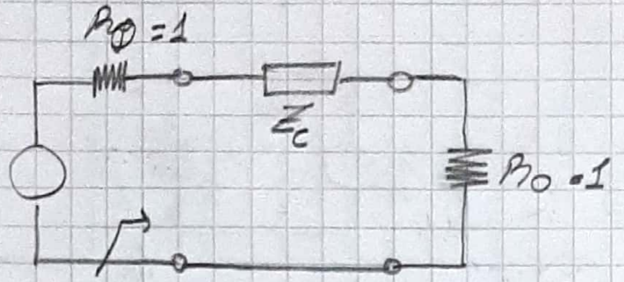
HOJA Nº 19

FECHA

2^{do} P R4001 - 2020

1)



$$S_{11} = \frac{10s + 100}{2s^2 + 232s + 120}$$

a)

$$S_{11}\Big|_{\substack{a_2=0 \\ R_{01}=R_{02}}} = \frac{Z_1 - R_0}{Z_1 + R_0} = \frac{Z_c}{Z_c + 2R_0} \Rightarrow S_{11} Z_c + S_{11} 2R_0 = Z_c$$

$$S_{11} 2R_0 = Z_c (1 - S_{11})$$

$$Z_c = \frac{2 S_{11} R_0}{1 - S_{11}}$$

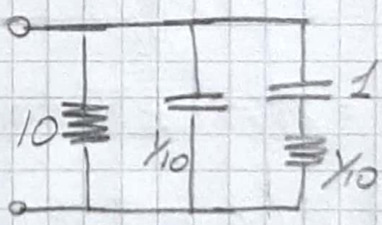
b)

$$Z_c = \frac{2S_{11}}{1 - S_{11}} = \frac{20s + 200}{2s^2 + 222s + 20}$$

$$Y_c = \frac{2s^2 + 222s + 20}{20s + 200} = \frac{2(s^2 + 111s + 10)}{20(s + 10)}$$

$$\Rightarrow Y_c = \frac{1}{10} \frac{s^2 + 111s + 10}{s + 10}$$

$$Y_c = G_0 + C_\infty s + \frac{K_1 s}{s + 10}$$



$$G_0 = \lim_{s \to 0} Y_c = \frac{1}{10} \Rightarrow R_0 = 10$$

$$C_\infty = \lim_{s \to \infty} \frac{Y_c}{s} = \frac{1}{10} \Rightarrow C_\infty = 1/10$$

$$K_1 = \lim_{s \to -10} Y_c \frac{(s+10)}{s} = \lim_{s \to -10} \frac{s^2 + 111s + 10}{10 . s} = 10$$

$$\frac{K_1 s}{s + 10} = \frac{1}{\frac{1}{K_1} + \frac{10}{K_1 s}} \Rightarrow R_1 = 1/K_1 = 1/10$$

$$C_1 = 1$$

c)

$$Z_c = \frac{10(s + 10)}{s^2 + 111s + 10}$$

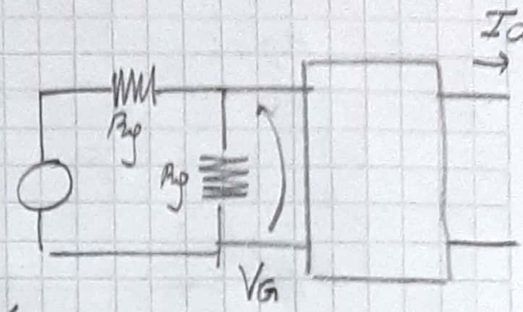
Si $s \to 0 \Rightarrow Z_c = R_0 = 10$ si $s \to \infty$ $Z_c = 0$

NOTA

2) a)

$$T = \begin{pmatrix} 0 & -100 \\ 0 & 0 \end{pmatrix} \qquad \begin{cases} V_1 = V_2 A + (-I_2) B \\ I_1 = V_2 C + (-I_2) D \end{cases}$$

$$B = -100 = \left.\frac{V_1}{-I_2}\right|_{V_2=0} = \frac{1}{gm}$$



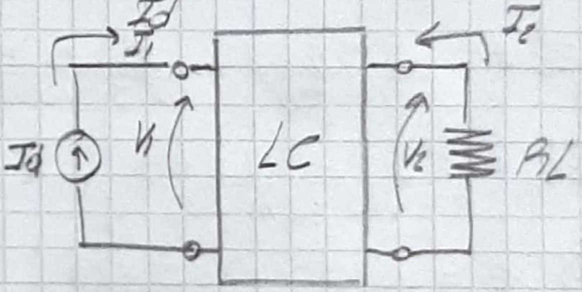
$$\frac{Vg}{Id} = \frac{Vg}{V_G} \cdot \frac{V_G}{Id}$$

$$V_G = \frac{Vg}{2} \Rightarrow \frac{Vg}{V_G} = 2 \quad y \quad \frac{V_G}{Id} = \frac{V_1}{(-I_2)} = gm$$

$$\Rightarrow \frac{Vg}{Id} = 2 \cdot \frac{-1}{gm} = \frac{-2}{gm} = 200$$

b)

$$\frac{V_0}{Vg} = \frac{Id}{Vg} \cdot \frac{V_0}{Id}$$



$$\frac{V_0}{Id} = \left.\frac{V_2}{I_1}\right|_{I_2 = \frac{(-V_2)}{RL}}$$

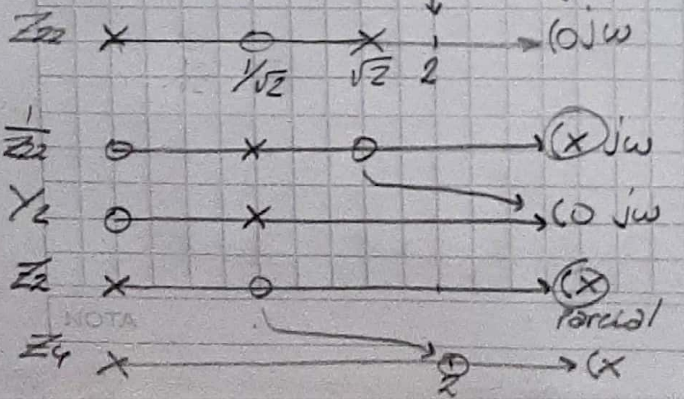
$$V_2 = I_1 Z_{21} + I_2 Z_{22} = I_1 Z_{21} + \frac{(-V_2)}{RL} Z_{22}$$

$$\Rightarrow V_2 (1 + Z_{22}/RL) = I_1 Z_{21} \Rightarrow \left.\frac{V_2}{I_1}\right|_{RL=1} = \frac{Z_{21}}{1 + Z_{22}}$$

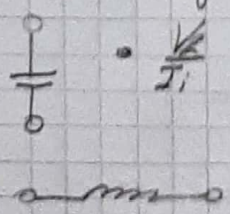
$\Omega\omega = 2{,}5$ GHz $\Rightarrow$ Hay un cero en

$$\Rightarrow \frac{V_2}{I_1} = \frac{(s^2 + 2^2)}{s^3 + 2s^2 + 2s + 1} = \frac{\frac{s^2+4}{s^3+2s}}{1 + \frac{2s^2+1}{s^3+2s}}$$

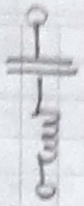
$$Z_{22} = \frac{2(s^2 + 1/2)}{s(s^2+2)}$$

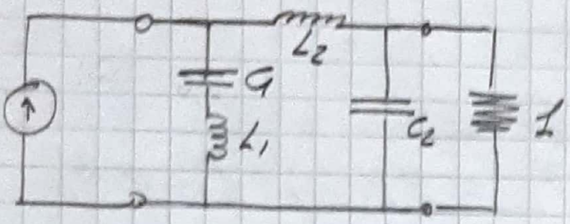


- 1° comp tiene que ir en derivación x el gen Id.
- $\frac{V_2}{I_1}$ impone ceros en 2 y en inf



$Y_4 \circ \xrightarrow{\; x/2 \;} (0$





$$Y_2 = \frac{1}{Z_{22}} - sC_2 \qquad \Rightarrow C_2 = \lim_{s\to\infty} \frac{1}{Z_{22}} \cdot \frac{1}{s} = \frac{(s^2+2)}{2(s^2+1/2)}$$

$$C_2 = 1/2$$

$$\Rightarrow Y_2 = \frac{s^3+2s}{2(s^2+1/2)} - \frac{s}{2}$$

$$Y_2 = \frac{s^3+2s-(s^3+1/2s)}{2(s^2+1/2)} = \frac{3/2\, s}{2(s^2+1/2)}$$

$$Z_2 = \frac{4(s^2+1/2)}{3s} \qquad \Rightarrow Z_4\Big|_{s^2=-4} = Z_2 - sL_2 = 0$$

$$\Rightarrow L_2 = \lim_{s\to -2} \frac{Z_2}{s} = \frac{4}{3}\,\frac{s^2+1/2}{s^2} = \frac{7}{6} \Rightarrow L_2 = 7/6$$

$$Z_4 = \frac{4(s^2+1/2)}{3s} - 7/6\, s = \frac{4(s^2+1/2) - 7/2\, s^2}{3s}$$

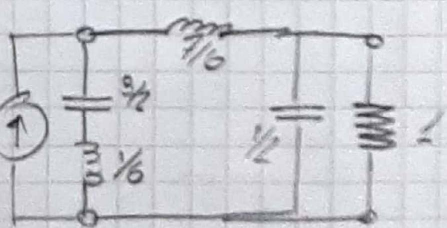
$$\Rightarrow Z_4 = \frac{1/2(s^2+4)}{3s} \qquad \Rightarrow Y_4 = 6\,\frac{s}{s^2+4}$$

$$Y_4 = \frac{1}{\frac{s}{6} + \frac{2}{3s}} \qquad \Rightarrow L_1 = 1/6 \;\; y \;\; C_1 = 3/2$$

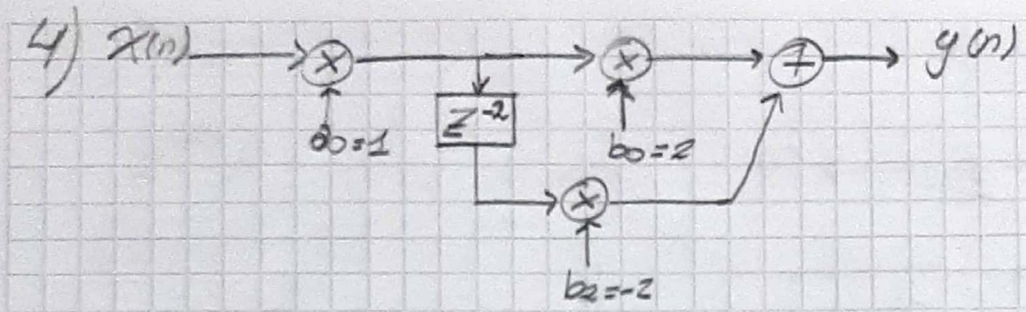
c)

$$C = \frac{C'}{\Omega\omega \cdot \Omega z} \qquad \text{siendo} \quad \Omega\omega = 2{,}5\,GHz \;\; y \;\; \Omega z = 50\,\Omega$$

$$y \;\; L = \frac{L}{\Omega\omega}\,\Omega z$$



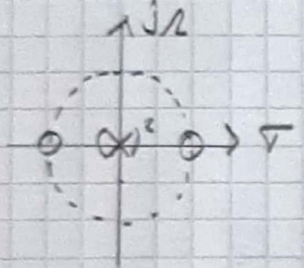
4)



$$y(n) = x(n)\, b_0 + x(n-2)\, b_2$$

$$Y(Z) = X(Z)(2 - 2Z^{-2}) = 2X(Z)(1 - Z^{-2})$$

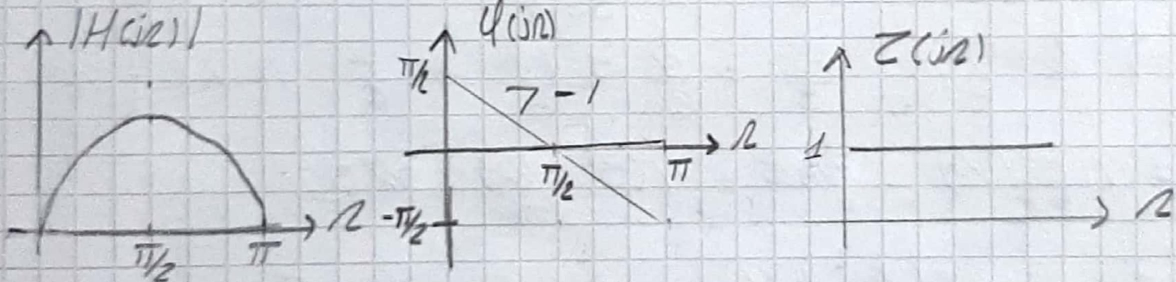
$$H(Z) = \frac{Y(Z)}{X(Z)} = 2(1 - Z^{-2}) \Rightarrow H(Z) = 2\,\frac{Z^2 - 1}{Z^2}$$



$$H(j\Omega) = 2(1 - e^{-j2\Omega})$$

$$H(j\Omega) = 2 \cdot e^{-j\Omega}(e^{j\Omega} - e^{-j\Omega})$$

$$H(j\Omega) = \underbrace{e^{j(\pi/2 - \Omega)}}_{\varphi(j\Omega)}\ \underbrace{4\,\mathrm{sen}(\Omega)}_{|H(j\Omega)|}$$



b) No, no es un filtro recursivo ya que no se realimenta la salida ⇒ Es un FIR, paso alto.

HOJA N° 21

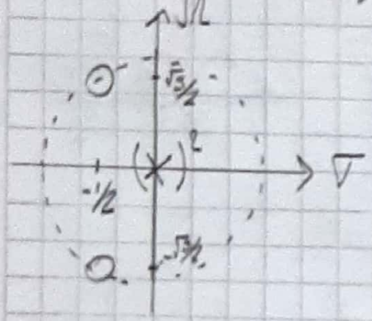
FECHA

2do P - 2023 - R4032

1) a- $h(n) = (\underline{1}, 1, 1)$ → Filtro promediador 3° orden

$$Y(Z) = X(Z)(1 + Z^{-1} + Z^{-2})$$

$$H(Z) = \frac{Y(Z)}{X(Z)} = 1 + Z^{-1} + Z^{-2} = \frac{Z^2 + Z + 1}{Z^2}$$

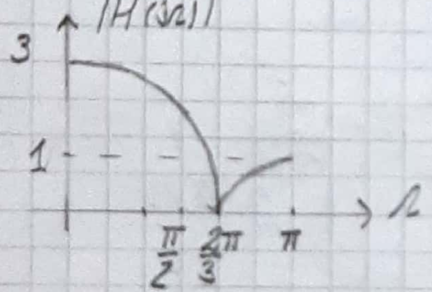


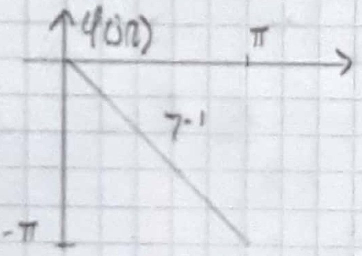
ceros $= (-\tfrac{1}{2} \pm j\tfrac{\sqrt{3}}{2})$

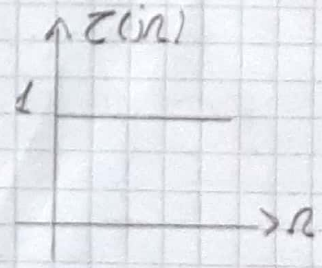
$$H(j\Omega) = 1 + e^{-j\Omega} + e^{-2j\Omega}$$

$$H(j\Omega) = e^{-j\Omega}(e^{j\Omega} + e^{0} + e^{-j\Omega})$$

$$H(j\Omega) = \underbrace{e^{-j\Omega}}_{\varphi(j\Omega)}\ \underbrace{[1 + 2\cos(\Omega)]}_{|H(j\Omega)|}$$

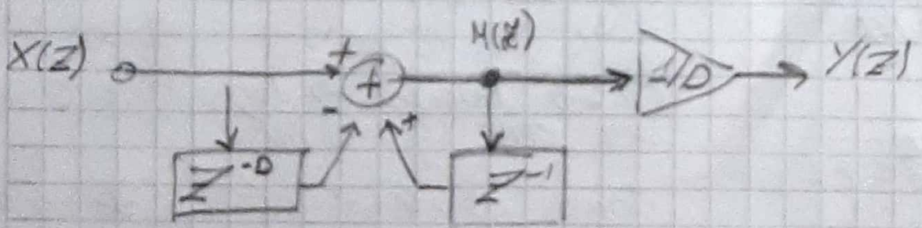






b- $M(Z) = X(Z) + (-X(Z) Z^{-D}) + M(Z) Z^{-1}$ → la cant. de sumas y multiplicaciones no depende de D son 2 sumas y una mult.

$\frac{M(Z)}{D} = Y(Z)$



En el filtro a si D = 5 son 4 sumas y 0 mult.

$$M(Z)(1 - Z^{-1}) = X(Z)(1 - Z^{-D})$$

$$Y(Z)\,D = X(Z)\frac{(1 - Z^{-D})}{1 - Z^{-1}} \Rightarrow H(Z) = \frac{1}{D}\frac{(1 - Z^{-D})}{1 - Z^{-1}}$$

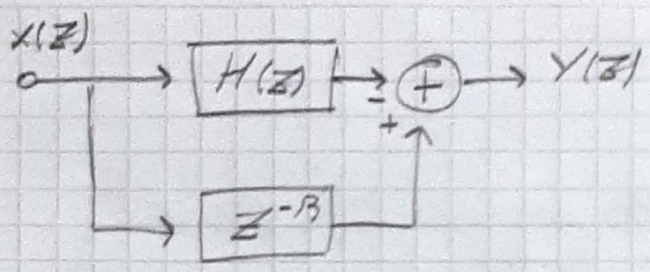
$$\text{Si } D = 3 \Rightarrow H(Z) = \frac{1}{3}\frac{(1 - Z^{-3})}{1 - Z^{-1}}$$

$$H(Z) = \frac{1}{3}\frac{Z^3 - 1}{Z^3 - Z^2} = \frac{1}{3}\frac{Z^3 - 1}{Z^2(Z - 1)} = \frac{1}{3}\frac{Z^2 + Z + 1}{Z^2}$$

∴ Si $D = 3$ son equivalentes

NOTA

c)



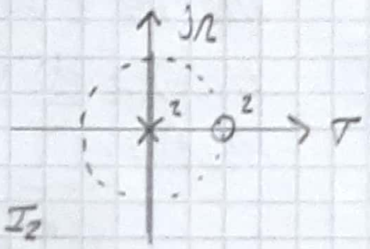
$$y(Z) = X(Z)\left[Z^{-B} - H(z)\right]$$

$$Y(Z) = X(Z)\left[Z^{-B} - \frac{1}{3}\,\frac{Z^2+Z+1}{Z^2}\right]$$

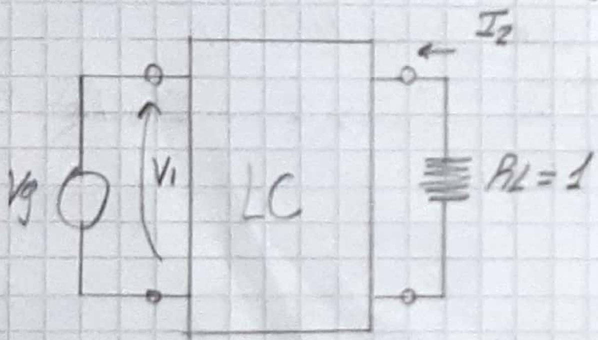
$$\frac{Y(Z)}{X(Z)} = \frac{3Z^{-B+2} - (Z^2+Z+1)}{Z^2}$$

si $B = 1 \Rightarrow H = \frac{-(Z^2-2Z+1)}{Z^2}$

$$\Rightarrow H(Z) = -\frac{(Z-1)^2}{Z^2}$$



2) a)



$$Y(s) = \left.\frac{-I_2}{V_1}\right|_{V_2 = (-I_2)R_L}$$

$$I_2 = Y_{21}V_1 + Y_{22}V_2 = Y_{21}V_1 + Y_{22}(-I_2)R_L$$

$$\Rightarrow I_2(1 + Y_{22}R_L) = Y_{21}V_1$$

$$\Rightarrow \frac{I_2}{V_1} = \frac{Y_{21}}{1+Y_{22}}$$ siendo $R_L = 1\,\Omega$

$$Y(s) = \frac{s^2}{s^3+2s^2+2s+1}$$

$$Y(s) = \frac{\frac{s^2}{s^3+2s}}{1 + \frac{2s^2+1}{s^3+2s}}$$

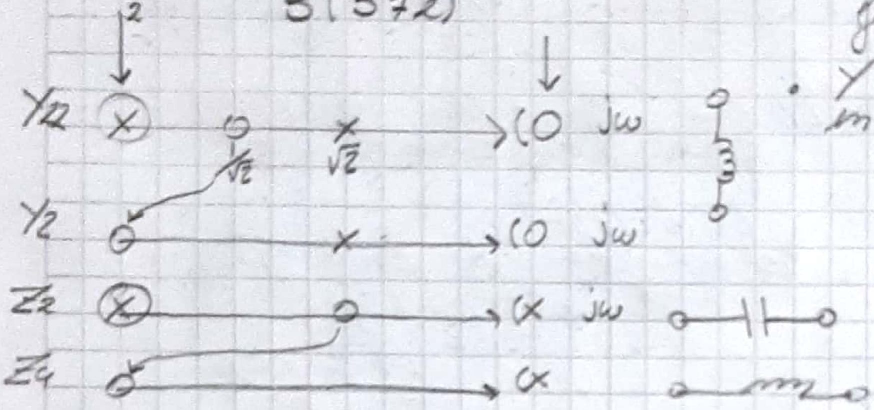
Pasa banda → tiene ceros en cero y en inf

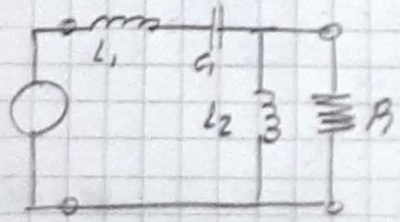
Como es de 3° orden y se desea mayor atenuación en frecuencias bajas ⇒ el cero en el origen será de orden 2

NOTA

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

- 1° comp en serie x q el generador es de tensión
- Y impone un cero doble en el origen y uno en inf

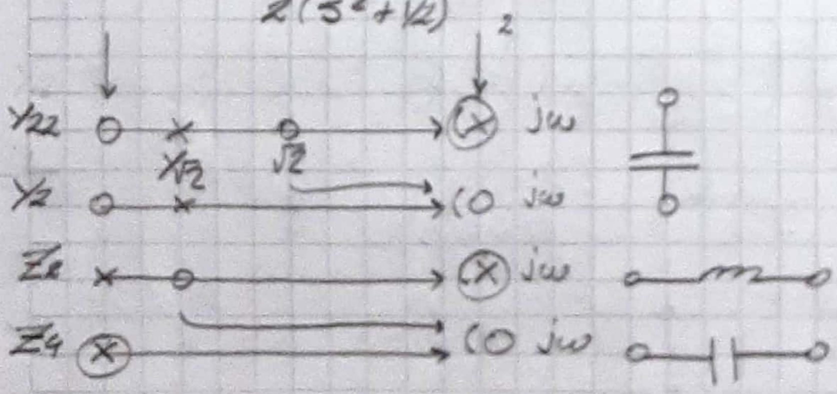


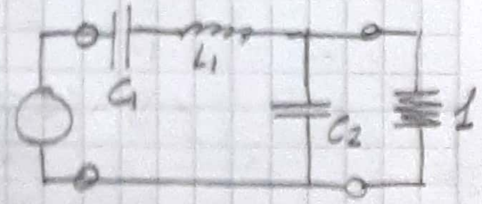


c) $Y(s) = \dfrac{s}{s^3+2s^2+2s+1}$ → un cero simple en el origen y un cero doble en infinito

$$Y(s) = \frac{\frac{s}{2s^2+1}}{1+\frac{s^3+2s}{2s^2+1}}$$

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





d) $Y_2 = Y_{22} - sC_2 \qquad \Rightarrow C_2 = \lim_{s\to\infty} \frac{Y_{22}}{s} = \lim_{s\to\infty} \frac{(s^2+2)}{2(s^2+1/2)}$

$Y_2 = \frac{s^3+2s}{2(s^2+1/2)} - \frac{s}{2} \qquad C_2 = 1/2$

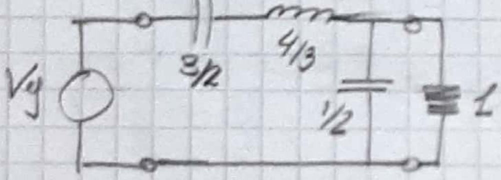
$Y_2 = \frac{s^3+2s-s(s^2+1/2)}{2(s^2+1/2)} = \frac{3}{4}\frac{s}{(s^2+1/2)} \Rightarrow Z_2 = \frac{4}{3}\frac{(s^2+1/2)}{s}$

$Z_4 = Z_2 - sL_1 \qquad \Rightarrow L_1 = \lim_{s\to\infty} \frac{Z_2}{s} = \lim_{s\to\infty} \frac{4}{3}\frac{(s^2+1/2)}{s^2}$

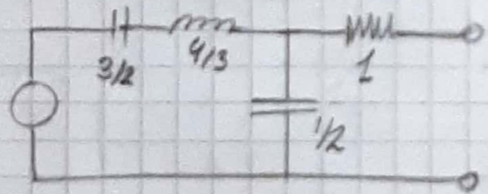
$L_1 = 4/3$

$\Rightarrow Z_4 = \frac{4}{3}\frac{(s^2+1/2)}{s} - \frac{4s}{3} = \frac{4s^2+2-\cancel{4s^2}}{3s} \Rightarrow Z_4 = \frac{2}{3}\frac{1}{s}$

$\Rightarrow C_1 = 3/2$



e) $\begin{cases} V_1 = V_2 A + (-I_2) B \\ I_1 = V_2 C + (-I_2) D \end{cases} \qquad \frac{1}{B}\Big|_{V_2=0} = \frac{-I_2}{V_1} \rightarrow$ me impone $V_2 = 0$



$$T = \begin{pmatrix} 1 & \frac{1}{sC_1} + sL_1 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ sC_2 & 1 \end{pmatrix} \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$$

$$T = \begin{pmatrix} 1 + \frac{1+s^2L_1C_1}{sC_1} \cdot sC_2 & \frac{1+s^2L_1C_1}{sC_1} \\ x & x \end{pmatrix} \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$$

$$B = 1 + (1+s^2L_1C_1)\frac{C_2}{C_1} + \frac{1+s^2L_1C_1}{sC_1}$$

$$B = \frac{sC_1 + sC_2(1+s^2L_1C_1) + 1 + s^2L_1C_1}{sC_1}$$

$$B = \frac{s^3L_1C_1C_2 + s^2L_1C_1 + s(C_1+C_2) + 1}{sC_1}$$

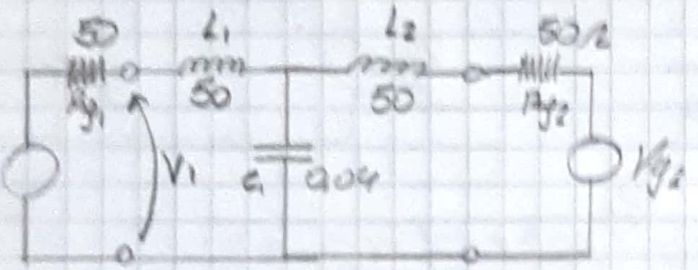
$$Y(s) = 1/B = \frac{s\,\frac{1}{L_1C_2}}{s^3 + s^2\frac{1}{C_2} + s\frac{(C_1+C_2)}{L_1C_1C_2} + \frac{1}{L_1C_1C_2}} = \frac{\frac{1}{2}s}{s^3+s^2 2+s2+1}$$

1) $C_R = \frac{C_R'}{R_Z \cdot R_\omega} = \frac{1/2}{100\Omega \cdot 100kHz} = 50\,nF$

$L_1 = \frac{L_1'}{R_\omega} R_Z = 1,33\,mHy$ $\quad R_1 = R_Z = 100\,\Omega$

$C_1 = \frac{C_1'}{R_Z\, R_\omega} = \frac{3/2}{100\Omega\; 100kHz} = 150\,nF$

3)



2)

$S_{11}\Big|_{\substack{V_{g2}=0 \\ R_{02}=R_{g2}}} = \frac{Z_1 - R_{01}}{Z_1 + R_{01}}$

$Z_{a1} = 50s + 50$

$Y_{P1} = 0,04\,s + \frac{1}{50s+50}$

$Y_{P1} = \frac{(0,04\,s)(50s+50)+1}{50s+50}$

$Y_{P1} = \frac{2s^2+2s+1}{50(s+1)}$

$Z_1 = 50s + \frac{50s+50}{2s^2+2s+1}$

$Z_1 = \frac{50s(2s^2+2s+1)+50s+50}{2s^2+2s+1}$

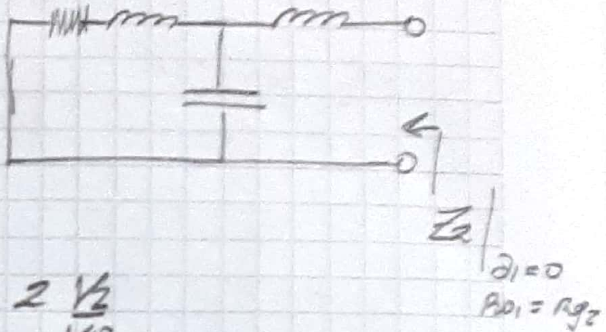
$Z_1 = 50\frac{(2s^3+2s^2+2s+1)}{2s^2+2s+1}$

$S_{11} = \frac{50\left(\frac{2s^3+2s^2+2s+1}{2s^2+2s+1} - 1\right)}{50\left(\frac{2s^3+2s^2+2s+1}{2s^2+2s+1}+1\right)} = \frac{2s^3}{2s^3+4s^2+4s+2}$

$S_{11} = \frac{s^3}{s^3+2s^2+2s+1}$

coeficiente de reflexión
(Reflection Loss)
lo que se refleja del generador
a la entrada del cuadripolo

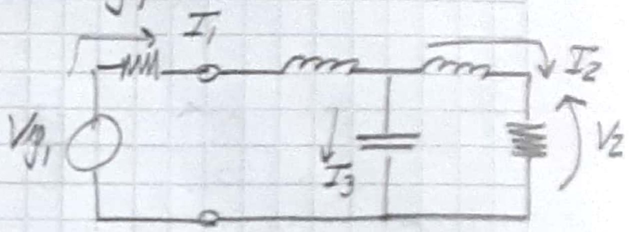
$S_{22} = \frac{Z_2 - R_{o2}}{Z_2 + R_{o2}}$



$S_{11} = S_{22}$ xq es simétrica
↳ son iguales xq es un cuadripolo pasivo.

$S_{21} = S_{12}$

$$S_{21} = \frac{V_2}{V_{g1}/2}\underbrace{\sqrt{\frac{R_{o2}}{R_{o1}}}}_{=1 \text{ xq } R_{o2} = R_{o1}} \Rightarrow S_{21} = 2\frac{V_2}{V_{g1}}$$



$$I_2 = I_1 \cdot \frac{\frac{1}{0{,}04s}}{\frac{1}{0{,}04s} + 50s + 50}$$

$$I_1 = \frac{V_{g1}}{(Z_1 + R_{o1})} = \frac{V_{g1}}{50\left(\frac{2s^3+4s^2+4s+2}{2s^2+2s+1}\right)}$$

$$I_2 = \frac{V_{g1}}{50\left(\frac{2s^3+4s^2+4s+2}{\cancel{2s^2+2s+1}}\right)} \cdot \frac{1}{\cancel{2s^2+2s+1}}$$

$$\Rightarrow I_2 = \frac{V_g}{50\cdot(2s^3+4s^2+4s+2)}$$

$$V_2 = I_2 R_{o2} \Rightarrow \frac{V_2}{V_g} = \frac{1}{2s^3+4s^2+4s+2}$$

$$\frac{V_2}{V_g} = \frac{1}{2}\,\frac{1}{s^3+2s^2+2s+1}$$

$$\Rightarrow S_{21} = \frac{1}{s^3+2s^2+2s+1}$$ → lo que se transmite del generador a la carga.

Coeficiente de transmisión directo

S_{12} → lo que se transmite de la carga al generador

Coeficiente de transmisión inverso.

b) Según el coeficiente de transmisión directo, el filtro es un pasabajos Butter.

$$f_c = \frac{\omega_0}{2\pi} = \frac{\sqrt{L_1 C_1 C_2}}{2\pi} = \frac{1/\Omega}{2\pi} =$$

NOTA 28/11 +5h