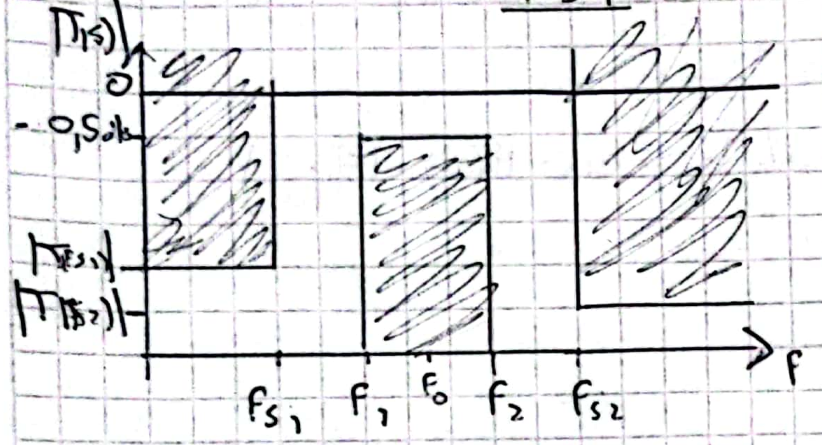
TS4



$\omega_0 = 2\pi \cdot 22\ kHz$

$Q = 5$

Mediante Cheby con ripple de 0,5 dB

$f_{s_1} = 17\ kHz$ $\quad f_{s_2} = 36\ kHz$

$T(f_{s_1}) = -16\ dB$ $\quad T(f_{s_2}) = -24\ dB$

$K(s) = Q\,\dfrac{s^2+1}{s}$ Con $\omega_0 = 1$ $\quad \omega_{s_1} = 0{,}772$ $\quad \omega_{s_2} = 1{,}6\overline{3}$ $\quad K(\omega) = Q\,\dfrac{\omega^2-1}{\omega}$

$\begin{cases} BW = \omega_2 - \omega_1 & Q = \dfrac{\omega_0}{BW} = 5 \rightarrow BW = 0{,}2 \\ \omega_0^2 = \omega_2\,\omega_1 & \rightarrow \omega_2 = \dfrac{1}{\omega_1} \rightarrow 0{,}2 = \dfrac{1}{\omega_1} - \omega_1 = \dfrac{1-\omega_1^2}{\omega_1} \end{cases}$

$\rightarrow \omega_1^2 + 0{,}2\,\omega_1 - 1 = 0 \rightarrow \omega_1\ \cancel{-1{,}1}$ $\quad \boxed{\omega_1 = 0{,}9}$ $\quad \boxed{\omega_2 = 1{,}1}$

Convierto a LP: $\Omega_1(\omega) = Q\,\dfrac{\omega_1^2-1}{\omega_1} = -1{,}05$

$\Omega_2 = Q\,\dfrac{\omega_2^2-1}{\omega_2} = 1{,}04$ $\quad \Omega_{s_1} = -2{,}61$ $\quad \Omega_{s_2} = 5{,}12$

Como se puede ver $|\Omega_1| \simeq |\Omega_2| \simeq 1$, ya que es LP. $\rightarrow \boxed{\Omega_p = 1}$

$|\Omega_{s_1}| < |\Omega_{s_2}|$, se elige la mas chica $\boxed{\Omega_s = 2{,}61}$

Igualmente analizo por Chebichev $\alpha_{max} = 0{,}5\ dB$

$\varepsilon = \sqrt{10^{\alpha_{max}/10} - 1} = 0{,}34 \rightarrow \varepsilon^2 = 0{,}12$

HOJA N°

FECHA

Cambio a α_{dB}: $\alpha_{s_1} = 16\,dB$ $\quad \alpha_{s_2} = 24\,dB$

$\alpha_{min} = 10 \log\left(1 + C_n^2(\omega_s)\right)$ con $C_n(\omega_s) = \varepsilon \cosh^2\left[n \cosh^{-1}(\omega_s)\right]$

- Pruebo con $\Omega_s = 2{,}67$

$n = 1 \to \alpha_{min} = 2{,}58$ ✗ $\quad n = 2 \to \alpha_{min} = 10{,}89$ ✗ $\quad n = 3 \to \alpha_{min} = 21{,}73$ ✓

- Pruebo con $\Omega_{s_2} = 5{,}12$

$n = 1 \to \alpha_{min} = 17{,}41$ ✗ $\quad n = 2 \to \alpha_{min} = 34{,}39$ ✓

El que más me exige es $\boxed{\Omega_s = 2{,}67}$ con $\boxed{n = 3}$

$$|H(j\omega)|^2 = \frac{1}{1 + C_3^2(\omega)} = H(s)H(-s) = \frac{1}{1 + \varepsilon^2 (4\omega^3 - 3\omega)^2}$$

$$= \frac{1}{1 + \varepsilon^2 (16\omega^6 - 24\omega^4 + 9\omega^2)}\Bigg|_{\omega = \frac{s}{j}} = \frac{1}{1 + \varepsilon^2 (-16 s^6 - 24 s^4 - 9 s^2)}$$

- Me quedo con polos negativos: $x_{1,2} = -0{,}313 \pm j1{,}021 \quad x_3 = -0{,}626 +$

$$H(s) = \frac{1/4\varepsilon}{(s - 0{,}313 + j1{,}021)(s - 0{,}313 - j1{,}021)(s + 0{,}626)}$$

Transferencia Pasa-Bajos:

$$H(s) = \frac{\frac{1}{4\varepsilon}}{(s^2 + 0{,}626\, s + 1{,}14)(s + 0{,}626)}$$

Convierto a Pasa-Banda: $s = 5\,\frac{s^2+1}{s}$

$$H(s) = \frac{1/4\varepsilon}{\left(25\,\frac{s^4 + 2s^2 + 1}{s^2} + 0{,}626 \cdot 5\,\frac{s^2+1}{s} + 1{,}14\right)\left(5\frac{(s^2+1)}{s} + 0{,}626\right)}$$

$$H(s) = \frac{s^2 \cdot 1/4\varepsilon \cdot s}{(25s^4 + 50s^2 + 25 + 3{,}13(s^3 + s) + 1{,}14 s^2)\, 5\left(s^2 + 1 + s\,\frac{0{,}626}{5}\right)}$$

$$H(s) = \frac{1/4\varepsilon \cdot s^3}{(25s^4 + 3{,}13s^3 + 51{,}14s^2 + 3{,}13s + 25)(s^2 + 0{,}125s + 1)}$$

$$H(s) = \frac{1/25 \cdot 1/4\varepsilon \cdot s^3 \cdot 1/5}{(s^4 + 0{,}125s^3 + 2{,}04s^2 + 0{,}125s + 1)(s^2 + 0{,}125s + 1)}$$

Polos del orden 4 $\quad x_{1,2} = -0{,}0342 \pm j1{,}1 \quad x_{3,4} = -0{,}028 \pm j0{,}9$

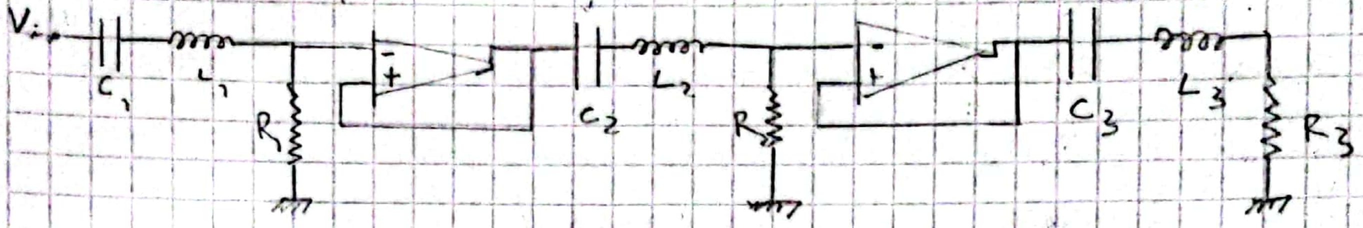
$$H(s) = \frac{1/25 \cdot \frac{1}{4\varepsilon} \cdot s^3 \cdot 1/5}{(s^2 + 0{,}0684s + 1{,}21)(s^2 + 0{,}056s + 0{,}81)(s^2 + 0{,}125s + 1)}$$

NOTA

$$H(s)=\frac{0{,}068\cdot\frac{1}{0{,}068}\,s^3\;0{,}056\cdot\frac{1}{0{,}056}\;\;0{,}125\,\frac{1}{0{,}125}}{(s^2+s\,0{,}068+1{,}21)(s^2+s\cdot0{,}056+0{,}81)(s^2+0{,}125\,s+1)}\cdot 5{,}88\cdot10^{-3}$$

$$K_{tot}=\frac{5{,}88\cdot10^{-3}}{0{,}068\cdot0{,}056\cdot0{,}125}=11{,}77$$

Red lineal adaptada mediante Buffers



T(s) de la forma: $H(s)=\dfrac{s\frac{R}{L}\,k}{s^2+s\frac{R}{L}+\frac{1}{LC}}$ $\quad \omega_0^2=\dfrac{1}{LC}$ $\quad \dfrac{R}{L}=\dfrac{\omega_0}{Q}\rightarrow Q=\dfrac{L}{R}\dfrac{1}{\sqrt{LC}}$

Con $V_1=K_{tot}V_i$ siendo K_{tot} ganancia inicial

Despejando: $L=\dfrac{R\cdot Q}{\omega_0}$ $\quad C=\dfrac{1}{L\omega_0^2}=\dfrac{\omega_0}{RQ\omega_0^2}\rightarrow C=\dfrac{1}{RQ\omega_0}$

$H_1(s)=\dfrac{0{,}068\,s}{(s^2+s\,0{,}068+1{,}21)}$ $\quad \omega_0=1{,}1$ $\quad Q=\dfrac{\omega_0}{0{,}068}=16{,}17$

$R_1=1\Omega$ $\quad L_1=14{,}7\,H$ $\quad C_1=56{,}22\,mF$

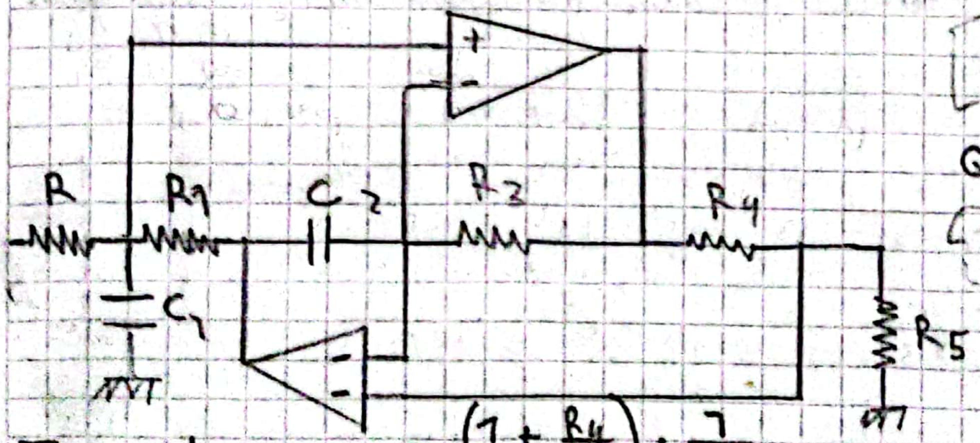
% de error hace que no sean iguales

$H_2=\dfrac{0{,}056\,s}{s^2+s\,0{,}056+0{,}81}$ $\quad \omega_0=0{,}9$ $\quad Q=16{,}1$

$R_2=1\Omega$ $\quad L_2=17{,}8\,H$ $\quad C_2=69\,mF$

$H_3=\dfrac{0{,}125\,s}{s^2+0{,}125\,s+1}$ $\quad \omega_0=1$ $\quad Q=8$

$R_3=1$ $\quad L_3=8H$ $\quad C_3=0{,}125$



$$\omega_0^2=\frac{R_4}{C_1C_2R_1R_3R_5}$$

$$Q=\omega_0C_1R$$

$$Q=R\sqrt{\frac{C_1R_4}{C_2R_1R_3R_5}}$$

$$k=1+\frac{R_4}{R_5}$$

$$T(s)=\frac{V_2}{V_1}=\frac{s\left(1+\frac{R_4}{R_5}\right)\cdot\frac{1}{C_1R}}{s^2+s\frac{1}{C_1R}+\frac{R_4}{C_1C_2R_1R_3R_5}}$$

$K_{TOT} = 11,77 \rightarrow$ Lo divido en partes iguales: $K_1 = K_2 = K_3 = 2,27$

Adopto: $R_1 = R_3 = R_4 = 1$ $\frac{1}{R} = \omega_0$ y $C_1 = Q$

Primer BP: $\omega_0 = 1 = R$ $Q = 7,987$

$K = 1 + \frac{R_4}{R_5} \rightarrow R_5 = 0,78$ $C_2 = \frac{R_4}{C_1 \omega_0^2 R_1 R_3 R_5} \rightarrow C_2 = \frac{1,27}{C_1}$

$Q = R \sqrt{\frac{C_1 R_4}{C_2 R_1 R_3 R_5}} = \sqrt{\frac{C_1^2 R_4}{R_4}} = C_1 = Q$ $C_2 = 0,16\ F$

Segundo BP: $\omega_0 = 0,9 = R^{-1}$ $Q = 16,03 = C_1$

$R_5 = 0,78$ $C_2 = \frac{1}{C_1 \omega_0^2 R_5} = 98,738\ mF$

Tercer BP: $\omega_0 = 1,1 = R^{-1}$ $Q = 16,03 = C_1$

$R_5 = 0,78$ $C_2 = 65,47\ mF$