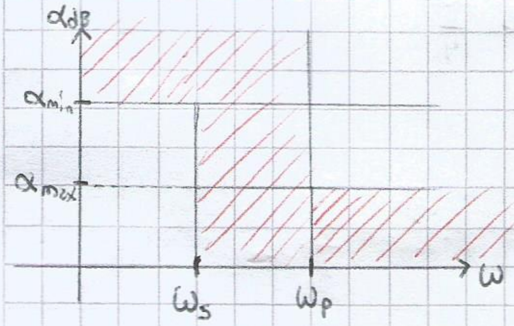
TS3

HOJA Nº 1

FECHA

Plantilla de Filtro deseado:



$\alpha_{min} = 35\,dB$

$\alpha_{max} = 1\,dB$

$F_p = 3500\,Hz \Rightarrow \omega_p = 21991{,}15\ \frac{rad}{seg}$

$f_s = 1000\,Hz \Rightarrow \omega_s = 6283{,}19\ \frac{rad}{seg}$

Trabajo en frec. Angulares porque las transf. son más simples expresadas así!

Normalizando: $\omega_p = 1$; $\omega_s = 0{,}2857$
$(\Omega_\omega = \omega_p)$

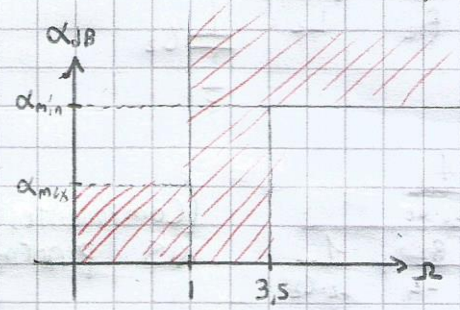
- Se trata de un filtro pasa altos, por lo que usando la transformación $\Omega = \frac{1}{\omega}$, obtengo la plantilla del filtro pasabajos equivalente

$\Omega_p = 1$

$\Omega_s = \frac{1}{\omega_s} = 3{,}5$

$\alpha_{max} = \alpha_{max(\omega)}$

$\alpha_{min} = \alpha_{min(\omega)}$



- Diseño de máxima planicidad:

∘ $\alpha_{max} = 20\log\left(\frac{1}{\sqrt{|T(\omega)|^2}}\right) = 20\log\left(\sqrt{1+\xi^2\cdot 1^{2n}}\right) = 10\cdot\log(1+\xi^2)$

$\xi^2 = 10^{\frac{\alpha_{max}}{10}} - 1 = \underline{0{,}2589} \Rightarrow \boxed{\xi = 0{,}5088}$

∘ $\alpha_{min} = 20\log\left(\sqrt{1+\xi^2\Omega_s^{2n}}\right) \Rightarrow 35\,dB = 10\cdot\log(1+\xi^2\, 3{,}5^{2n})$

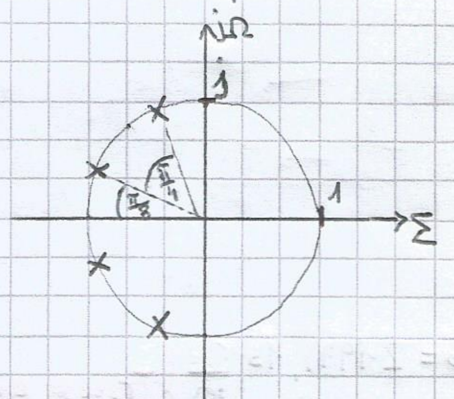
Con $\underline{n = 4}$: $\boxed{\alpha_{min} = 37{,}66\,dB}$

∘∘∘ $|T_{LP}(j\Omega)|^2 = \frac{1}{1+\xi^2\Omega^8} \Rightarrow$ Normalizando con $\Omega_\Omega = \frac{\omega_p}{\xi^{1/4}} \Rightarrow \boxed{|T_{LP}(j\Omega)|^2 = \frac{1}{1+\Omega^8}}$

$\boxed{\Omega_\Omega = \frac{1}{\omega_p\cdot\xi^{1/4}} = \frac{\Omega_p}{\xi^{1/4}}}$

NOTA

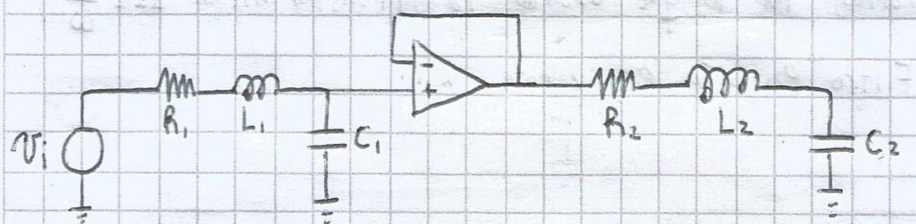
Polos de LP equiv. Norm. $T_{LP(p)}$



- Primer Par de polos a $\frac{\pi}{8}$
- Distancia entre polos Angular $\frac{\pi}{4}$

$$T_{LP(p)} = \frac{1}{p^2 + p\cdot 2\cdot \cos\frac{\pi}{8} + 1} \cdot \frac{1}{p^2 + p\cdot 2\cdot \cos\left(\frac{\pi}{8}+\frac{\pi}{4}\right) + 1} = \boxed{\frac{1}{p^2+p\cdot 1{,}848+1} \cdot \frac{1}{p^2+p\cdot 0{,}765+1}}$$

- Diseño Circuito Pasivo buffereado que cumpla con $T_{LP}(p)$:



$$T_{(p)} = \frac{\frac{1}{L_1 C_1}}{p^2 + p\cdot\frac{R_1}{L_1} + \frac{1}{L_1\cdot C_1}} \cdot \frac{\frac{1}{L_2\cdot C_2}}{p^2 + p\cdot\frac{R_2}{L_2} + \frac{1}{L_2\cdot C_2}}$$

(Componentes normalizados y p normalizada)

$\therefore \frac{1}{\dot{L}_1\cdot\dot{C}_1} = \frac{1}{\dot{L}_2\cdot\dot{C}_2} = 1$; $\frac{\dot{R}_1}{\dot{L}_1} = 1{,}848$; $\frac{\dot{R}_2}{\dot{L}_2} = 0{,}765$

- Hago $\dot{L}_1 = \dot{L}_2 \equiv \dot{L} \implies \dot{C}_1 = \dot{C}_2 \equiv \dot{C} = \frac{1}{\dot{L}}$ (Para que los circ. de activación sean iguales posteriormente)

- $\dot{R}_1 = 1 \implies \dot{L} = \frac{1}{1{,}848} = 0{,}541 \implies \dot{C} = \frac{1}{\dot{L}} = 1{,}848$

Tomando $\Omega_Z = 1K$

- $\dot{R}_2 = 0{,}765\cdot\dot{L} = \boxed{0{,}4142}$

- Transformación de Componentes (Normalizados de P. Altos)

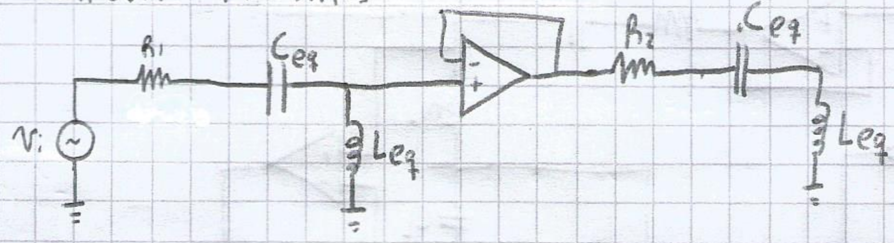
- $Z_R^{LP} = \dot{R} = Z_R^{HP}$
- $Z_L^{LP} = p\cdot\dot{L} = \frac{1}{s}\cdot\dot{L} = \frac{1}{s\cdot\dot{C}_{eq}} = Z_C^{HP} \implies \boxed{\dot{C}_{eq} = \frac{1}{\dot{L}}} = 1{,}848$
- $Z_C^{LP} = \frac{1}{p\dot{C}} = s\frac{1}{\dot{C}} = s\cdot\dot{L}_{eq} = Z_L^{HP} \implies \boxed{\dot{L}_{eq} = \frac{1}{\dot{C}}} = 0{,}541$

$\boxed{\dot{R}_1 = 1}$

$\boxed{\dot{R}_2 = 0{,}4142}$

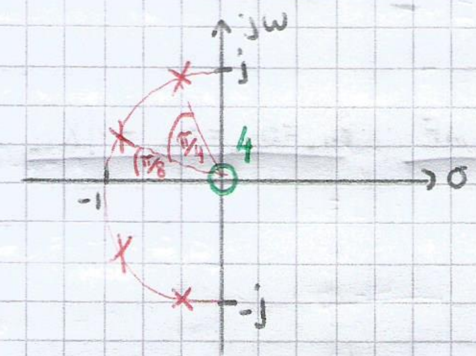
NOTA

○ Circuito Pasa Altos:



$$T_{(s)} = \frac{s^2}{s^2 + s\,\frac{\dot{R}_1}{\dot{L}_{eq}} + \frac{1}{\dot{L}_{eq}\,\dot{C}_{eq}}} \cdot \frac{s^2}{s^2 + s\,\frac{\dot{R}_2}{\dot{L}_{eq}} + \frac{1}{\dot{L}_{eq}\,\dot{C}_{eq}}} = \frac{s^2}{s^2 + s\,1{,}848 + 1} \cdot \frac{s^2}{s^2 + s\,0{,}765 + 1}$$

Diagrama de Polos y Ceros normalizado



donde $\Omega_\omega = \frac{1}{\Omega_\Omega} = \omega_p \cdot \xi^{1/4}$ ∧ $\Omega_z = 1K\Omega$

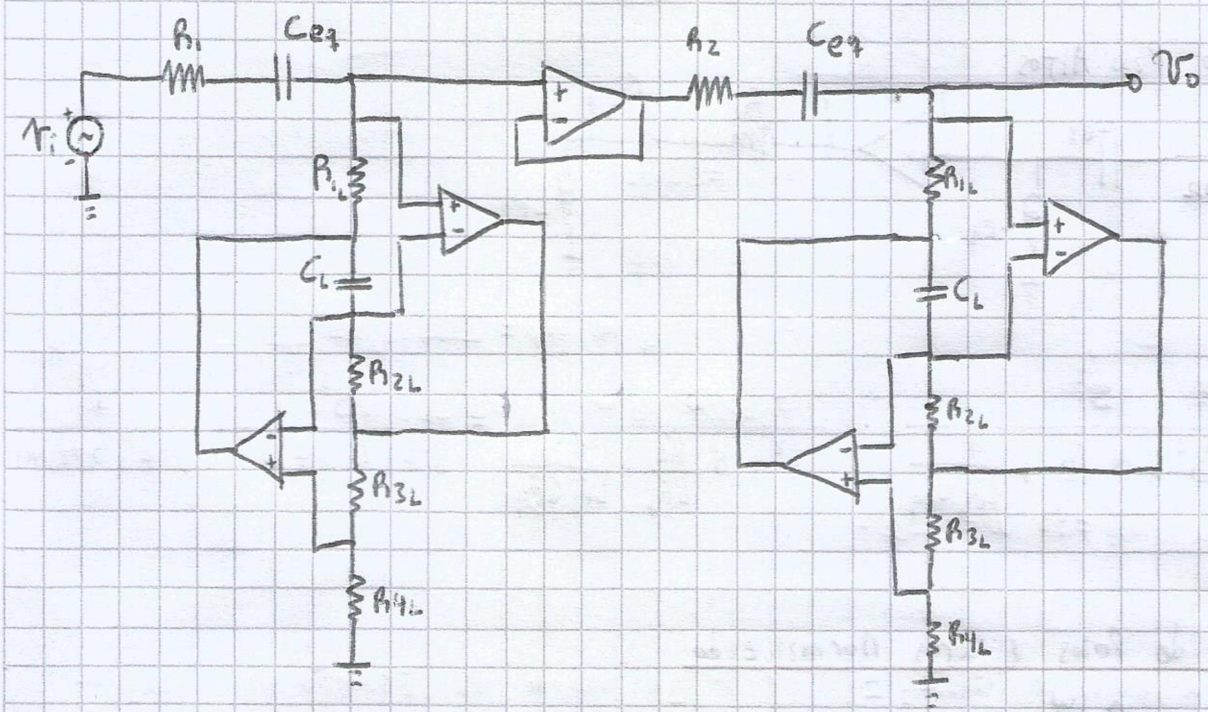
○○○ $R_1 = \dot{R}_1 \cdot \Omega_z = 1K\Omega$; $R_2 = \dot{R}_2 \cdot \Omega_z = 414{,}21\Omega$

$L_{eq} = \frac{\dot{L}_{eq}}{\Omega_\omega} \cdot \Omega_z = 29{,}138\,mHy$; $C_{eq} = \frac{\dot{C}_{eq}}{\Omega_\omega \cdot \Omega_z} = 99{,}4834\,nF$

Normalizando solo por impedancia con $\Omega_z = 1K\Omega$ se tiene:

$\dot{R}_1 = 1\Omega$; $\dot{R}_2 = 0{,}41421\Omega$; $\dot{L}_{eq} = 29{,}138\,MHy$; $\dot{C}_{eq} = 99{,}4834\,\mu F$

Activación de bobinas con estructura de OPAMPS



$L_{eq} = \frac{C_L \cdot R_{1L} \cdot R_{2L} \cdot R_{4L}}{R_{3L}}$ Supongo $\underline{C_L = 1MF}$; $\underline{R_{1L} = R_{2L} = R_{4L} = 1K\Omega}$

$\therefore R_{3L} = \frac{1MF \cdot (1K\Omega)^3}{29,138 mH} = \underline{34319,445\Omega}$

Normalizando cada componente por frecuencia (de Butter.) e impedancia:

$\Omega_w = \frac{1}{\Omega_\Omega} = W_p \cdot \xi^{1/4}$ | $\Omega_z = 1K\Omega$

$\mathring{R}_1 = 1$; $\mathring{R}_2 = 0,4142$; $\mathring{R}_{1L} = \mathring{R}_{2L} = \mathring{R}_{4L} = 1$; $\mathring{R}_3 = 34,319$

$\mathring{C}_{eq} = 1,848$; $\mathring{C}_L = 18,574$ ($\Longrightarrow$ Se verifica que $\mathring{L}_{eq} = \frac{\mathring{C}_L \cdot 1}{\mathring{R}_{3L}} = 0,541$)