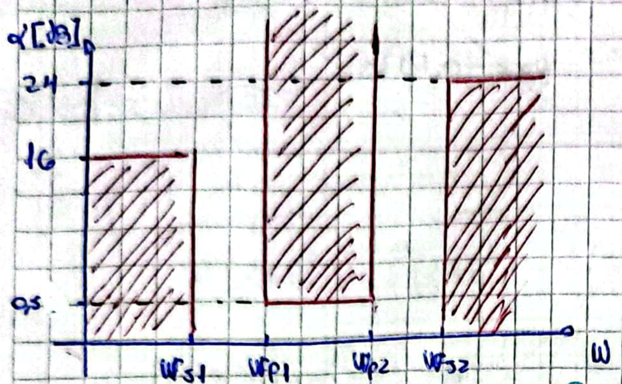
HOJA N°

FECHA

Tarea Semanal 4 bis bis

① Obtengo plantilla de atenuación



Dado que la plantilla es asimétrica y los métodos vistos son simétricos, elijo las restricciones más críticas.

$\alpha_{min} = 24dB$

② Normalizo plantilla $\Omega\omega = \omega_0 = 2\pi \cdot 22k$

$$\omega_0 = \sqrt{\omega_{p1} \cdot \omega_{p2}} = 138.238 \ \frac{rad}{seg}$$

$$Q = 5 = \frac{\omega_0}{B\omega} = \frac{\omega_0}{\omega_{p2} - \omega_{p1}}$$

$\omega_{p1} = 2\pi \cdot 19{,}909k \rightarrow \omega_{p1} = 0{,}905$

$\omega_{p2} = 2\pi \cdot 24{,}309k \rightarrow \omega_{p2} = 1{,}105$

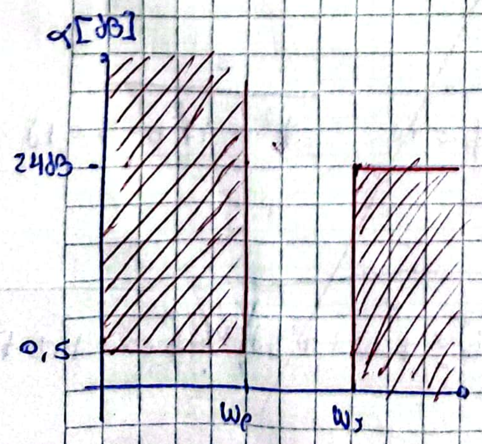
$\omega_{s1} = 2\pi \cdot 17kHz \rightarrow \omega_{s1} = 0{,}773$

$\omega_{s2} = 2\pi \cdot 36k \rightarrow \omega_{s2} = 1{,}636$

③ Aplico Kernell $\omega_{pe} = \frac{\omega^2 - 1}{\omega} \cdot Q$

$$\omega_{p1} = \frac{0{,}905^2 - 1}{0{,}905} \cdot Q \qquad \omega_{p2} = \frac{1{,}105^2 - 1}{1{,}105} Q \qquad \omega_{s1} = \frac{0{,}773^2 - 1}{0{,}773} Q \qquad \omega_{s2} = \frac{1{,}636^2 - 1}{1{,}636} Q$$

$$\underbrace{\omega_{p1} = -1 \qquad \omega_{p2} = 1}_{\omega_p =} \qquad \underbrace{\omega_{s1} = -2{,}603 \qquad \omega_{s2} = 5{,}123}_{\omega_s = 2{,}603}$$



④ Diseño Filtro Cheby

$$\varepsilon^2 = 10^{\alpha_{min} \cdot 0{,}1} - 1 = 0{,}122 \rightarrow \varepsilon = 0{,}349$$

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

Iteración:

n	α_{min}	
1	2,61	✗
2	13,07	✗
3	26,84	✓

NOTA

Forma transferencia Cheby

$C_0 = 1$

$C_1 = w$

$C_n = 2w \cdot C_{n-1} - C_{n-2}$

$C_2 = 2w(w) - (1) = 2w^2 - 1$

$C_3 = 2w(2w^2 - 1) - (w) = 4w^3 - 3w$

$\hookrightarrow C_3^2 = 16w^6 - 24w^4 + 9w^2$

$$|T(jw)|^2 = \frac{1}{1 + \xi^2 \cdot C_3^2} = \frac{1}{1 + \xi^2 (16w^6 - 24w^4 + 9w^2)} = \frac{1}{w^6(16\xi^2) + w^4(-24\xi^2) + w^2(9\xi^2) + 1}$$

$$T(p) \cdot T(-p) = |T(p)|^2 = |T(jw)|^2 \Big|_{w = \frac{p}{j}} = \frac{1}{p^6 \underbrace{(-16\xi^2)}_{-1,9523} + p^4 \underbrace{(-24\xi^2)}_{-2,9284} + p^2 \underbrace{(-9\xi^2)}_{-1,098} + 1}$$

Forma Transferencia LP genérica

$$T(p) \cdot T(-p) = \frac{e}{p^3 \cdot a + p^2 b + p \cdot c + d} \cdot \frac{e}{-p^3 \cdot a + p^2 b - p c + d}$$

$$= \frac{e^2}{p^6(-a^2) + p^5(\cancel{ab - ab}) + p^4(+b^2 - ac - ac) + p^3(\cancel{ad - ad + bc - bc}) + p^2(2bd - c^2) + \dots}$$

$$\dots \; \frac{}{p(\cancel{cd - cd}) + d^2}$$

$$|T(p)|^2 = \frac{e^2}{p^6(-a^2) + p^4(b^2 - ac) + p^2(2bd - c^2) + d^2}$$

NOTA

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④ Igualación de Términos

$c^2 = 1 \rightarrow c = 1$

$d^2 = 1 \rightarrow d = 1$

$-a^2 = -16\xi^2 \rightarrow a = 4\xi = 1,3972$

$b^2 - 2ac = -24\xi^2 \rightarrow b = \sqrt{2ac - 24\xi^2}$ } $b = 1,7506$

$2bd - c^2 = -9\xi^2 \rightarrow 2 \cdot 1 \cdot \sqrt{2ac - 24\xi^2} - c^2 = -9\xi^2$ } $c = 2,1446$

$$T(s) = \frac{1}{s^3 \cdot 1,3972 + s^2 \cdot 1,7506 + s\, 2,1446 + 1}$$

$$T(s) = \frac{0,7157}{s^3 + s^2 \cdot 1,2529 + s \cdot 1,5349 + 0,7157} = \frac{A}{s^3 + s^2 B + sC + D}$$

⑤ Aplico kernel pasabanda y forma transferencia

$$s = \frac{s_{PB}^2 + 1}{s_{PB}} \cdot Q$$

$$T(s) = \frac{A \cdot \frac{s^3}{Q^3}}{\left[\left(\frac{s^2+1}{s} \cdot Q\right)^3 + \left(\frac{s^2+1}{s} Q\right)^2 \cdot B + \left(\frac{s^2+1}{s} Q\right) \cdot C + D\right] \frac{s^3}{Q^3}}$$

$$T(s) = \frac{A \cdot s^3/Q^3}{\left[(s^6 + 3s^4 + 3s^2 + 1)\frac{Q^3}{s^3} + (s^4 + 2s^2 + 1)\frac{Q^2}{s^2} \cdot B + (s^2+1)\frac{Q}{s} \cdot C + D\right] \frac{s^3}{Q^3}}$$

$$T(s) = \frac{A \cdot s^3/Q^3}{(s^6 + 3s^4 + 3s^2 + 1) + (s^4 B + 2s^2 B + B)\frac{s}{Q} + (Cs^2 + C)\frac{s^2}{Q^2} + D \cdot \frac{s^3}{Q^3}}$$

$$T(s) = \frac{A/Q^3 \cdot s^3}{s^6 + 3s^4 + 3s^2 + 1 + s^5 \frac{B}{Q} + \frac{2Bs^3}{Q} + s\frac{B}{Q} + s^4 \cdot \frac{C}{Q^2} + s^2 \cdot \frac{C}{Q^2} + D\frac{s^3}{Q^3}}$$

$$T(s) = \frac{s^3\, A/Q^3}{s^6 + s^5\left(\frac{B}{Q}\right) + s^4\left(3 + \frac{C}{Q^2}\right) + s^3\left(\frac{2B}{Q} + \frac{D}{Q^3}\right) + s^2\left(3 + \frac{C}{Q^2}\right) + s(B/Q) + 1}$$

NOTA

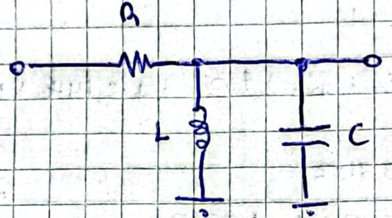
$$T(s) = \frac{0{,}0057256\, s^3}{s^6 + s^5 \cdot 0{,}23058 + s^4 \cdot 3{,}061396 + s^3 \cdot 0{,}50089 + s^2\, 0{,}25088 + 1}$$

(*) Descompongo en transferencias de segundo orden (Python)

$$T(s) = \frac{s \cdot 0{,}06902}{s^2 + s \cdot 0{,}06902 + 1{,}22646} \cdot \frac{0{,}1253\, s}{s^2 + s \cdot 0{,}1253 + 1} \cdot \frac{0{,}05627\, s}{s^2 + s\, 0{,}05627 + 0{,}81535} \cdot 11{,}7663$$

$Q = 16{,}0454$	$Q = 7{,}9808$	$Q = 16{,}0454$
$W_0 = 1{,}1074$	$W_0 = 1$	$W_0 = 0{,}90296$

(*) Bloque Pasabanda Bufferado



$$T(s) = \frac{s \frac{1}{CR}}{s^2 + s \frac{1}{CR} + \frac{1}{LC}}$$

(*) Elaborar Diseño

$$C = \frac{Q}{W_0\, R}$$

$$L = \frac{R}{W_0\, Q}$$

(*) Normalizo $L = 1 \rightarrow R = W_0 \cdot Q$

$$C = \frac{Q}{W_0 \cdot R}$$

Etapa 1: $W_0 = 1{,}1074$ $Q = 16{,}0454$

$L = 1$ $R = 17{,}768$ $C = 0{,}8154$

Etapa 2: $W_0 = 1$ $Q = 7{,}9808$

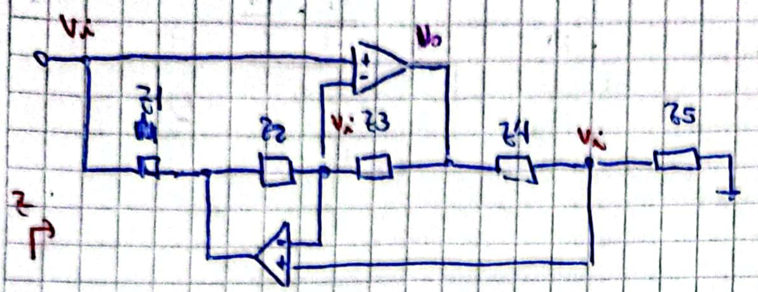
$L = 1$ $R = 7{,}9808$ $C = 1$

Etapa 3: $W_0 = 0{,}90296$ $Q = 16{,}0454$

$L = 1$ $R = 14{,}4884$ $C = 1{,}2263$

Escaneado con CamScanner

Activación de las Bobinas



$$Z = \frac{Z_1 \cdot Z_3 \cdot Z_5}{Z_2 \cdot Z_4} \rightarrow Z_2 = \frac{1}{sC_{GC}}$$

$$Z_1 = Z_3 = Z_5 = Z_4 = R = 1$$

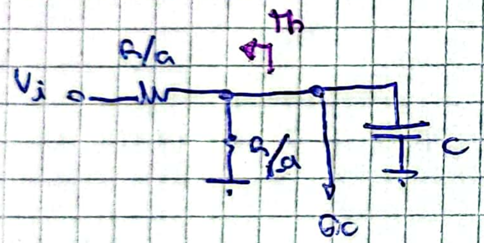
Para emular la Bobina

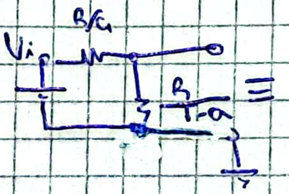
$$L = C_{GC}$$

Cálculo de Vo

$$V_i = V_o \cdot \frac{Z_5}{Z_4+Z_5} = V_o \cdot \frac{R}{R+R} = \frac{V_o}{2} \longrightarrow V_o = 2 \cdot V_i$$

Análisis Levantamiento





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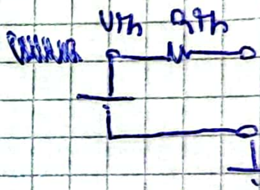

$$V_{Th} = V_i \cdot \frac{R}{1-a} \cdot \frac{1}{\frac{1-a}{(1-a)}\frac{R}{a} + \frac{R}{1-a}\frac{a}{a}} = V_i \cdot \frac{R}{1-a} \cdot \frac{(1-a)\cdot a}{R - Ra + R \cdot a} = V_i \cdot a \rightarrow$$ atenúa la entrada

$$R_{Th} = \frac{R}{a} \parallel \frac{R}{1-a} = R \rightarrow$$ No cambian polos y ceros del sistema

Forma conexión

Dado que el GIC añade una ganancia del doble de tensión, podemos adaptar el nivel de ganancia con el atenuador haciendo que a = 0,5 para las etapas 2 y 3