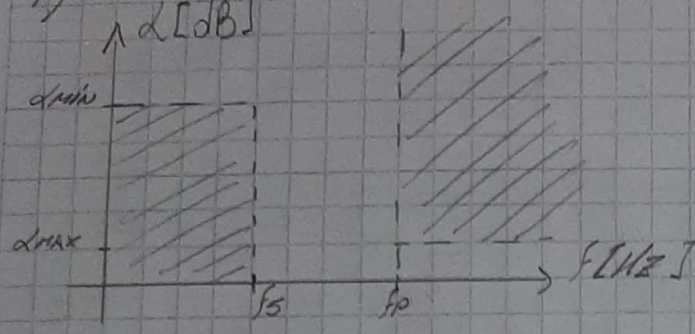
4)



$\alpha_{MAX}[dB] = 1\,dB$

$\alpha_{MIN}[dB] = 85\,dB$

$f_P = 3500\ Hz$

$f_S = 1000\ Hz$

$\omega_P = 1 \quad y \quad \omega_S = 0{,}286$

a) Para Max planicidad en la banda de paso.

Para el F_{LP} prototipo $\Rightarrow \begin{cases} \omega_{P_{LP}} = \dfrac{1}{\omega_{P_{HP}}} = 1 \\ \omega_{S_{LP}} = \dfrac{1}{\omega_{S_{HP}}} = 3{,}5 \end{cases}$

$$\varepsilon^2 = 10^{\frac{\alpha_{MAX}}{10}} - 1 = \boxed{0{,}256}$$

$$\alpha_{MIN} = 10 \log\left(1 + \varepsilon^2 \omega_{S_{LP}}^{2N}\right)$$

Itero N $\Rightarrow$ $\alpha_{MIN_2} = 15{,}96\,dB$; $\alpha_{MIN_3} = 26{,}74\,dB$

$\alpha_{MIN_4} = 37{,}6\,dB$

$$\boxed{n = 4}$$

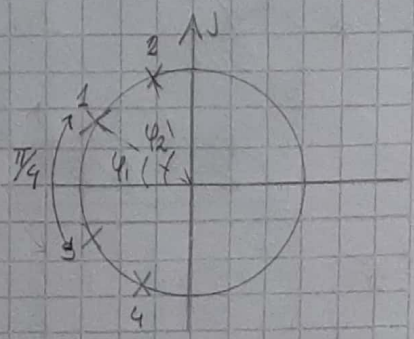
$$|T(j\omega)|^2 = \frac{1}{1 + \varepsilon^2 \omega^{2n}} = \frac{1}{1 + \left(\frac{\omega}{\varepsilon^{-1/n}}\right)^{2n}}$$

↳ Renormalización

$\omega_B = \omega_P \cdot \varepsilon^{-1/n} =$

$\omega_B = \varepsilon^{-1/4} = 1{,}186$

$$|T_{B_4}(s)| = \frac{1}{s^2 + 2\cos\varphi_1 + 1} \cdot \frac{1}{s^2 + 2\cos\varphi_2 + 1}$$



$$Q_1 = \frac{1}{2\cos \pi/8} = 0{,}541$$

$$Q_2 = \frac{1}{2\cos 3\pi/8} = 1{,}306$$

$\varphi_1 = \pi/8$

$\varphi_2 = \varphi_1 + \pi/4 = 3/8\,\pi$

$$|T_{B_4}(s)| = \frac{1}{s^2 + 1{,}848 + 1} \cdot \frac{1}{s^2 + 5.0{,}766 + 1}$$

NOTA 14:55 → 16:30

$$T_{B4_{HP(s)}} = T_{B4_{LP}}(1/s) = \frac{1}{1/s^2 + 1/s\,1{,}848 + 1} \cdot \frac{1}{1/s^2 + 1/s\,0{,}766 + 1}$$

$$T_{B4_{HP}}(s) = \frac{s^2}{s^2 + s\,1{,}848 + 1} \cdot \frac{s^2}{s^2 + s\,0{,}766 + 1}$$

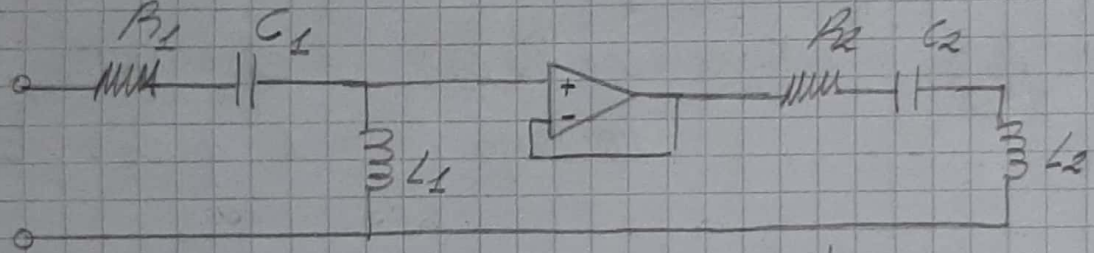
$$T_{B4_{HP}}(s) = \frac{s^2}{s^2 + s\frac{\omega_B}{Q_1} + \omega_B^2} \cdot \frac{s^2}{s^2 + s\frac{\omega_B}{Q_2} + \omega_B^2}$$

$$T_{B4_{HP}}(s) = \frac{s^2}{s^2 + s\,2{,}19 + 1{,}406} \cdot \frac{s^2}{s^2 + s\,0{,}908 + 1{,}406}$$

1) $P_{1,3} = -1{,}095 \pm j0{,}455$ y $P_{2,4} = -0{,}455 \pm j1{,}095$

Cero de orden 4 en el origen.

b)



$$\begin{cases} \frac{R_1}{L_1} = 2{,}19 \\ \frac{1}{L_1 C_1} = 1{,}406 \end{cases} \qquad \begin{cases} R_2 = R_1 \Rightarrow R_1 = 1 \\ \frac{R_2}{L_2} = 0{,}908 \\ \frac{1}{L_2 C_2} = 1{,}406 \end{cases}$$

$$\frac{1}{L_1} = 2{,}19 \Rightarrow L_1 = \frac{1}{2{,}19} = \boxed{0{,}457}$$

$$C_1 = \frac{1}{L_1 \cdot 1{,}406} = \boxed{1{,}556}$$

Con $\boxed{L_1 = L_2 = L}$ y $\boxed{C_1 = C_2 = C}$ $\Rightarrow$ $\boxed{R_2 = 0{,}908 \cdot L_2 = 0{,}415}$

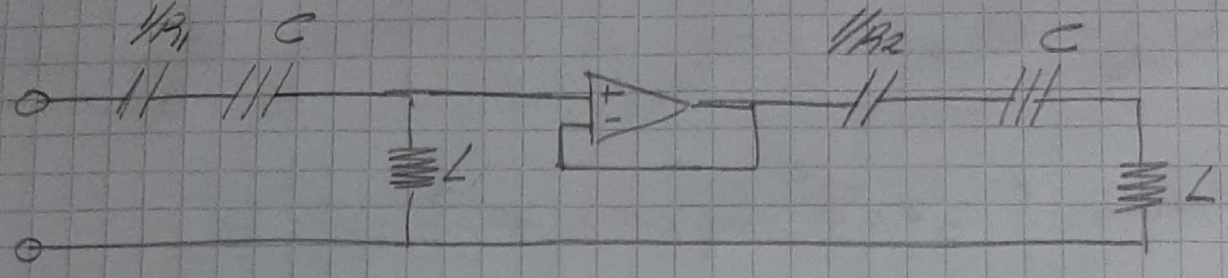
c) Si $R_2 = 1K\Omega \Rightarrow R_1 = 1K\Omega$ $R_2 = 415$

$$C = \frac{C'}{R_2 \cdot R_\omega} = \frac{1{,}556}{1K\Omega \cdot 2\pi \cdot 3{,}5KHz} = 70{,}76\,nF$$

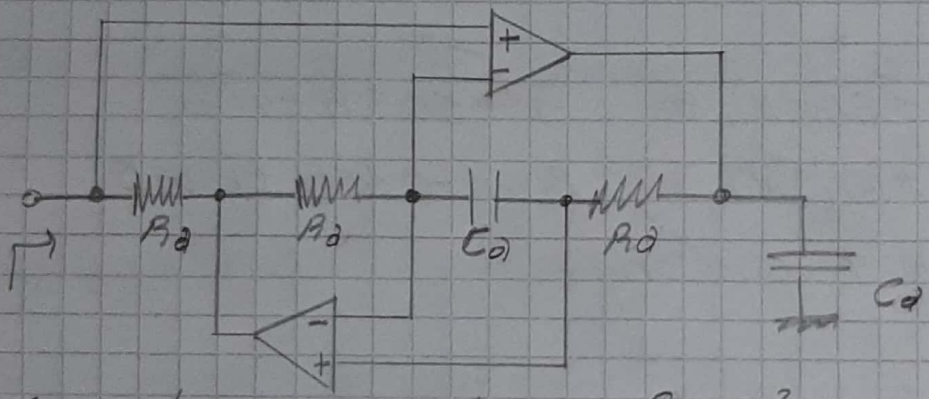
$$L = \frac{L'}{R_\omega} \cdot R_2 = \frac{0{,}457}{2\pi\,3{,}5KHz} \cdot 1K\Omega = 20{,}78\,mHy$$

NOTA

d) Hago Transformación de Bruton y uso un Girc de Antoniuc como FDNR



Los 2 FDNR son iguales



$Z_{in} = \frac{1}{S^2 D}$ siendo $D = R_a C_a^2 = C = 1{,}556$

Propongo $R_a = 1$ y $C_a = \sqrt{C} \equiv 1{,}247$