FECHA

TRABAJO SEMANAL 4

- $W_0 = 2\pi\ 22KHz$
- $Q = 5$

} PASABANDAS.

- APROXIMACIÓN DE CHEBYCHEV → RIPPLE 0,5dB

$$BW = \frac{W_0}{Q} = \frac{2\pi\ 22KHz}{5} = 2\pi \cdot 4,4KHz.$$

$$\Rightarrow BW = \omega_{p_2} - \omega_{p_1} = 2\pi\ 4,4KHz$$

$$\omega_0 = \sqrt{\omega_{p_1} \cdot \omega_{p_2}} = 2\pi\ 22KHz.$$

$$\omega_{p_1} = \frac{(2\pi\ 22KHz)^2}{\omega_{p_2}}$$

$$\omega_{p_2} - \frac{(2\pi\ 22KHz)^2}{\omega_{p_2}} = 2\pi\ 4,4KHz.$$

$$\omega_{p_2}^2 - 2\pi\ 4,4KHz\ \omega_{p_2} - (2\pi\ 22KHz)^2 = 0.$$

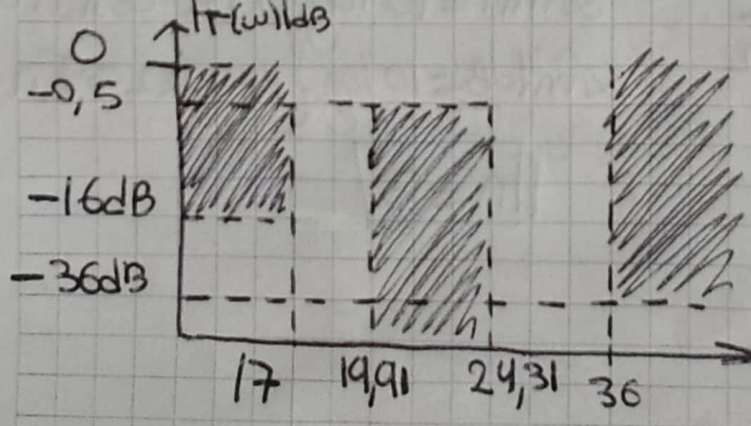
$$\omega_{p_2} = 152742,51\frac{rad}{s} \vee -125096,5\frac{rad}{s}.$$

$$\boxed{\omega_{p_2} = 152742,51\frac{rad}{s}}$$

$$\Rightarrow \boxed{\omega_{p_1} = 125096,5\frac{rad}{s}}$$

$W_{S1} = 2\pi 17KHz. \rightarrow \alpha = +16dB.$

$W_{S2} = 2\pi \cdot 36KHz \rightarrow \alpha = +24dB.$



NOTA

Núcleo de transformación: $K(s) = Q\,\frac{s^2+\omega_0}{s\omega_0}$

Normalizando por ω_0 $\Omega_\omega = \omega_0$

$$K(\$) = Q\,\frac{\$^2+1}{\$}$$

$$\Omega_p = Q\,\frac{\omega_{p_1N}^2-1}{\omega_{p_1N}}, \quad \omega_{p_1N} = \frac{\omega_{p_1}}{\Omega_\omega}$$

$$\Omega_p = 5\,\frac{0{,}905^2-1}{0{,}905}$$

$$\begin{cases} \omega_{p_1N} = 0{,}905 \\ \omega_{p_2N} = 1{,}105 \\ \omega_{s_1N} = 0{,}773 \\ \omega_{s_2N} = 1{,}64 \end{cases}$$

$$\boxed{\Omega_p = -1}$$

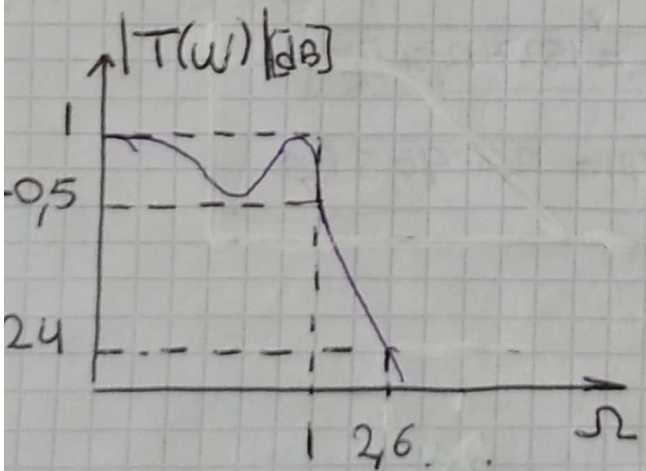
$$\Omega_{s_2} = Q\,\frac{\omega_{s_1N}^2-1}{\omega_{s_1N}}$$

$$= 5\,\frac{1{,}64^2-1}{1{,}64}$$

$$\Omega_{s_2} = 5{,}15$$

$$\Omega_{s_1} = -2{,}6$$

$$\boxed{\Omega_s = 2{,}6}$$



PLANTILLA

- $\alpha_{MAX} = 0{,}5\,dB$ @ $\Omega_p = 1$
- $\alpha_{min} = 24\,dB$ @ $\Omega_s = 2{,}6$

$$\varepsilon^2 = 10^{\frac{\alpha_{MAX}}{10}} - 1$$

$$\boxed{\varepsilon^2 = 0{,}122}$$

$$\alpha_{min} = 10\log\left[1+\varepsilon^2\cos^2\left[n\cos^{-1}(\Omega_s)\right]\right]$$

$$24\,dB = 10\log\left\{1+0{,}122\cos^2\left[n\cos^{-1}(2{,}6)\right]\right\}$$

$$\boxed{n = 3}$$

$$|T(\Omega)|^2 = \frac{1}{1+\varepsilon^2 C_3^2(\Omega)}$$

$$|T(\Omega)|^2 = \frac{1}{1+\varepsilon^2 \cdot (4\Omega^3 - 3\Omega)^2}$$

$$|T(\Omega)|^2 = \frac{1}{1+\varepsilon^2 (16\Omega^6 - 24\Omega^4 + 9\Omega^2)}$$

$$|T(p)|^2 = \frac{1}{1+\varepsilon^2 (-16p^6 - 24p^4 - 9p^2)}$$

$$\frac{1}{1+\varepsilon^2 (-16p^6 - 24p^4 - 9p^2)} = \frac{1}{(p^3 a + p^2 b + pc + d)(-p^3 a + p^2 b}$$

$$\begin{cases} -\varepsilon^2 16 = -a^2 \longrightarrow a = 4\varepsilon \\ -\varepsilon^2 \cdot 24 = -a \cdot c2 + b^2 \longrightarrow -\varepsilon^2 24 = -8\varepsilon c + b^2 \\ -\varepsilon^2 \cdot 9 = 2bd - c^2 \longrightarrow -\varepsilon^2 9 = 2b - c^2 \\ 1 = d \qquad b = -\dfrac{\varepsilon^2 9 + c^2}{2} \\ 0 = ab - ab \\ 0 = ad - ad - bc + bc \end{cases}$$

$$-\varepsilon^2 24 = -8\varepsilon c + \left(\frac{-\varepsilon^2 9 + c^2}{2}\right)^2$$

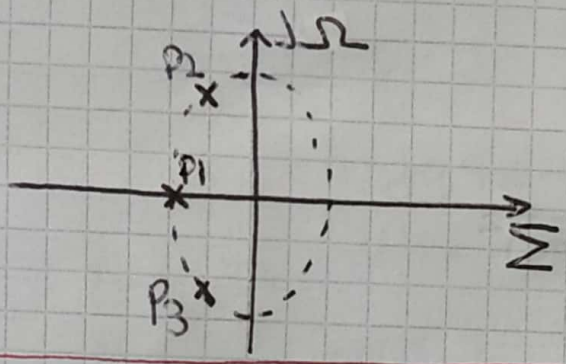
$$-\varepsilon^2 24 = -8\varepsilon c + \frac{1}{4}(c^4 - 18c^2\varepsilon^2 + \varepsilon^4 6561)$$

$$-\varepsilon^2 24 = -8\varepsilon c + \frac{c^4}{4} - \frac{9}{2}\varepsilon^2 c^2 + \varepsilon^4 \cdot 1640{,}25$$

$$\begin{cases} b = 1{,}75057 & a = 4\sqrt{0{,}122} \\ c = 2{,}14456 & d = 1 \end{cases}$$

NOTA

$$\Rightarrow T(p) = \frac{1}{p^3 4\sqrt{0,122} + p^2 1,75 + p\, 2,144 + 1}$$



$p_1 = -0,63$

$p_2 = -0,31 + j\,1,02$

$p_3 = -0,31 - j\,1,02$

$$T(p) = \frac{(4\sqrt{0,122})^{-1}}{(p+0,63)(p^2+0,63p+1,14)}$$

$$p = Q\,\frac{\$^2+1}{\$}$$

$$T(\$) = \frac{(4\sqrt{0,122})^{-1}}{\left[Q\frac{(\$^2+1)}{\$}+0,63\right]\left\{\left[Q\frac{(\$^2+1)}{\$}\right]^2+0,63\,Q\frac{(\$^2+1)}{\$}+1,1\right.}$$

$$T(\$) = \frac{\$\,(4\sqrt{0,122})^{-1}\,\$^2}{\left[\$0,63+(\$^2+1)Q\right]\left\{Q^2(\$^2+1)^2+\$(\$^2+1)0,63Q+1,14\$^2\right.}$$

$$T(\$) = \frac{0,716\;\$\frac{1}{Q}}{\$^2+\$\frac{0,63}{Q}+1}\;\frac{\$^2}{\$^4Q^2+2Q^2\$^2+Q^2+\$^3 0,63Q+\$^2 1,14+S0,6}$$

$$T(\$) = \underbrace{\frac{0,716\;\$\frac{1}{Q}}{\$^2+\$\frac{0,63}{Q}+1}}_{T_1}\;\underbrace{\frac{\$^2\frac{1}{Q^2}}{(\$^2+0,057\$+0,816)}}_{T_2}\;\underbrace{(\$^2+0,069\$+1,226)}_{T_3}$$

HOJA Nº

FECHA

Polos T1

$P_1 = -0,063 + j0,998$

$P_2 = -0,063 - j0,998$

$\omega_{0_1} = 1 \quad \psi_1 = 1,508 \text{ rad}$

Polos T2

$P_1 = -0,0285 + j0,903$

$P_2 = -0,0285 - j0,903$

$\omega_{0_2} = 0,903$

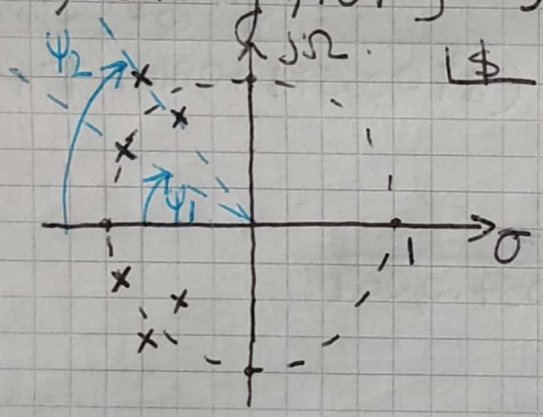
$\psi_2 = 1,539 \text{ rad}$

Polos T2

$P_1 = -0,0345 + j\,1,107$

$P_2 = -0,0345 - j\,1,107$

$\omega_{0_3} = 1,107, \quad \psi_2 = 1,539 \text{ rad}$



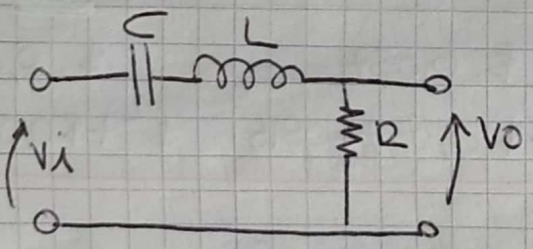
Q1 ∈ T1

$$Q_1 = \frac{1}{2\cos\psi_1} = 7,936.$$

Q2 ∈ T2, T3

$$Q_2 = \frac{1}{2\cos\psi_2} = 15,728$$

Red utilizada para cada sección



T1

$$\frac{0,63}{Q} = \frac{R_1'}{L_1'}, \qquad 1 = \frac{1}{\sqrt{L_1' C_1'}}$$

$$C_1' = \frac{1}{L_1'}, \quad L_1' = \frac{R_1' Q}{0,63}$$

Adopto $R_1' = 1\ \Omega$

$L_1' = 7,94 \text{ Hy.}$

$C_1' = 0,126 \text{ F.}$

T2

$$0,057 = \frac{R_2'}{L_2'}, \qquad 0,816 = \frac{1}{L_2' C_2'}$$

$$C_2' = \frac{1}{0,816\, L_2'}, \qquad L_2' = \frac{R_2'}{0,057}, \quad R_2' = 1\Omega \Rightarrow L_2' = 17,54 \text{ Hy}$$

$C_2' = 0,07 \text{ F}$

NOTA

T3

$$0,069 = \frac{R_3'}{L_3'} \qquad 1,226 = \frac{1}{L_3' C_3'}$$

$$C_3' = \frac{1}{1,226 \cdot L_3'} \qquad L_3' = \frac{R_3'}{0,069}$$

$$R_3' = 1\,\Omega$$

$$L_3' = 14,49\ HY$$

$$C_3' = 0,056\ F$$

$$T(\$) = \frac{0,716 \left[\frac{1}{Q}\right] \$ \frac{0,63}{\$^2 + \$\frac{0,63}{Q} + 1}}{(\$^2 + 0,057\$ + 0,816)(\$^2 + 0,069\$ + 1,226)} \cdot \frac{\$^2 \frac{1}{Q^2} \cdot \frac{0,057}{0,057} \cdot \frac{0,069}{0,069}}{}$$

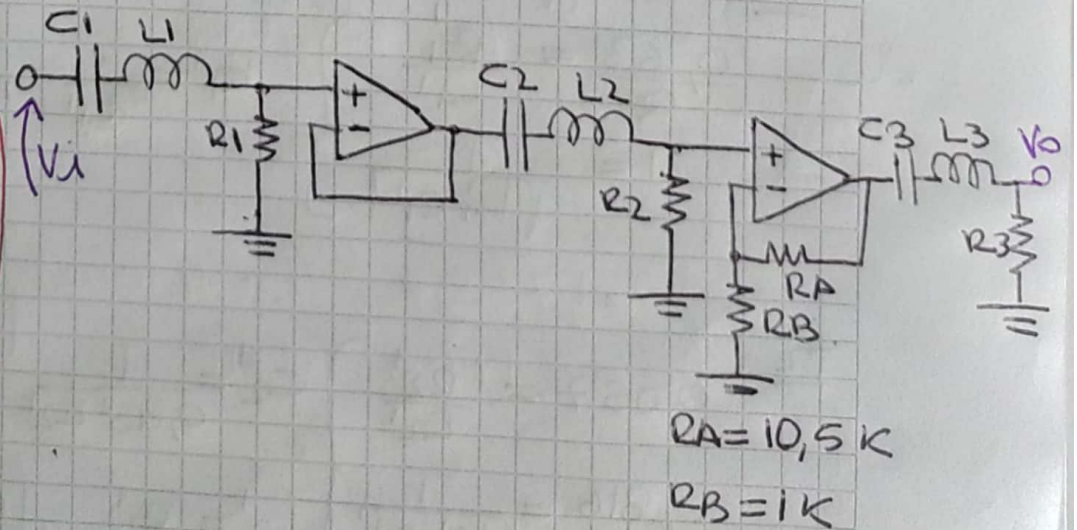
$$\Rightarrow K = \frac{0,716}{0,63} \cdot \frac{1}{Q^2\, 0,057 \cdot 0,069}$$

$$K = 11,56$$

$$T(\$) = K \frac{\$ \cdot \frac{0,63}{Q}}{\$^2 + \$\frac{0,63}{Q} + 1} \cdot \frac{\$ \cdot 0,057}{\$^2 + \$ \cdot 0,057 + 0,816} \cdot \frac{\$ \cdot 0,069}{\$^2 + \$ 0,069 + 1,226}$$

- Desnormalizando por $W_o = 2\pi\, 22K$.

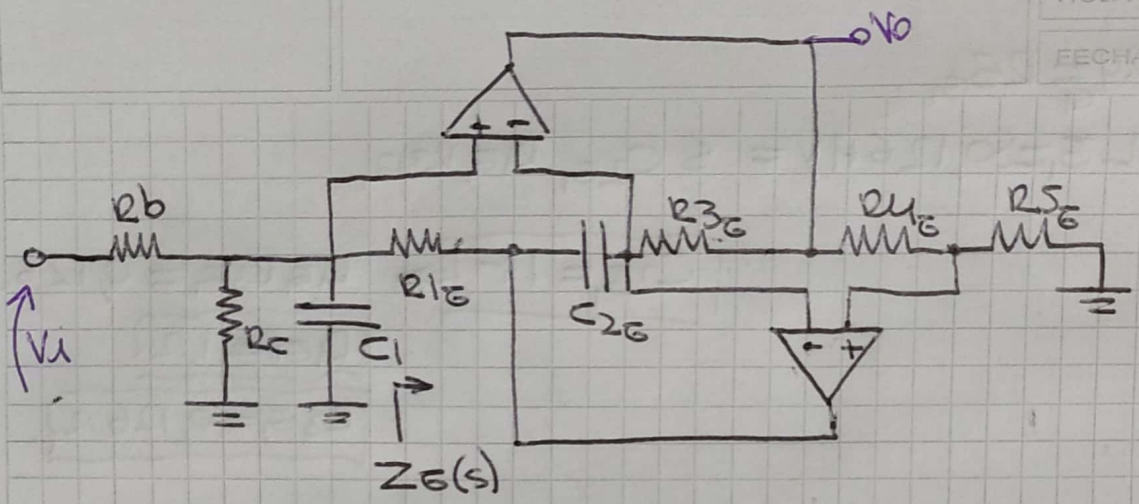
$C_1 = 911,52\,nF$
$C_2 = 506,4\,nF$
$C_3 = 405,12\,nF$
$L_1 = 57,44\,\mu HY$
$L_2 = 126,89\,\mu HY$
$L_3 = 104,83\,\mu HY$
$R_1 = R_2 = R_3 = 1\,\Omega$



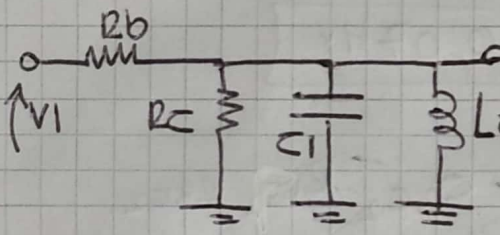
$R_A = 10,5\,K$

$R_B = 1\,K$

NOTA



$$Z_E(s) = \frac{R_{1E} R_{3E} \; R_{5E}}{\frac{1}{sC_{2E}} R_{4E}} = sC_{2E} \frac{R_{1E} R_{3E} R_{5E}}{R_{4E}}$$



$$V_o = V_x \left(1 + \frac{R_4}{R_5}\right)$$

$$R_b = \frac{R}{a}$$

$$R_c = \frac{R}{1-a}$$

$$\frac{V_x}{V_i} = \frac{\frac{1}{1/R_c + sC_1 + 1/sL_E}}{R_b + \frac{1}{\frac{1}{R_c} + sC_1}}$$

$$\frac{V_x}{V_i} = \frac{R_c}{R_c + R_b} \cdot \frac{s \frac{1}{C_1 R_c // R_b}}{s^2 + s \frac{1}{C_1 R_c // R_b} + \frac{1}{L_E C_1}}$$

T1

$$\begin{cases} \frac{0,63}{Q} = \frac{1}{C_1 R_c // R_b} \Rightarrow C_1 = \frac{Q}{0,63} \frac{1}{R_c // R_b} \\ 1 = \frac{1}{L_{E_1} C_1}, \; L_{E_1} = \frac{1}{C_1} \end{cases}$$

Adopto $R_c = R_b$

$\Rightarrow a = \frac{1}{2}$

$\Rightarrow C_1 = \frac{Q}{0,63} \frac{1}{R}$

- $R_c = 2R$
- $\frac{R_c}{R_c + R_b} = 0,5$
- $R_c // R_b = \frac{R_c}{2} = R$

Adopto $\boxed{R = 1}$

$\Rightarrow \boxed{C_1 = 7,936 F}$

$\boxed{L_{E_1} = 0,126 HY}$

NOTA

$\Rightarrow R4_{G1} = R5_{G1}$

$SL_{G1} = 50{,}126\,HY = S\,C_{2G1} \cdot R_{1G1} R_{3G1}$.

$\boxed{C_{2G1} = 1\,F} \Rightarrow R_{1G1} R_{3G1} = 0{,}126\,\Omega^2$.

$\boxed{R_{1G1} = 1\,\Omega}$

$\boxed{R_{3G1} = 0{,}126\,\Omega}$.

T2

MISMO CRITERIO PARA DIVISOR RESISTIVO, $R = 1 \wedge a = \frac{1}{2}$.

$$\begin{cases} 0{,}057 = \dfrac{1}{C_2 R_C // R_b} = \dfrac{1}{C_2 1\Omega} \Rightarrow \boxed{C_2 = 17{,}54\,F} \\ 0{,}816 = \dfrac{1}{C_2 L_{G2}} \Rightarrow \boxed{L_{G2} = 0{,}07\,HY} \end{cases}$$

- $R4_G = R4_G$ $\quad 0{,}07\,HY = C_{2G2}\, R_{1G2}\, R_{3G2}$.

$\boxed{C_{2G2} = 1F} \Rightarrow R_{1G2} R_{3G2} = 0{,}07\,\Omega^2$

$\boxed{R_{1G2} = 0{,}1\,\Omega}$.

$\boxed{R_{2G2} = 0{,}7\,\Omega}$.

T3

MISMO CRITERIO PARA DIVISOR RESISTIVO, $R = 1 \wedge a = \frac{1}{2}$.

$$\begin{cases} 0{,}069 = \dfrac{1}{C_3 R_C // R_b} = \dfrac{1}{C_3 1\Omega} \Rightarrow \boxed{C_2 = 14{,}44\,F} \\ 1{,}226 = \dfrac{1}{C_3 L_{G3}} \Rightarrow \boxed{L_{G3} = 0{,}056\,HY} \end{cases}$$

PARA QUE la ganancia total sea 11,56, $1 + \frac{R4}{R5} = \frac{11{,}56}{0{,}5}$

$1 + \frac{R4}{R5} = 23{,}12$.

$\frac{R4}{R5} = 22{,}12$.

$\boxed{R4 = 22\,\Omega}$

$\boxed{R5 = 1\,\Omega}$

$L_{G3} = 0{,}056\,HY = C_{3G3}\, R_{1G3}\, R_{3G3}\, \frac{R5_{G3}}{R4_{G3}}$

$0{,}056\,HY \cdot 22 = C_{3G3} \cdot R_{1G3} R_{3G3}$.

$1{,}232\,HY = C_{3G3} R_{1G3} R_{3G3}$.

NOTA

HOJA Nº

FECHA

$C_{3G_3} = 1F$

$R_{1G_3} = 1\Omega.$

$R_{3G_3} = 1,22\Omega.$