\underbrace{\frac{(-\omega)}{1+\omega^2}}_{Imag.}}$$

ω	Re	Im	|M|	φ
0	1	0	1	0°
0,5	0,8	-0,4	0,8944	-26,56°
1	0,5	-0,5	0,707	-45°
2	0,2	-0,4	0,4472	-63,43°
∞	0	0	0	-90°

Diagrama Polar:

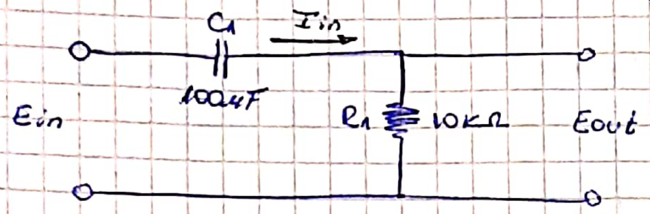


Circuito:

• Pasivo porque $\frac{E_{out}}{E_{in}} \leq 1.$

• Atrasador (ángulos negativos).

39) Encontrar función de transf. y trazar diag. polar.



$$F(P) = \frac{E_{out}}{E_{in}} = \frac{I_{in} \cdot R_1}{I_{in}\left(R_1 + \frac{1}{C_1 P}\right)}$$

$$F(P) = \frac{R_1 C_1 P}{1 + R_1 \cdot C_1 P}$$

$$\boxed{F(P) = \frac{P}{P+1}}$$

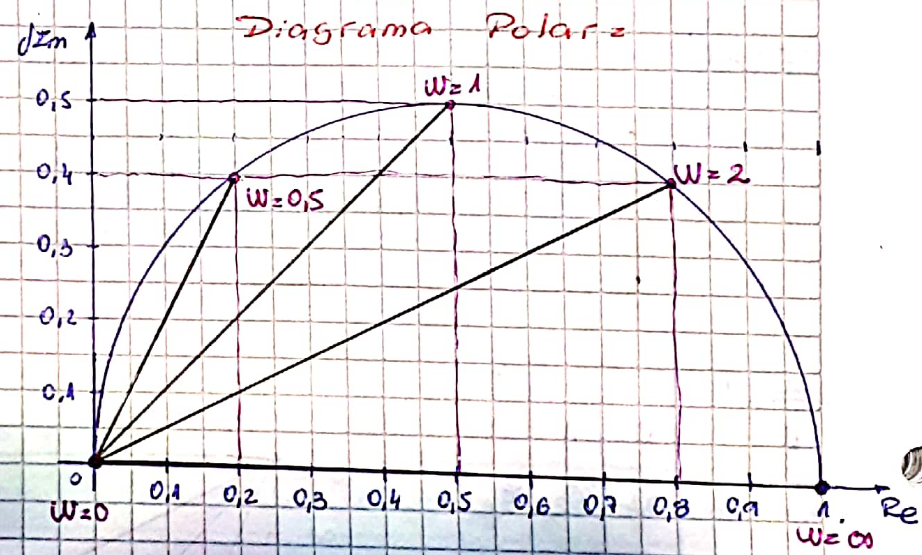
$P \to j\omega \therefore F(P) \to F(j\omega)$.

$$F(j\omega) = \frac{j\omega}{1+j\omega} \cdot \frac{1-j\omega}{1-j\omega} = \frac{\omega^2}{1+\omega^2} + j\frac{\omega}{1+\omega^2}.$$

$$\boxed{F(j\omega) = \frac{\omega^2}{1+\omega^2} + j\frac{\omega}{1+\omega^2}}$$

ω	Re	Im	|M|	φ
0	0	0	0	90°
0,5	0,2	0,4	0,4472	63,43°
1	0,5	0,5	0,7071	45°
2	0,8	0,4	0,8944	26,56°
∞	1	0	1	0

Diagrama Polar:



Circuito:

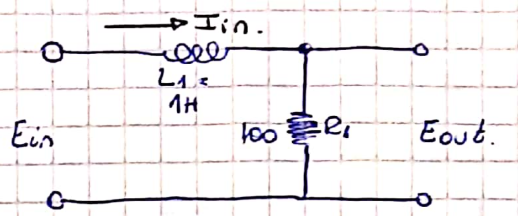
- Pasivo
- Adelantador.

Comprobación:

- E_{out} $\begin{cases} \omega = 0: & E_{out} = 0 \to \frac{E_{out}}{E_{in}} = 0 \\ \omega = \infty: & E_{out} = E_{in} \to \frac{E_{out}}{E_{in}} = 1 \end{cases}$

- $F(P)$ | $P = 0 \to F(P) = 0$
  | $P = \infty = F(P) = 1$.

40) Encontrar la función de transferencia y trazar diag. polar.



$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}} \cdot R_1}{\cancel{I_{in}}(R_1 + L_1 \cdot P)}$$

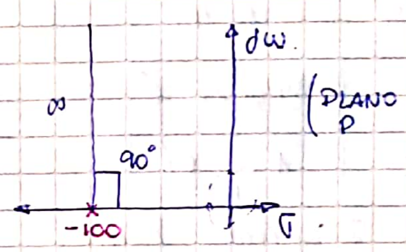
$$\boxed{F(P) = \frac{100}{P + 100}}$$

$P \to j\omega \quad \therefore \quad F(P) \to F(j\omega)$.

$$F(j\omega) = \frac{100}{100 + j\omega} \cdot \frac{100 - j\omega}{100 - j\omega} = \underbrace{\frac{1\times10^4}{1\times10^4 + \omega^2}}_{Re} + j\underbrace{\frac{(-100\,\omega)}{1\times10^4 + \omega^2}}_{Imag.}$$

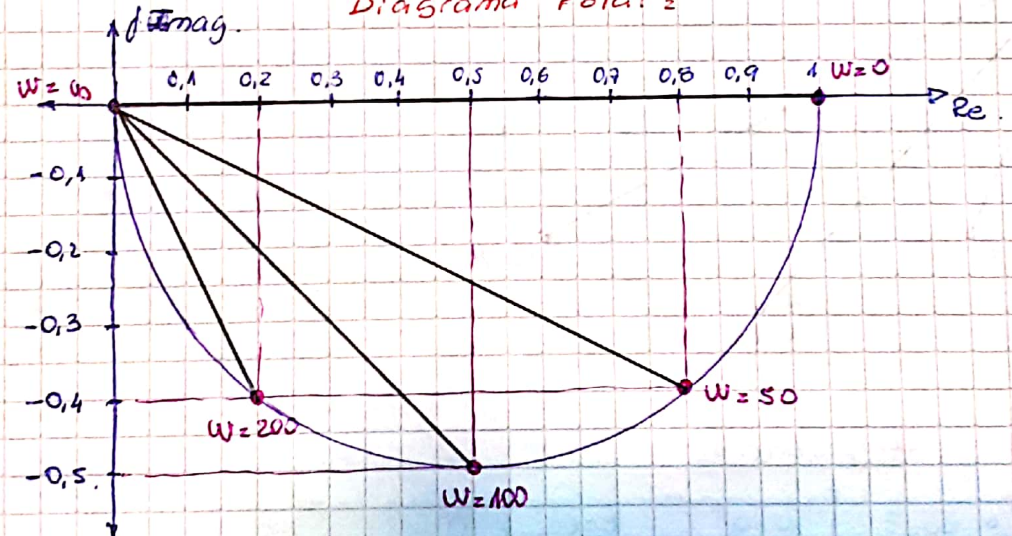
ω	Re	Im	M	φ
0	1	0	0	0°
50	0,8	-0,4	0,8944	-26,56°
100	0,5	-0,5	0,7071	-45°
200	0,2	-0,4	0,4472	-63,43°
∞	0	0	0	-90°.

Análisis $\varphi|_{\omega=\infty}$



$\varphi|_{\omega=\infty} = 0 - 90° = -90°$.

Diagrama Polar:



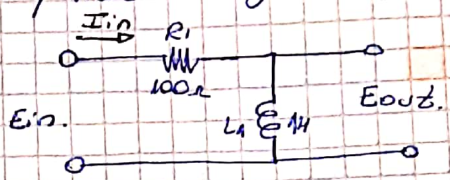
Circuito

- Pasivo
- Atrasador
- Filtro Pasa bajo.

Comprobación

- $\dfrac{E_{out}}{E_{in}}$ | $W = 0$: $\dfrac{E_{out}}{E_{in}} = 1$. ; $W = \infty$: $\dfrac{E_{out}}{E_{in}} = 0$.
- $F(P)$ | $P = 0$: $F(P) = 1$; $P = \infty$: $F(P) = 0$

41) Encontrar función de transferencia y trazar diagrama polar.



$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}}(\cdot L_1 \cdot P)}{\cancel{I_{in}}(R_1 + L_1 P)}$$

$$\boxed{F(P) = \frac{P}{P+100}}$$

$$P \to j\omega \quad \therefore \quad F(P) \to F(j\omega)$$

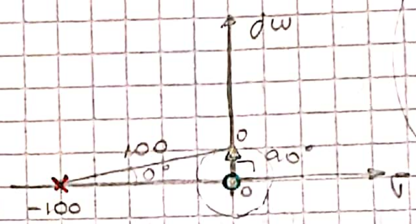
$$F(j\omega) = \frac{j\omega}{100+j\omega} \cdot \frac{100-j\omega}{100-j\omega} = \frac{\omega^2}{\omega^2 + 1\times10^4} + j\,\frac{100\,\omega}{\omega^2 + 1\times10^4}$$

ω	Re	Im	|M|	φ
0	0	0	0	90°
50	0,2	0,4	0,4472	63,43°
100	0,5	0,5	0,7071	45°
200	0,8	0,4	0,8944	26,56°
∞	1	0	1	0°

Análisis p/ ω=0.

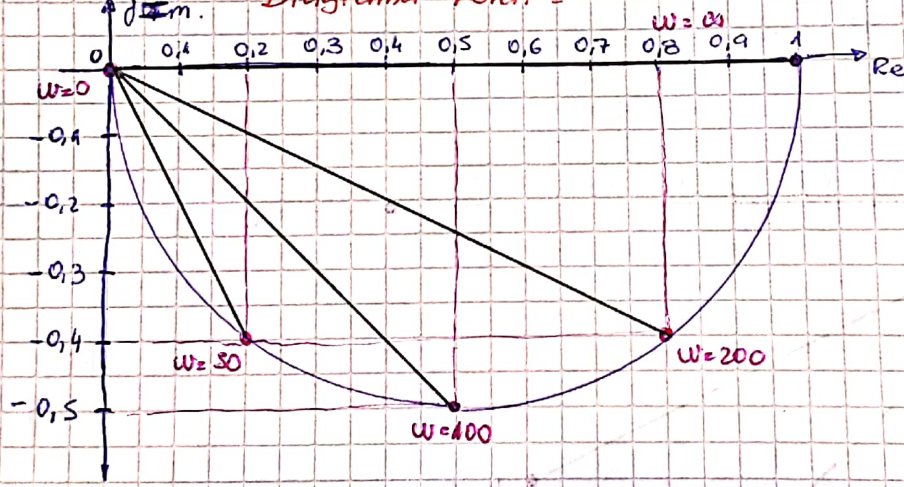
$$\varphi = tg^{-1}\left(\frac{100}{\omega}\right)$$

$$\varphi\Big|_{\omega=0} = tg^{-1}(\infty) = 90°$$



$$\varphi\Big|_{\omega=0} = 90° - 0° = 90°.$$

Diagrama Polar:



* Circuito
  - Pasivo
  - Atrasador
  - Filtro pasa alto

* Comprobación

• $\frac{E_{out}}{E_{in}}$ | $\omega = 0$: $\frac{E_{out}}{E_{in}} = 0$
  $\omega = \infty$: $\frac{E_{out}}{E_{in}} = 1$.

• $F(P)$ | $P = 0$: $F(P) = 0$
  $P = \infty$: $F(P) = 1$.

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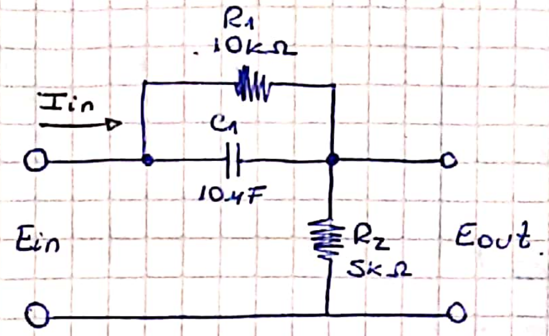
42) Encontar la función de transferencia y trazar diag. polar.



$$E_{out} = I_{in} \cdot R_2$$

$$E_{in} = I_{in}\left[\frac{R_1 \cdot \frac{1}{C_1 P}}{R_1 + \frac{1}{C_1 P}} + R_2\right]$$

$$E_{in} = I_{in}\left[\frac{R_1}{R_1 C_1 P + 1} + R_2\right]$$

$$E_{in} = I_{in}\left[\frac{R_1 + R_2 + R_1 R_2 C_1 P}{R_1 C_1 P + 1}\right]$$

$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}} \cdot R_2}{\cancel{I_{in}}\left[\frac{R_1 + R_2 + R_1 R_2 C_1 P}{R_1 C_1 P + 1}\right]} = \frac{R_2 R_1 C_1 P + R_2}{R_2 R_1 C_1 P + R_1 + R_2}$$

$$F(P) = \frac{500 P + 5\times10^3}{500 P + 15\times10^3} = \frac{500}{500}\frac{(P+10)}{(P+30)}$$

$$\boxed{F(P) = \frac{P+10}{P+30}}$$

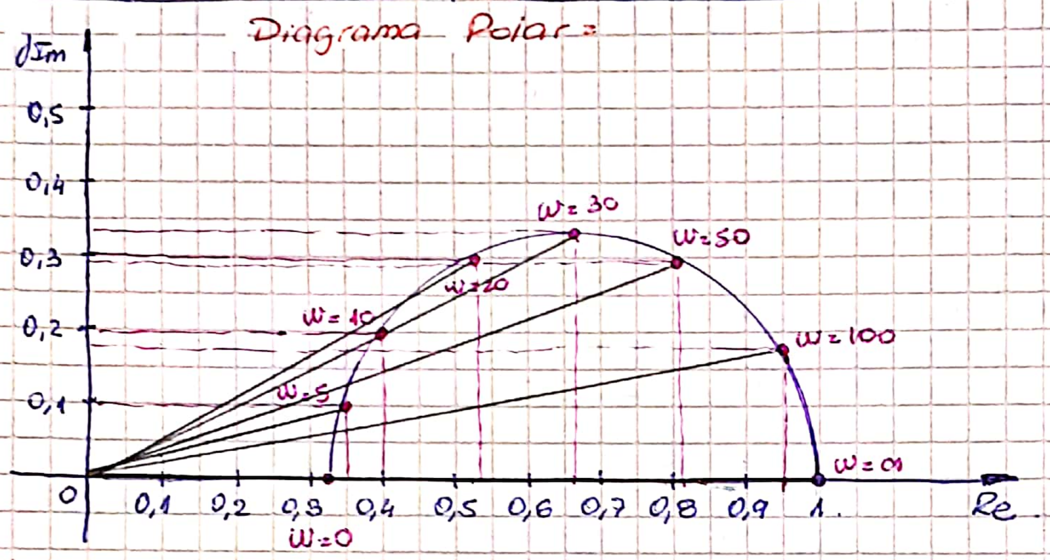
$$P \to j\omega \quad \therefore \quad F(P) \to F(j\omega)$$

$$F(j\omega) = \frac{10 + j\omega}{30 + j\omega} \cdot \frac{30 - j\omega}{30 - j\omega} = \frac{300 + \omega^2}{900 + \omega^2} + j\,\frac{30\omega - 10\omega}{900 + \omega^2}$$

$$\boxed{F(j\omega) = \underbrace{\frac{300 + \omega^2}{900 + \omega^2}}_{Re} + j\,\underbrace{\frac{20\omega}{900 + \omega^2}}_{Imag}}$$

ω	Re	Im	|M|	φ	ω	Re	Im	|M|	φ
0	0,3333	0	0,333	0°	30	0,667	0,3333	0,7453	26,56°
5	0,3513	0,1081	0,367	17,10°	50	0,8235	0,2941	0,8744	19,65°
10	0,4	0,2	0,447	26,56°	100	0,9449	0,1834	0,9625	10,98°
20	0,5384	0,3076	0,62	29,74°	∞	1	0	1	0°

Diagrama Polar:

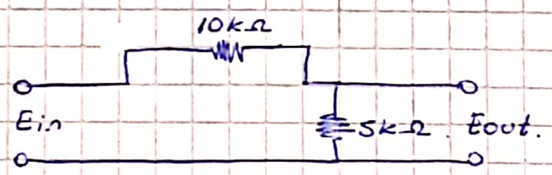


Circuito

- Pasivo
- Adelantador

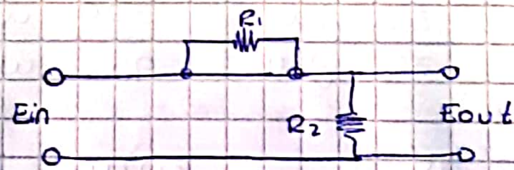
Comprobación

- $\frac{E_{out}}{E_{in}}$ | W=0 :



$\frac{E_{out}}{E_{in}} = \frac{5k\Omega}{15k\Omega} = 0,3333$

W = ∞



$\frac{E_{out}}{E_{in}} = 1.$

- $F(P) = \frac{P+10}{P+30}$ | $P = 0$: $F(P) = 0,3333$

$P = \infty$: $F(P) = 1.$

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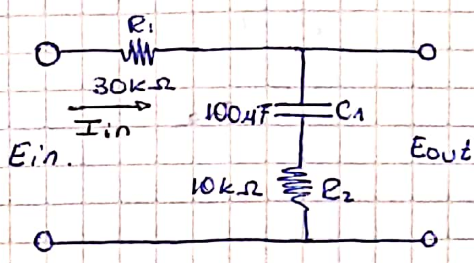
43) Encontrar la función de transferencia y trazar diag. polar.

$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}}\left(R_2 + \frac{1}{C_1 P}\right)}{\cancel{I_{in}}\left(R_1 + R_2 + \frac{1}{C_1 P}\right)}$$



$$F(P) = \frac{\frac{1}{C_1 P}}{\frac{\cancel{1}}{\cancel{C_1 P}}} \frac{(R_2 C_1 P + 1)}{(R_1 C_1 P + R_2 C_1 P + 1)} = \frac{P+1}{3P + P + 1} = \frac{P+1}{4P+1}$$

$$\boxed{F(P) = \frac{0{,}25\,(P+1)}{P + 0{,}25}}$$

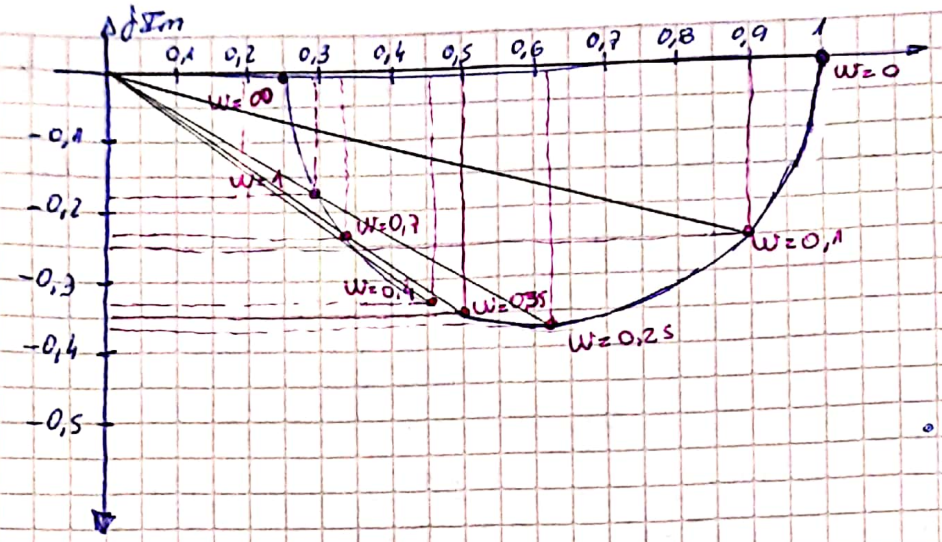
$$P \rightarrow j\omega \quad \therefore \quad F(P) \rightarrow F(j\omega)$$

$$F(j\omega) = \frac{0{,}25\,j\omega + 0{,}25}{0{,}25 + j\omega} \cdot \frac{0{,}25 - j\omega}{0{,}25 - j\omega} = \frac{0{,}0625 + 0{,}25\omega^2 + 0{,}0625 j\omega - j0{,}25\omega}{0{,}0625 + \omega^2}$$

$$\boxed{F(j\omega) = \underbrace{\frac{0{,}0625 + 0{,}25\omega^2}{0{,}0625 + \omega^2}}_{Re} + j\,\underbrace{\frac{(-0{,}1875\,\omega)}{0{,}0625 + \omega^2}}_{Im}}$$

ω	Re	Im	|M|	φ
0	1	0	1	0°
0,1	0,8965	-0,2586	0,933	-16,09°
0,25	0,625	-0,375	0,7289	-30,96°
0,35	0,5034	-0,3547	0,6158	-35,17
0,4	0,4607	-0,3371	0,5709	-36,19°
0,7	0,3348	-0,2375	0,4105	-35,35°
1	0,2941	-0,1765	0,261	-42,55°
∞	0,25	0	0,25	0°

Diagrama Polar:

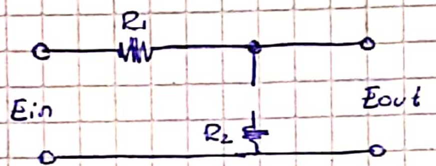


- Circuito
  - Atrasador.
  - Pasivo.

- Comprobación.

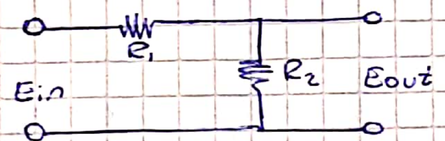
- $\frac{E_{out}}{E_{in}}$:

$W=0$



$\frac{E_{out}}{E_{in}} = 1.$

$W=\infty$



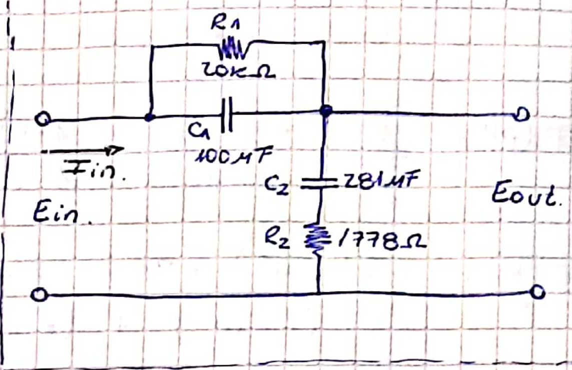
$\frac{E_{out}}{E_{in}} = \frac{R_2}{R_2+R_1} = \frac{10k}{40k} = 0,25.$

- $F(P) = \frac{0,25(P+1)}{P+0,25}$

$P=0$: $F(P) = 1$

$P=\infty$: $F(P) = 0,25.$

44) Encontrar $F(P)$ y trazar diagrama polar.



$$E_{out} = I_{in}\left(R_2 + \frac{1}{C_2 P}\right) = I_{in}\left(\frac{R_2 C_2 P + 1}{C_2 P}\right)$$

$$E_{in} = I_{in}\left(\frac{R_1 \cdot \frac{1}{C_1 P}}{R_1 + \frac{1}{C_1 P}} + R_2 + \frac{1}{C_2 P}\right)$$

$$E_{in} = I_{in}\left(\frac{R_1}{C_1 R_1 P + 1} + R_2 + \frac{1}{C_2 P}\right)$$

$$E_{in} = I_{in}\left(\frac{R_1 + R_1 R_2 C_1 P + \frac{R_1 C_1 P}{C_2 P} + R_2 + \frac{1}{C_2 P}}{C_1 R_1 P + 1}\right)$$

$$E_{in} = I_{in}\left(\frac{R_1 C_2 P + R_1 R_2 C_1 C_2 P^2 + R_1 C_1 P + R_2 C_2 P + 1}{(C_2 P)(C_1 R_1 P + 1)}\right)$$

$$F(P) = \frac{E_{out}}{E_{in}} = \frac{\cancel{I_{in}}\left(\frac{R_2 C_2 P + 1}{\cancel{C_2 P}}\right)}{\cancel{I_{in}}\left(\frac{R_1 R_2 C_1 C_2 P^2 + R_1 C_2 P + R_1 C_1 P + R_2 C_2 P + 1}{\cancel{(C_2 P)}(R_1 C_1 P + 1)}\right)}$$

$$F(P) = \frac{(R_2 C_2 P + 1)(R_1 C_1 P + 1)}{R_1 R_2 C_1 C_2 P^2 + R_1 C_2 P + R_1 C_1 P + R_2 C_2 P + 1}$$

$$F(P) = \frac{(0{,}5P + 1)(2P + 1)}{P^2 + 5{,}62P + 2P + 0{,}5P + 1} = \frac{(0{,}5P + 1)(2P + 1)}{P^2 + 8{,}12P + 1}$$

$$F(P) = \frac{0{,}5(P + 2) \cdot 2(P + 0{,}5)}{(P + 0{,}125) \cdot (P + 8)}$$

$$\boxed{F(P) = \frac{(P + 2)(P + 0{,}5)}{(P + 0{,}125)(P + 8)}}$$

$p \to j\omega \;\therefore\; F(p) \to F(j\omega)$.

$$F(j\omega) = \frac{(2+j\omega)(0{,}5+j\omega)}{(8+j\omega)(0{,}125+j\omega)} = \frac{1-\omega^2+j0{,}5\omega+j2\omega}{1-\omega^2+j8\omega+j0{,}125\omega} = \frac{1-\omega^2+j2{,}5\omega}{1-\omega^2+j8{,}125\omega}$$

$$F(j\omega) = \frac{(1-\omega^2)+j2{,}5\omega}{(1-\omega^2)+j8{,}125\omega} \cdot \frac{(1-\omega^2)-j8{,}125\omega}{(1-\omega^2)-j8{,}125\omega}$$

$$F(j\omega) = \frac{(1-\omega^2)^2+20{,}3125\omega^2+j2{,}5\omega(1-\omega^2)-j8{,}125\omega(1-\omega^2)}{(1-\omega^2)^2+(8{,}125\omega)^2}$$

$$F(j\omega) = \frac{1-2\omega^2+\omega^4+20{,}3125\omega^2+j(2{,}5\omega-2{,}5\omega^3-8{,}125\omega+8{,}125\omega^3)}{1-2\omega^2+\omega^4+66{,}015625\omega^2}$$

$$F(j\omega) = \frac{1+18{,}3125\omega^2+\omega^4+j(5{,}625\omega^3-5{,}625\omega)}{1+64{,}015625\omega^2+\omega^4}$$

$$F(j\omega) = \frac{1+18{,}3125\omega^2+\omega^4}{1+64{,}015625\omega^2+\omega^4} + j\,\frac{5{,}625\omega^3-5{,}625\omega}{1+64{,}015625\omega^2+\omega^4}.$$

ω	Re	Im	$\lvert M\rvert$	φ
0	1	0	1	0°
0,05	0,9015	-0,241	0,9331	-14,97°
0,15	0,5787	-0,337	0,6697	-30,21°
0,35	0,3678	-0,195	0,4163	-27,93°
1	0,3076	0	0,3076	0°
5	0,4868	0,3031	0,5734	31,91°
10	0,7213	0,3395	0,7972	25,20°
20	0,9015	0,2418	0,9333	15,01°
∞	1	0	1	0°

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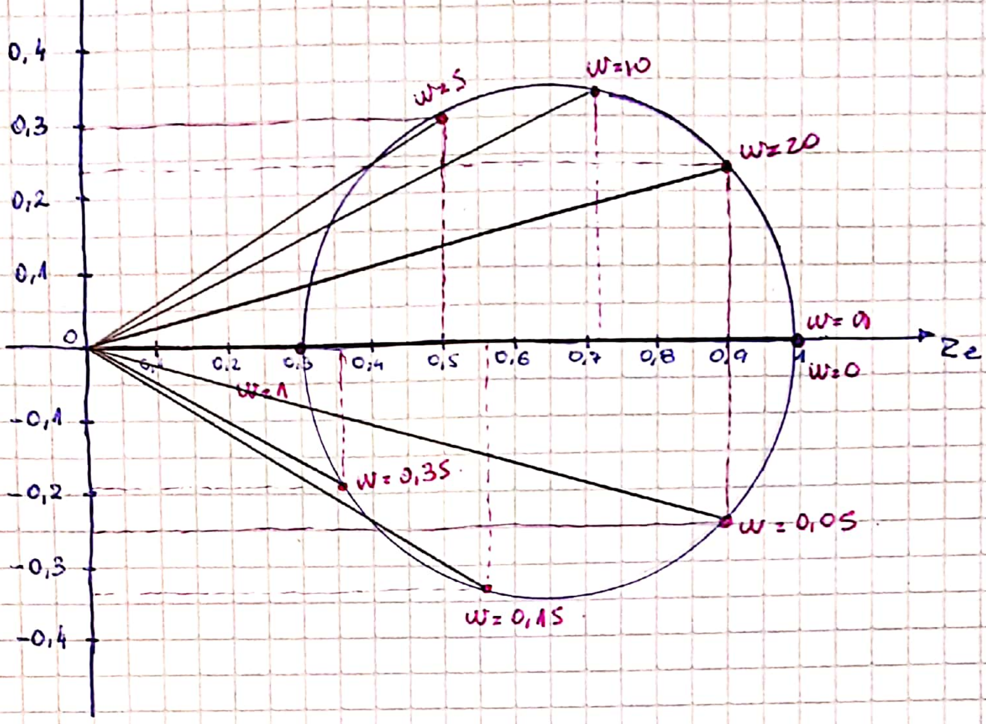
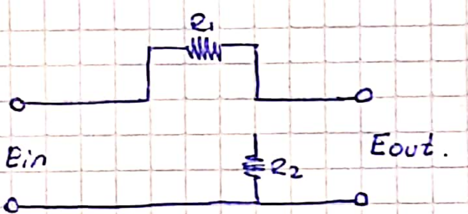
Diagrama Polar.



Comprobación.

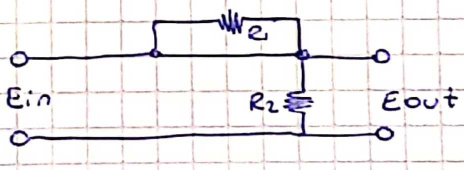
- $\frac{E_{out}}{E_{in}}$

$w = 0$



$\frac{E_{out}}{E_{in}} = 1.$

$w = \infty$



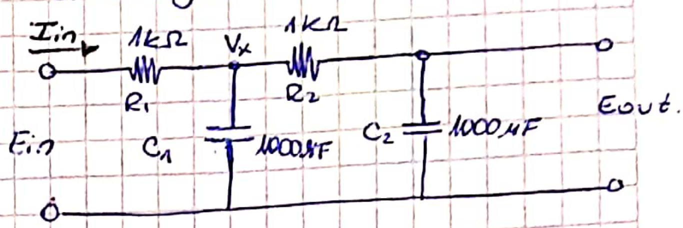
$\frac{E_{out}}{E_{in}} = 1.$

- $F(p) = \frac{(p+2)(p+0,5)}{(p+8)(p+0,125)}$

$p = 0$: $F(p) = 1.$

$p = \infty$: $F(p) = 1.$

45) Encontrar F(P) y trazar el diagrama polar.



$$E_{in} = I_{in}\left(R_1 + \frac{\frac{1}{C_1P}\left(R_2+\frac{1}{C_2P}\right)}{\frac{1}{C_1P}+R_2+\frac{1}{C_2P}}\right) = I_{in}\left(\frac{\frac{R_1}{C_1P}+R_1R_2+\frac{R_1}{C_2P}+\frac{R_2}{C_1P}+\frac{1}{C_1C_2P^2}}{R_2+\frac{1}{C_1P}+\frac{1}{C_2P}}\right)$$

$$E_{in} = I_{in}\left[\frac{R_1 \cdot C_2P + R_1 \cdot R_2 \cdot C_1 \cdot C_2 \cdot P^2 + R_1C_1 \cdot P + R_2C_2P + 1}{(C_1C_2P^2)\left(R_2+\frac{1}{C_1P}+\frac{1}{C_2P}\right)}\right]$$

$$E_{in} = I_{in}\left[\frac{R_1R_2C_1C_2 \cdot P^2 + R_1C_1P + R_1C_2P + R_2C_2P + 1}{P(R_2C_1C_2P + C_2 + C_1)}\right]$$

$$E_{out} = \underbrace{\underbrace{\underbrace{I_{in} \cdot \left[\frac{\frac{1}{C_1P}\cancel{\left(R_2+\frac{1}{C_2P}\right)}}{\left(\frac{1}{C_1P}+R_2+\frac{1}{C_2P}\right)}\right.}_{V_x} \cdot \frac{1}{\cancel{\left(R_2+\frac{1}{C_2P}\right)}}}_{I_{out}} \cdot \left.\frac{1}{C_2P}\right]}_{E_{out}}$$

$$E_{out} = I_{in}\left[\frac{1}{C_1C_2P^2\left(R_2+\frac{1}{C_1P}+\frac{1}{C_2P}\right)}\right]$$

$$E_{out} = I_{in}\left[\frac{1}{P(R_2C_1C_2P + C_2 + C_1)}\right]$$

$$F(P) = \frac{E_{out}}{E_{in}} = \frac{1}{R_1R_2C_1C_2P^2 + R_1C_1P + R_1C_2P + R_1C_2P + R_2C_2P + 1}$$

$$\boxed{F(P) = \frac{1}{P^2+3P+1}}$$

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$P \to jw \quad \therefore \quad F(p) \to F(jw)$

$$F(jw) = \frac{1}{-w^2+3jw+1} = \frac{1}{(1-w^2)+j3w} \cdot \frac{(1-w^2)-j3w}{(1-w^2)-j3w}$$

$$F(jw) = \frac{(1-w^2)}{(1-w^2)^2+9w^2} + \frac{j(-3w)}{(1-w^2)^2+9w^2}$$

$$F(jw) = \underbrace{\frac{1-w^2}{w^4+7w^2+1}}_{Re} + j\underbrace{\frac{(-3w)}{w^4+7w^2+1}}_{Imag.}$$

w	Re	Im	|M|	φ
0	1	0	1	0°
0,1	0,9251	-0,28	0,9665	-16,84°
0,3	0,5555	-0,549	0,781	-44,66°
0,5	0,2666	-0,533	0,5959	-63,43°
1	0	-0,333	0,333	-90°
2	-0,066	-0,133	0,1485	-116,39°
∞	0	0	0	-180°

Cruce en ejes:

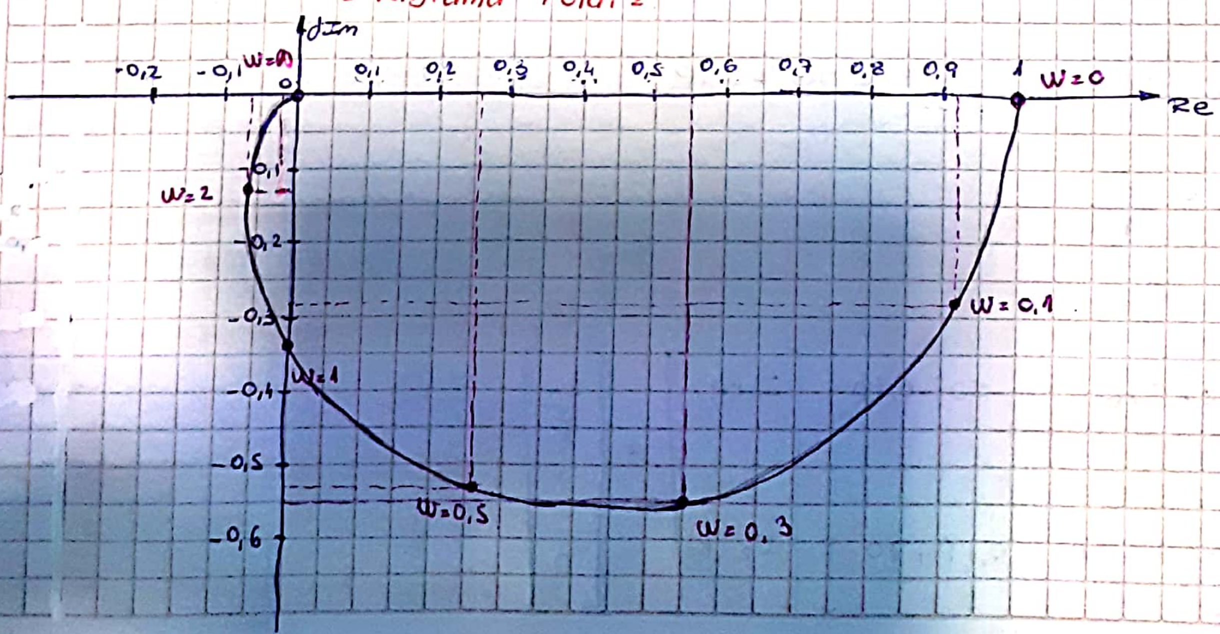
* $Re = 0$

$1-w^2 = 0 \Rightarrow \boxed{w=1}$

↳ Cruza eje Im en $w=1$.

* $Im\big|_{w=0} = -0,333$

Diagrama Polar:



Circuito:

- Pasivo
- Atrasador.

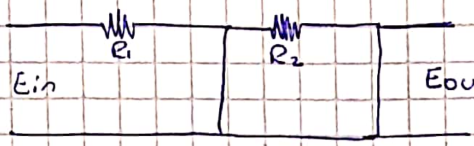
Comprobación

• $\dfrac{E_{out}}{E_{in}}$

$\omega = 0$

$\dfrac{E_{out}}{E_{in}} = 1.$

$\omega = \infty$



$\dfrac{E_{out}}{E_{in}} = 0.$

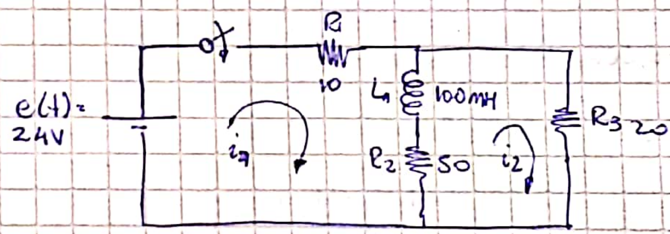
• $F(p) = \dfrac{1}{p^2+3p+1}$

$p = 0 : F(p) = 1$

$p = \infty : F(p) = 0.$

---

11) Mediante método de mallas determinar $i_1(t)$ e $i_2(t)$.



$Z_{11} = 10 + 50 + 0{,}1P = 60 + 0{,}1P.$

$Z_{12} = -50 - 0{,}1P$

$Z_{22} = 50 + 20 + 0{,}1P = 70 + 0{,}1P.$

$V_1 = \dfrac{24}{P}$

$V_2 = 0.$

$$\begin{bmatrix} 0{,}1P+60 & -50-0{,}1P \\ -50-0{,}1P & 0{,}1P+70 \end{bmatrix} \begin{bmatrix} I_1(p) \\ I_2(p) \end{bmatrix} = \begin{bmatrix} \dfrac{24}{p} \\ 0 \end{bmatrix}$$

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$$\Delta_p = (0{,}1p+70)(0{,}1p+60) - (50+0{,}1p)^2$$

$$\Delta_p = \cancel{0{,}01p^2} + 6p + 7p + 4200 - 2500 - 10p - \cancel{0{,}01p^2}.$$

$$\Delta_p = 3p + 1700 = 3(p + 566{,}67).$$

$$\Delta_1 = (0{,}1p+70)\cdot\frac{24}{p} = \frac{2{,}4}{p}(p+700).$$

$$\Delta_2 = (0{,}1p+50)\cdot\frac{24}{p} = \frac{2{,}4}{p}(p+500).$$

$$I_1(p) = \frac{\Delta_1}{\Delta_p} = \frac{2{,}4(p+700)}{3p(p+566{,}67)} = \frac{0{,}8(p+700)}{p(p+566{,}67)} = \frac{A}{p} + \frac{B}{p+566{,}67}$$

$$I_2(p) = \frac{\Delta_2}{\Delta_p} = \frac{0{,}8(p+500)}{p(p+566{,}67)} = \frac{C}{p} + \frac{D}{p+566{,}67}.$$

- $A = \lim\limits_{p\to 0} \dfrac{0{,}8(p+700)}{p+566{,}67} = 0{,}988.$

- $B = \lim\limits_{p\to -566{,}67} \dfrac{0{,}8(p+700)}{p} = -0{,}188$

- $C = \lim\limits_{p\to 0} \dfrac{0{,}8(p+500)}{p+566{,}67} = 0{,}705.$

- $D = \lim\limits_{p\to -566{,}67} \dfrac{0{,}8(p+500)}{p} = 0{,}095.$

$$I_1(p) = \frac{0{,}988}{p} - \frac{0{,}188}{p+566{,}667}$$

$$\boxed{i_1(t) = 0{,}988 - 0{,}188\cdot e^{-566{,}667\,t} \quad [A]}$$

$$I_2(p) = \frac{0{,}705}{p} + \frac{0{,}095}{p+566{,}667}$$

$$\boxed{i_2(t) = 0{,}705 + 0{,}095\cdot e^{-566{,}667\,t} \quad [A]}$$