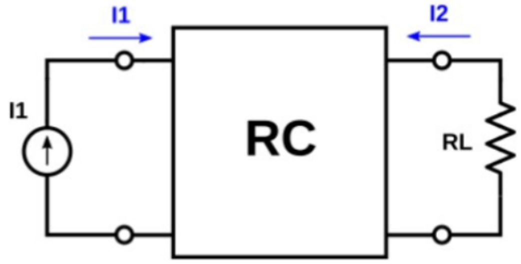
1) Ejercicio 5 TP 7

Sintetice la siguiente transferencia cargada con componentes RC:



$$\frac{-I2}{I1} = H.\frac{s^2+5s+4}{s^2+8s+12}$$

$$Z_{21} = 6H$$

↳ medido en vacío sin carga.

a) Obtener la topología mediante la **síntesis gráfica**, es decir la red sin valores.
b) Calcular el valor de los componentes, es decir la **síntesis analítica.**
c) Verificar la red hallada en **b)** y averiguar el valor de H**.**

Tenemos condicion de carga

$$V_2 = -I_2 . R_L$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

$$\left.\frac{-I_2}{I_1}\right|_{V_2=-I_2.R_L} = H\,\frac{s^2+5s+4}{s^2+8s+12}$$

$$V_2 = I_1 . Z_{21} + I_2 . Z_{22}$$

$$-I_2 . R_L - I_2 . Z_{22} = I_1 Z_{21}$$

$$-I_2 . (R_L + Z_{22}) = I_1 Z_{21}$$

$$-\frac{I_2}{I_1}(R_L + Z_{22}) = Z_{21}$$

$$Z_{22} = \frac{Z_{21}}{T(s)} - R_L$$ → aplicamos norma de impedancia $\rho = R_L$

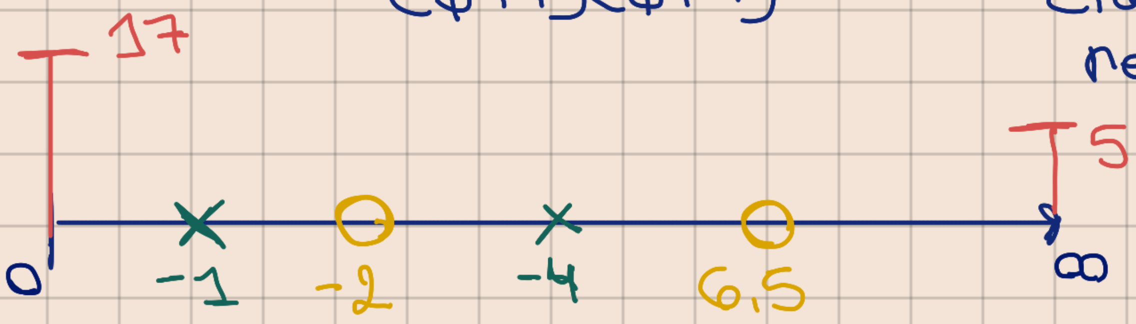
$$\boxed{Z_{22} = \frac{Z_{21}}{T(s)} - 1}$$

$$Z_{22} = \frac{6\cancel{H}}{\cancel{H}\,\frac{s^2+5s+4}{s^2+8s+12}} - 1$$

$$Z_{22} = \frac{6(s^2+8s+12)-(s^2+5s+4)}{s^2+5s+4}$$

$$Z_{22} = \frac{5s^2+43s+68}{s^2+5s+4}$$

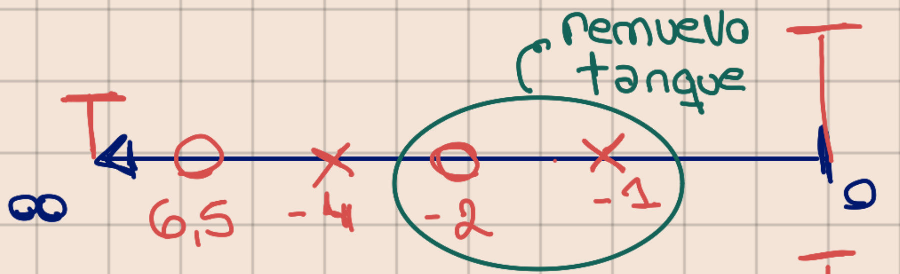
$$Z_{22} = \frac{5(s+2)(s+6{,}5)}{(s+1)(s+4)}$$ → los ceros no dan clavados, estan redondeados

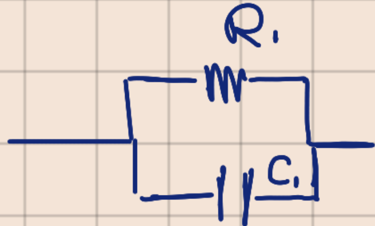


Cumple con alternancia; $Z_{22}(0) > Z_{22}(\infty)$

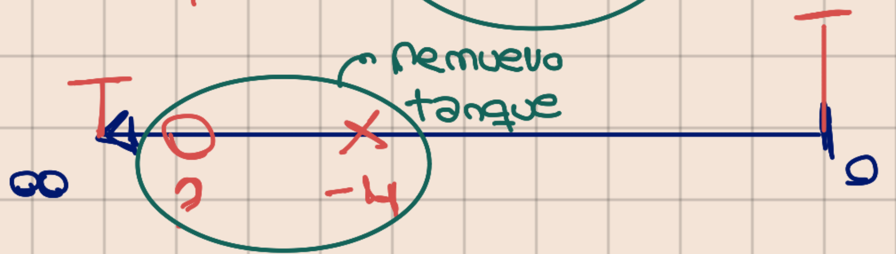
Sintesis metodo grafico: (debemos remover en 1 y 4)

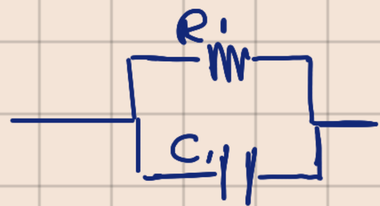
Z_{22}

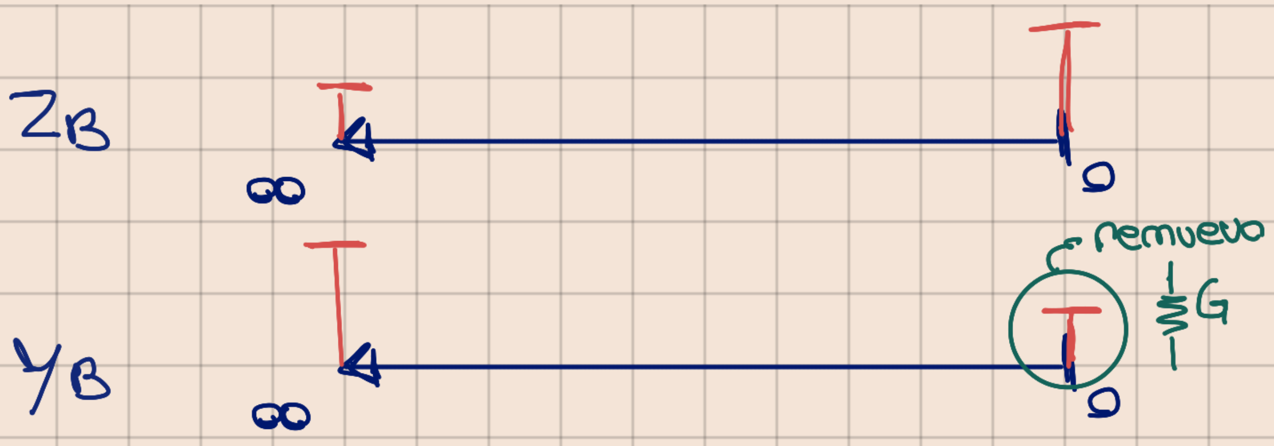




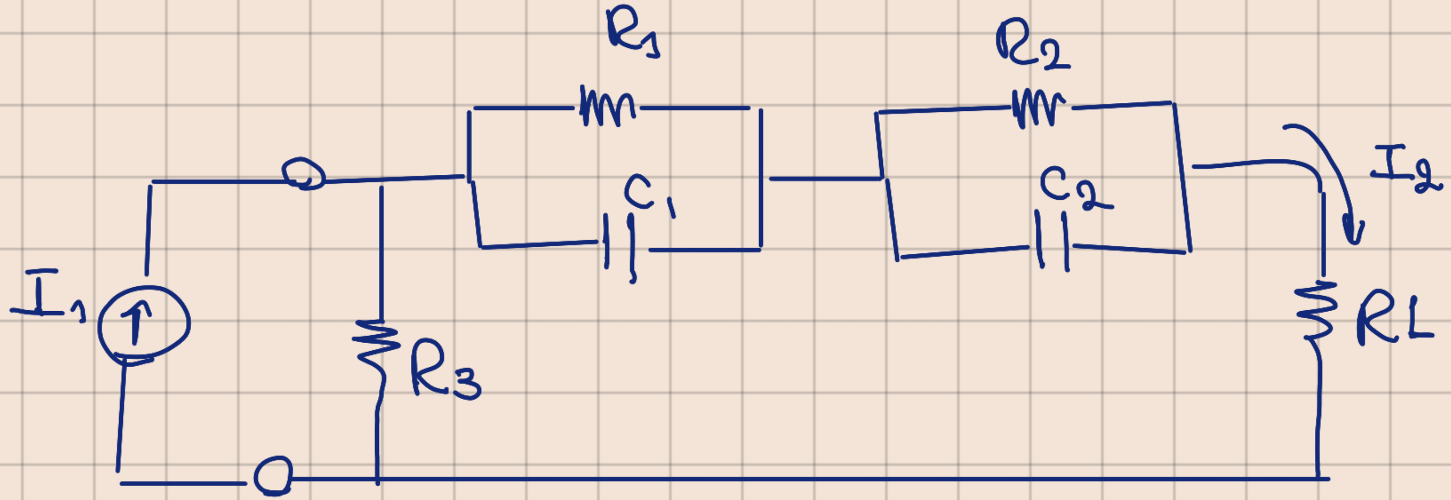
Z_A







Circuito resulstante :



$$T(s) = H\,\frac{s^2+5s+4}{s^2+8s+12} \longrightarrow T(s\to 0) = \frac{4}{12}\cdot k \quad ①$$

$$T(s\to\infty) = 1\cdot k \quad ②$$

En ① vemos que la corriente debe ser menor que en ② y esto se cumple ya que:

$$s=0 \qquad -\frac{I_2}{I_1} = \frac{R_3}{R_1+R_2+R_3+R_L}$$

$$s\to\infty \qquad -\frac{I_2}{I_1} = \frac{R_3}{R_3+R_L}$$

Calculos:

- Remuevo tanque RC

$$\lim_{s \to -1} Z_{22}(s+1) = k_1 = \frac{5\ (1)\ (5{,}5)}{3} = \frac{55}{6}$$

$$\frac{k_1}{s+\sigma} = \frac{55/6}{s+1} = \frac{1}{\dfrac{s}{\frac{55}{6}} + \dfrac{1}{\frac{55}{6}}}$$

resistencia $R = 55/6$

capacitor $C = 6/55$

$$Z_A = Z_{22} - \frac{55/6}{s+1}$$

uso con los valores aprox porq sino no da.

$$Z_A = \frac{5(s+2)(s+6{,}5)}{(s+1)(s+4)} - \frac{55/6}{s+1}$$

$$Z_A = \frac{5s^2 + 100/3\ s + 85/3}{(s+1)(s+4)} = \frac{\cancel{(s+1)}(s+17/3)5}{\cancel{(s+1)}(s+4)}$$

- Remuevo tanque RC

$$\lim_{s \to -4} (s+4) Z_A = k_2 = (-4+17/3).5$$

$$\frac{k_2}{s+\sigma} = \frac{25/3}{s+4} = \frac{1}{\dfrac{s}{25/3} + \dfrac{4}{25/3}}$$

resistencia $R = 25/12$

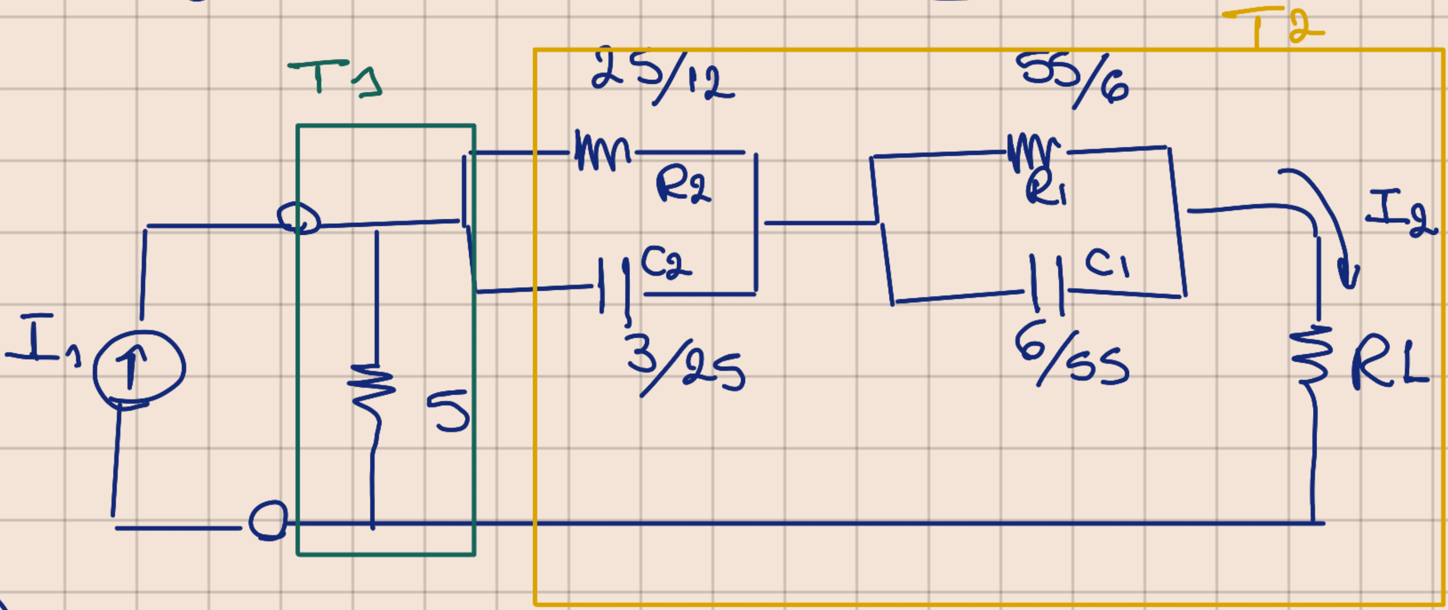
cap $C = 3/25$

$k_2 = 25/3$

$$Z_B = Z_A - \frac{25/3}{(s+4)} = \frac{5\left(s+17/3\right) - 25/3}{(s+4)} = \frac{5s+20}{(s+4)}$$

$$Z_B = \frac{5\,(s+4)}{(s+4)} = 5$$

$Y_B = \frac{1}{5} \rightsquigarrow$ Resistencia $R=5$



c) Verificacion:

$$T_1 = \begin{pmatrix} 1 & 0 \\ 1/5 & 1 \end{pmatrix} ; \quad T_2 = \begin{pmatrix} 1 & R_2//C_2 + R_1//C_1 + R_L \\ 0 & 1 \end{pmatrix}$$

$$T_2 = \begin{pmatrix} 1 & \dfrac{R_2 \cdot \frac{1}{sC_2}}{R_2 + \frac{1}{sC_2}} + \dfrac{R_1 \cdot \frac{1}{sC_1}}{R_1 + \frac{1}{sC_1}} + R_L \\ 0 & 1 \end{pmatrix}$$

$$T = T_1 . T_2$$

$$T = \begin{pmatrix} \cdots\cdots & \cdots\cdots \\ \cdots\cdots & D \end{pmatrix}$$

$$D = \frac{I_1}{(-I_2)} \longrightarrow T(\$) = D^{-1}$$

$$D = \frac{1}{5}(R_2//C_2 + R_1//C_1 + R_L) + 1$$

$$D = \frac{1}{5}\left(\frac{1/C_2}{\$ + 1/C_2R_2} + \frac{1/C_1}{\$ + 1/C_1R_1} + R_L \right) + 1$$

$$D = \frac{1}{5}\left(\frac{25/3}{\$ + 4} + \frac{55/6}{\$ + 1} + 1 \right) + 1$$

$$D = \frac{5/3}{\$ + 4} + \frac{11/6}{\$ + 1} + 6/5$$

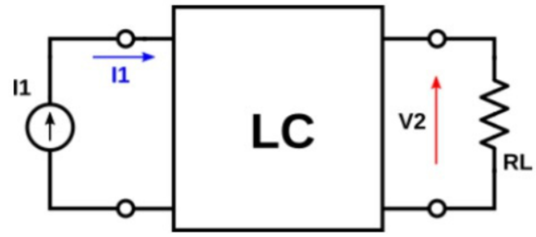
$$D = \frac{5/3(\$+1) + 11/6 . (\$+4) + (\$+4)(\$+1)6/5}{(\$+4)(\$+1)}$$

$$D = \frac{6}{5}\left(\frac{\$^2 + \$\left(\frac{95}{12}\right) + \frac{23}{2}}{(\$+4)(\$+1)} \right)$$

$$T(s) = \frac{5}{6}\left(\frac{(s+4)(s+1)}{(s+1{,}91)(s+6)}\right) \rightarrow \text{coincide}$$

$$\boxed{H = \frac{5}{6}}$$

2) Dada la siguiente **transferencia de impedancia**:



$$T(s) = \frac{V_2}{I_1} = \frac{k.(s^2+9)}{s^3+2.s^2+2.s+1}$$

a) Sintetizar un cuadripolo pasivo sin pérdidas, que cumpla con la **transimpedancia** indicada, cargado a la salida con una impedancia como se muestra en la figura.

b) Verificar la transimpedancia del circuito obtenido.

$$V_2 = I_1 . Z_{21} + I_2 Z_{22}$$

$$V_2 = I_1 Z_{21} + \left(\frac{-V_2}{RL}\right) . Z_{22}$$

$$V_2 \left(1 + \frac{Z_{22}}{RL}\right) = I_1 Z_{21}$$

$$\frac{V_2}{I_1} = \frac{Z_{21}}{1 + \frac{Z_{22}}{RL}} \longrightarrow \text{normaliza } RL = 1$$

$$\frac{V_2}{I_1} = \frac{Z_{21}}{1 + Z_{22}} = \frac{K(s^2+9)}{s^3+2s^2+2s+1}$$

par
debemos dividir por funcion impar

$$\frac{V_2}{I_1} = \frac{k\,(s^2+9)}{N\left(1+\frac{M}{N}\right)}$$

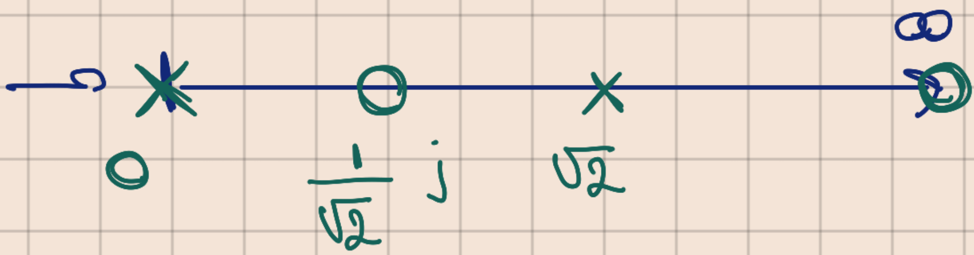
$M:\ 2s^2+1$

$N:\ s^3+2s$

$$\frac{V_2}{I_1} = \frac{\frac{k\,(s^2+9)}{s^3+2s}}{\left(1+\frac{2s^2+1}{s^3+2s}\right)} = \frac{Z_{21}}{1+Z_{22}}$$

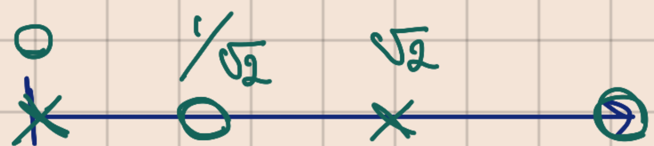
$$Z_{21} = \frac{s^2+9}{s^3+2s} = \frac{(s^2+9)}{s(s^2+2)}$$

$$Z_{22} = \frac{2s^2+1}{s^3+2s} \longrightarrow$$

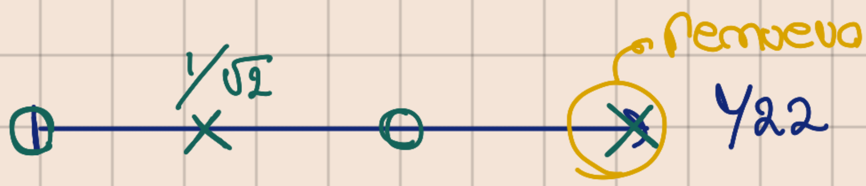


$$Z_{22} = \frac{2(s^2+1/2)}{s(s^2+2)}$$

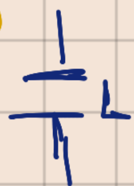
Se cumple que es FRP
debo remover en ∞ y 3

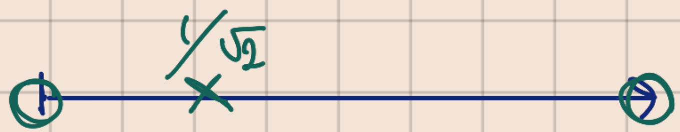


Z_{22}

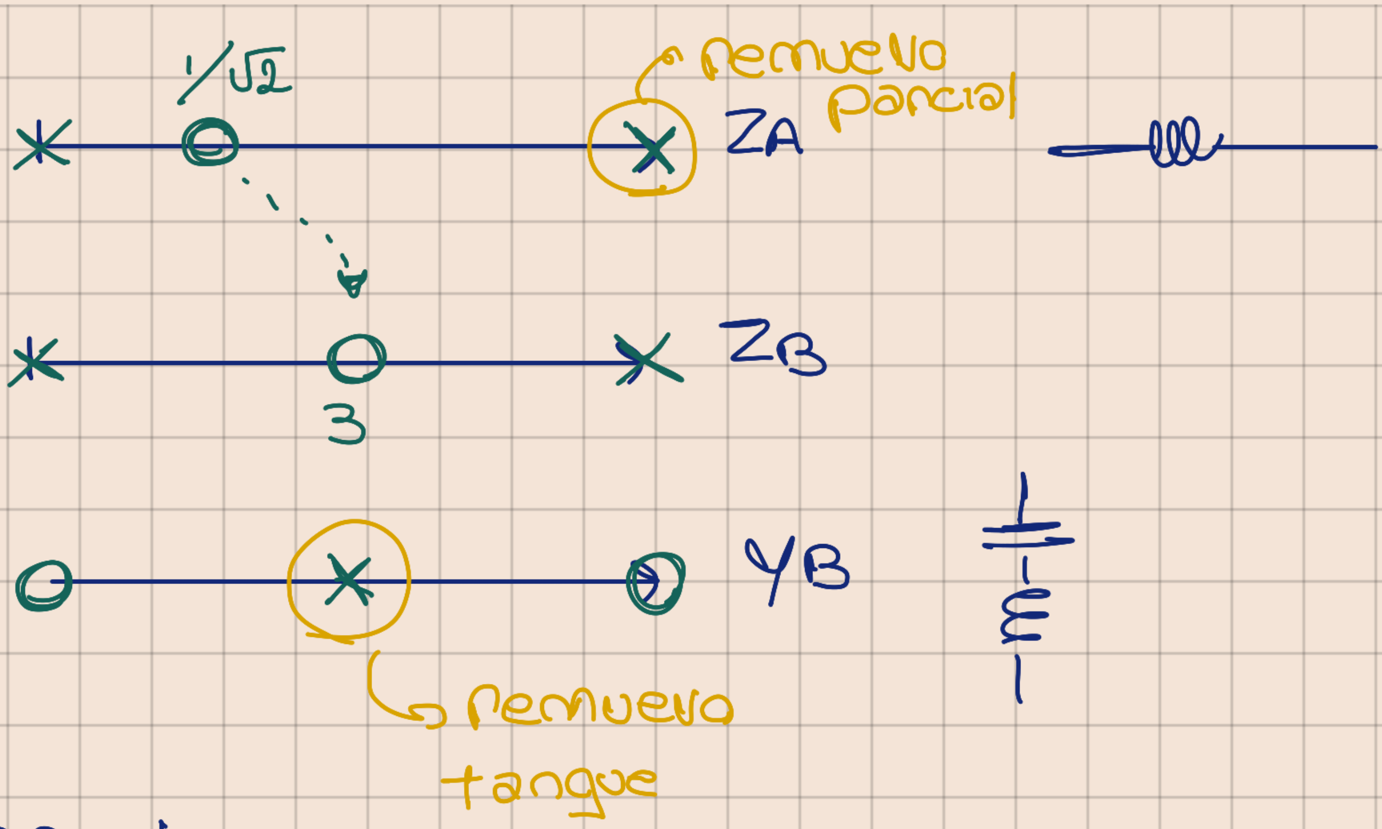


Y_{22}

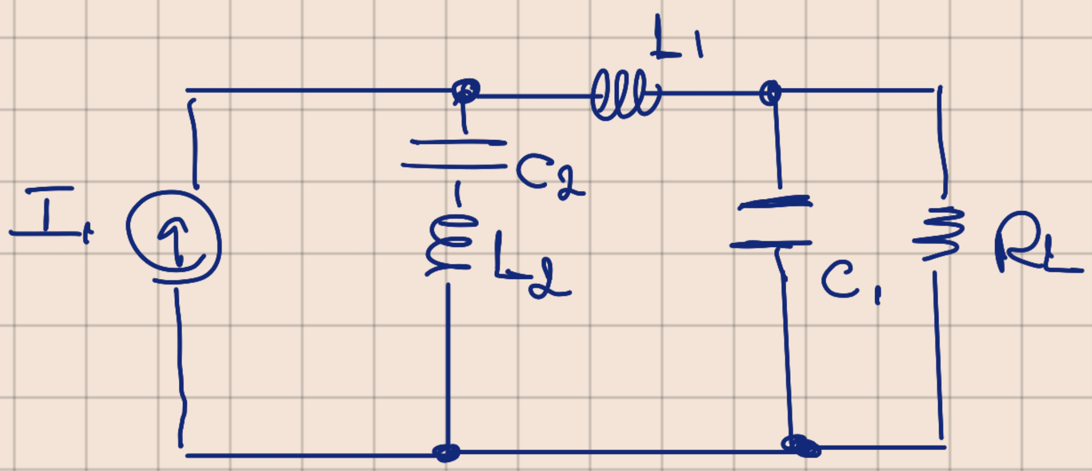




Y_A



Circuito:



$$T(s) = \frac{K(s^2+9)}{s^3+2s^2+2s+1} \longrightarrow T(s=0) = K \cdot 9$$

$$T(s \to \infty) = 0$$

Resolucion analitica:

$$Z_{22} = \frac{2(s^2+1/2)}{s(s^2+2)}$$

$$Y_{22} = \frac{s(s^2+2)}{2(s^2+1/2)}$$

Remuevo polo en inf:

$$\lim_{\$\to\infty} \frac{1}{\$}\, y_{22} = \frac{1}{2} \longrightarrow \text{cap de valor } C_1 = 1/2$$

$$y_A = y_{22} - \$\,\frac{1}{2} = \frac{\$(\$^2+2) - \$(\$^2+1/2)}{2(\$^2+1/2)}$$

$$y_A = \frac{\$^3 - \$^3 + 2\$ - \$/2}{2(\$^2+1/2)}$$

$$y_A = \frac{3/2\,\$}{2(\$^2+1/2)} = \frac{3}{4}\,\frac{\$}{(\$^2+1/2)}$$

$$Z_A = \frac{4}{3}\,\frac{(\$^2+1/2)}{\$}$$

Remuevo parcial en inf:

$$\left(Z_A - \$k_2\right)\Big|_{\$^2=-9} = 0$$

$$L = 34/27$$

$$\frac{4}{3}\,\frac{(-9+1/2)}{-9} = k_2 \longrightarrow k_2 = 34/27$$

$$Z_B = Z_A - \$\,\frac{34}{27} = \frac{4}{3}\,\frac{(\$^2+1/2)}{\$} - \$\,\frac{38}{27}$$

$$Z_B = \frac{4}{3}\left(\frac{s^2 + 1/2 - s^2 \cdot 17/18}{s}\right) = \frac{4}{3}\;\frac{s^2 \cdot 1/18 + 1/2}{s}$$

$$Z_B = \frac{2}{27}\;\frac{s^2+9}{s}$$

$$Y_B = \frac{27}{2}\;\frac{s}{s^2+9}$$

Resuelvo tanque LC. $\longrightarrow \dfrac{2k_1 s}{s^2+\omega_0^2}$

$$\lim_{s^2 \to -9} \frac{(s^2+9)}{s} Y_B = \frac{27}{2} = 2k_1$$

$$\frac{2k_1 s}{s^2+\omega_0^2} = \frac{1}{\dfrac{s^2}{2k_1 s} + \dfrac{\omega_0^2}{2k_1 s}} = \frac{1}{\dfrac{s}{\frac{27}{2}} + \dfrac{9}{s\,\frac{27}{2}}}$$

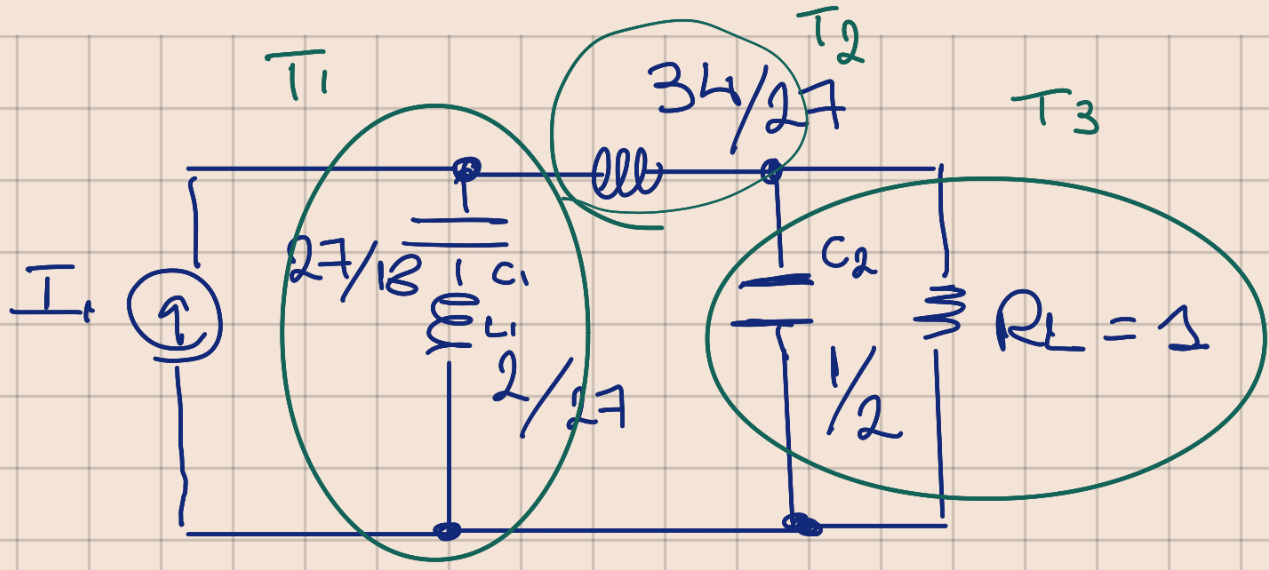
$$= \frac{1}{\dfrac{s\,2}{27} + \dfrac{18}{s\,27}}$$

ind

$L = \dfrac{2}{27}$

cap

$C = \dfrac{27}{18}$



Verificacion :

$$T = T_1 . T_2 . T_3 \longrightarrow G_T = \left.\frac{I_1}{V_2}\right|_{I_2=0}$$

$$C_1 + L_1 = \frac{1}{\$C} + \$L = \frac{\$^2 LC+1}{\$C} = \frac{\$^2\, 1/9 + 1}{\$\, 27/18} = \frac{\$^2 + 9}{\$\, 27/2}$$

$$C_2 // RL = \frac{\frac{1}{\$C} \cdot RL}{\frac{1}{\$C} + RL} = \frac{1/C}{\$ + 1/CR} = \frac{2}{\$ + 2}$$

$$T_1 = \begin{pmatrix} 1 & 0 \\ \frac{\$\, 27/2}{\$^2+9} & 1 \end{pmatrix} \qquad T_2 = \begin{pmatrix} 1 & \$\frac{34}{27} \\ 0 & 1 \end{pmatrix}$$

$$T_3 = \begin{pmatrix} 1 & 0 \\ \frac{\$+2}{2} & 1 \end{pmatrix}$$

$$T_A = T_1 . T_2 = \begin{pmatrix} \cdots & \cdots \\ \dfrac{\$\, 27/2}{\$^2+9} & \underbrace{\dfrac{\$\,\cancel{27}/\cancel{2}}{\$^2+9}\;\dfrac{\$\,\cancel{34}^{\,17}}{\cancel{27}}+1}_{\dfrac{17\$^2}{\$^2+9}+1} \end{pmatrix}$$

$$T_A . T_3 = \begin{pmatrix} \cdots & \cdots \\ \dfrac{27/2\,\$}{\$^2+9} + \left(\dfrac{17\$^2}{\$^2+9}+1\right)\dfrac{\$+2}{2} & \cdots \end{pmatrix}$$

$$\left(\frac{18\$^2+9}{\$^2+9}\right)\frac{\$+2}{2}$$

$$C = \frac{27\$ + 18\$^3+9\$+18+36\$^2}{(\$^2+9)2}$$

$$C = \frac{18\$^3+36\$^2+36\$+18}{2(\$^2+9)} = \frac{18}{2}\,\frac{\$^3+2\$^2+2\$+1}{(\$^2+9)}$$

$$C^{-1} = \frac{1}{9}\;\frac{\$^2+9}{s^3+2\$^2+2\$+1} = T(\$)$$