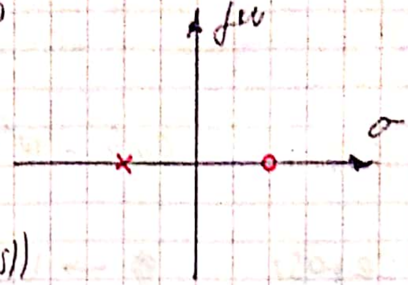
① a: **Pasa-Todo** 1° orden:

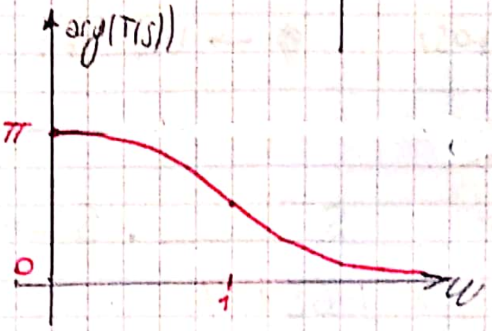
$$T(s)=\frac{S-W_0}{S+W_0} \xrightarrow{} T(s)=\frac{S-1}{S+1}$$

normalizo

① Diagrama de polos y ceros: →



② Respuesta de fase →



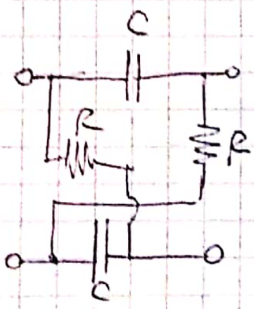
③ Fase: $\operatorname{arctg}\left(\frac{\omega}{-1}\right)-\operatorname{arctg}\left(\frac{\omega}{1}\right)+\pi$

$\arg(T(j\omega))=-2\operatorname{arctg}(\omega)+\pi$

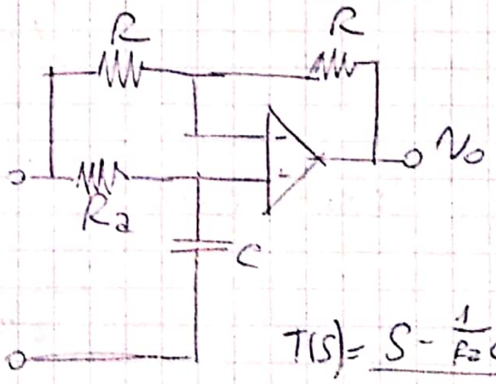
Retardo de grupo: $-\frac{\partial\theta}{\partial\omega}=+2\,\frac{\partial(\operatorname{arctg}(\omega))}{\partial\omega}=2\cdot\frac{1}{1+\omega^2}=\frac{2}{1+\omega^2}$

$$\boxed{\tau_g(\omega)=\frac{2}{1+\omega^2}}$$

ⓑ



$$T(s)=\frac{S-\frac{1}{RC}}{S+\frac{1}{RC}}$$



$$T(s)=\frac{S-\frac{1}{R_aC}}{S+\frac{1}{R_aC}}$$

$\theta=-2\operatorname{arctg}\left(\frac{\omega}{\omega_0}\right) = (15°)_{rad}=0{,}262$

$\operatorname{arctg}\left(\frac{\omega}{\omega_0}\right)=0{,}130 \Rightarrow \boxed{\omega_0\cong 8}$

En ⓐ $\boxed{R=1\quad C=125\,mF}$ ⓑ $\boxed{R_a=1\quad C=125\,mF\quad R=1}$

HOJA N°

FECHA

Ejercicio ②.

ⓐ $T(0) = \frac{K\,(\cancel{s^2} + \cancel{s\frac{\omega_n}{Q_n}} + \omega_n^2)}{\cancel{s^2} + \cancel{s\sqrt{2}} + 1}$.

$T(0) = \frac{K\,\omega_n^2}{1} = 1 \rightarrow K = \omega_n^{-2}$.

$T(\infty) = \frac{K\,(s^2 + \cancel{s\frac{\omega_n}{Q_n}}^{\,0} + \cancel{\omega_n^2}^{\,0})}{s^2 + \cancel{s\sqrt{2}}^{\,0} + \cancel{1}^{\,0}} = \frac{K\,\cancel{s^2}}{\cancel{s^2}} = K$.

$20 \cdot \log(K) = -12. \longrightarrow 0{,}2519$.

→ Filtro notch $Q_n \rightarrow \infty$

$T(s) = \frac{K\,(s^2 + 1/K)}{s^2 + \sqrt{2}\,s + 1}$ $/ K = 0{,}2519$.

ⓑ $T(0) = \frac{K\,(\cancel{s^2} + \cancel{s\frac{\omega_n}{Q_n}} + \omega_n^2)}{\cancel{s^2} + \cancel{\sqrt{2}\,s} + 1} = K\,W_n^2 = 1$.

$T(\infty) = \frac{K\,(s^2 + s\frac{\omega_n}{Q_n} + \omega_n^2)}{s^2 + \sqrt{2}\,s + 1} \Rightarrow K \therefore 20\log(K) = 0 \rightarrow K = 1$.

$\therefore K = 1 = W_n = 1$.

NOTA

$$T(1)\Big|_{dB} = 20\log(1/Q_n) - 20\log(\sqrt{2}) = -6dB$$

$$20\log\left(\frac{1}{Q_n}\right) = -3dB.$$

$$Q_n^{-1} = 10^{\frac{-3}{20}} \Rightarrow \sqrt{2}.$$

$$T(S) = \frac{S^2 + 0{,}707S + 1}{S^2 + 1{,}4125S + 1}.$$

ⓒ $T(S) = \dfrac{k\left(S^2 - S\frac{\omega_n}{Q} + \omega_n^2\right)}{S^2 + \sqrt{2}S + 1}.$

$T(1) = \dfrac{2+x}{2+\sqrt{2}} = 10^{-\frac{6}{20}}$

$x = (2+\sqrt{2})\sqrt{2} - 2.$

$$T(j\omega) = \frac{k\left(-\omega^2 - j\omega\frac{\omega_n}{Q} + \omega_n^2\right)}{-\omega^2 + j\omega\sqrt{2} + 1}.$$

$$\arg(T(j\omega)) = \operatorname{arctg}\left(\frac{\omega_n^2 - \omega^2}{-\omega\frac{\omega_n}{Q}}\right) - \operatorname{arctg}\left(\frac{1-\omega^2}{\omega\sqrt{2}}\right)$$

$$\operatorname{arctg}(T(j.1)) = \operatorname{arctg}\left(\frac{\omega_n^2 - 1}{-\frac{\omega_n}{Q}}\right) - \cancel{\operatorname{arctg}\left(\frac{1-1}{\sqrt{2}}\right)} \to \cancel{0}$$

$$-\frac{3}{2}\pi = \operatorname{arctg}\left(-\omega_n Q + \frac{Q}{\omega_n}\right)$$

$$\operatorname{tg}\left(-\frac{3}{2}\pi\right) = Q\left(\frac{\omega_n^2 - 1}{-\omega_n}\right) \to \text{si}$$

ⓒ Por el gráfico → Pasa todo.

$w_0 = 0{,}5 \ \frac{rd}{s}$

$$\therefore \quad H(s) = \frac{s^2 - s\frac{w_0}{Q} + w_0^2}{s^2 + s\frac{w_0}{Q} + w_0^2} = \frac{s^2 - \frac{\sqrt{2}}{2} s + \frac{1}{4}}{s^2 + \frac{\sqrt{2}}{2} s + \frac{1}{4}}$$

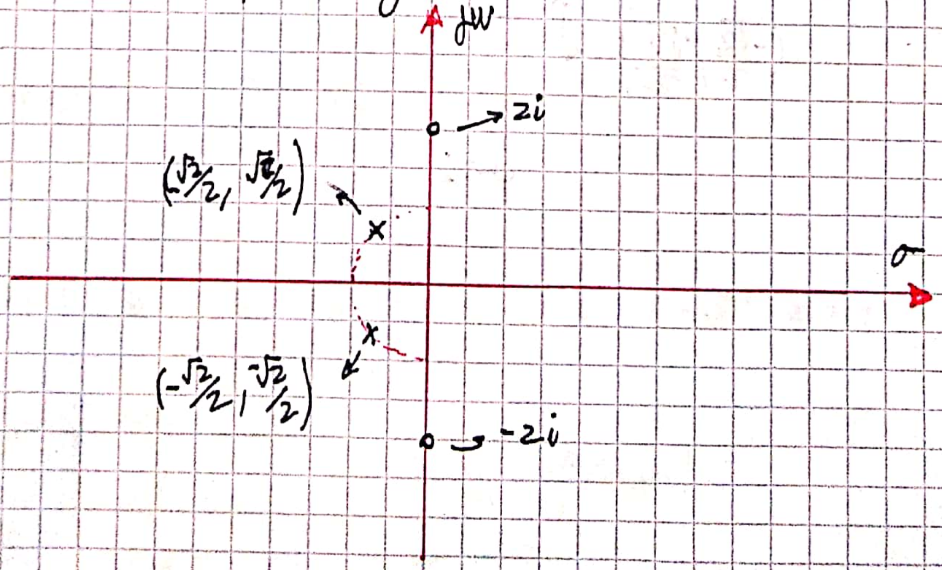
ⓓ Existe un salto de π en la fase → filtro Notch

$f_z = 3Hz \rightarrow w_z = 3Hz.$

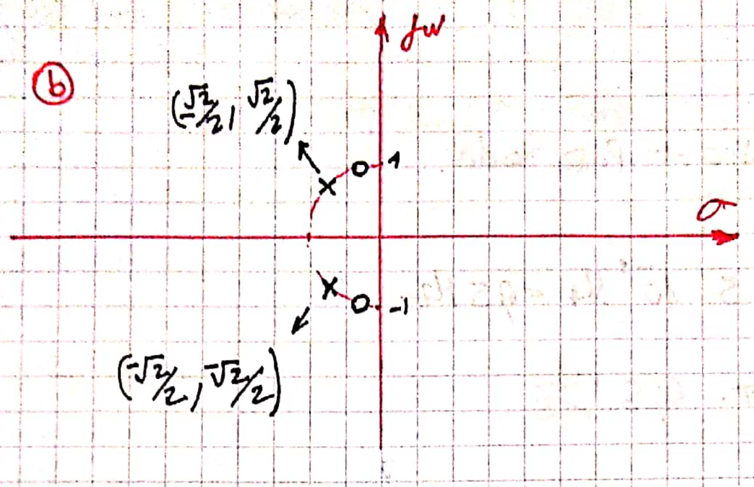
$$N(s) = \frac{s^2 + (3Hz)^2}{s^2 + \sqrt{2}\, s + 1}$$

• Diagramas de polos y ceros.

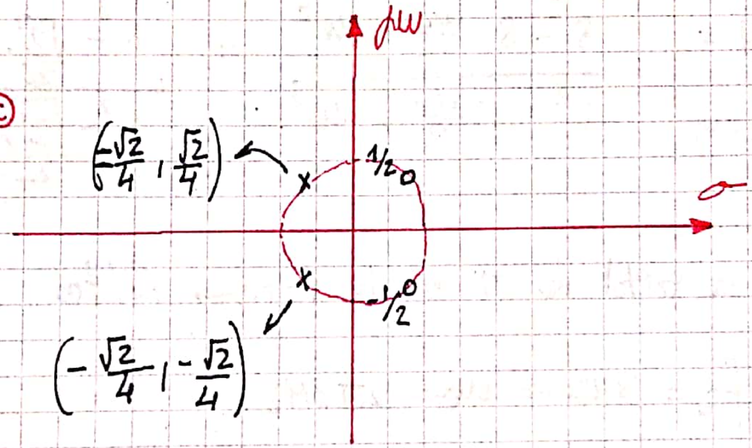
ⓐ



(b)



(c)



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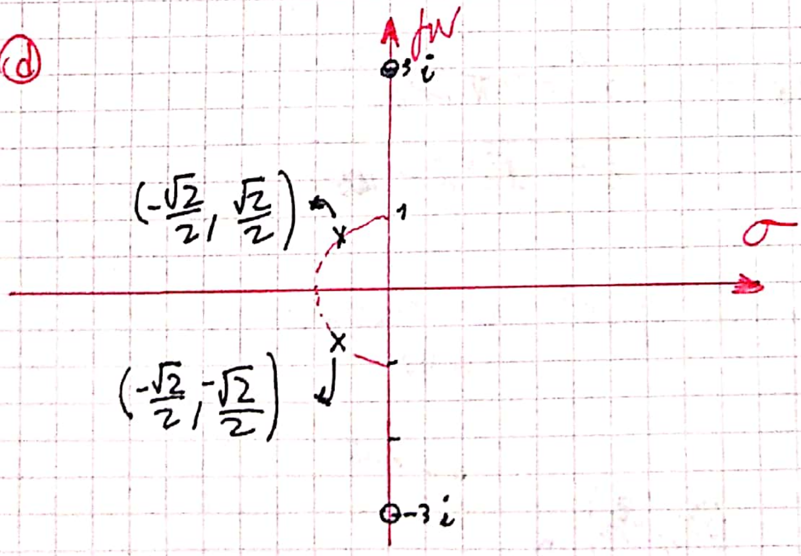


HOJA Nº

FECHA

② Proponga circuito:

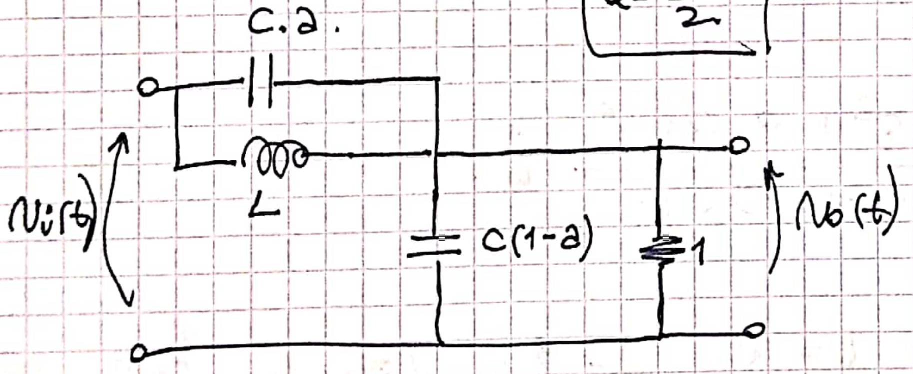
ⓐ $T(s) = \dfrac{0{,}2519\,(s^2 + 1/k)}{s^2 + \sqrt{2}\,s + 1}$ $\quad / \; k = 0{,}2519$

$$T(s) = a\,\frac{\left(s^2 + s\,\frac{b}{a}\cdot\frac{1}{RC} + \frac{d}{a}\cdot\frac{1}{LC}\right)}{s^2 + s\,\frac{1}{RC} + \frac{1}{LC}}.$$

$a = 0{,}2519 \quad b = 0 \quad d = 1.$

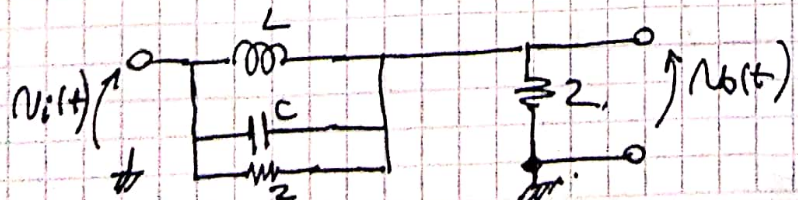
$R = 1 \quad Q = L \quad Q = \frac{1}{C}.$

$\boxed{Q = \frac{\sqrt{2}}{2}}$



ⓑ $T(s) = \dfrac{s^2 + \frac{\sqrt{2}}{2}\,s + 1}{s^2 + \sqrt{2}\,s + 1}$

$a = 1 \quad b = 0{,}5. \quad d = 1 \quad L = Q \quad C = Q^{-1} \quad R = 1 \quad Q = \frac{\sqrt{2}}{2}$



NOTA

ⓒ. Filtro pasa-todo.

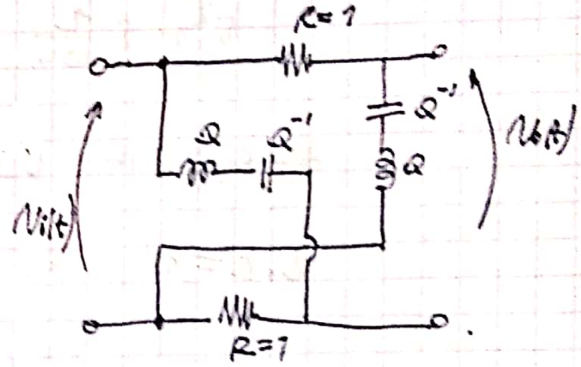
$Z_1 = \frac{1}{sC} + sL$

$Z_2 = R.$

Lattice.

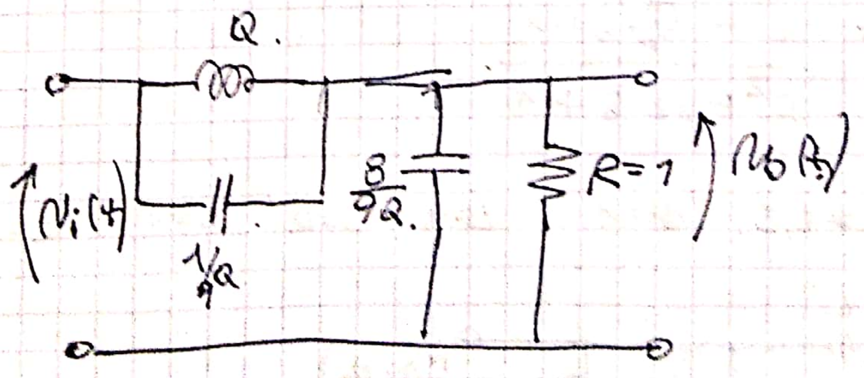
$$H(s) = \frac{Z_2 - Z_1}{Z_2 + Z_1} = \frac{s^2 + \frac{1}{LC} - s\frac{R}{L}}{s^2 + \frac{1}{LC} + s\frac{R}{L}}$$

$$H(s) = \frac{s^2 - s\,R/L + 1/LC}{s^2 + s\,R/L + 1/LC}.$$



ⓓ $$H(s) = \frac{s^2 + 9\cdot(1Hz)^2}{s^2 + \sqrt{2}\,s + 1}\,\frac{1}{9}.$$

$a = \frac{1}{9}$ $b = 0$ $d = 9.$ $L = Q = \frac{\sqrt{2}}{2}$ $C = \frac{1}{L}$ $R = 1$



HOJA N°

FECHA

③ $\varphi(w) = \frac{\pi}{2} - \operatorname{arctg}\left(\frac{6w}{-w^2+4}\right)$

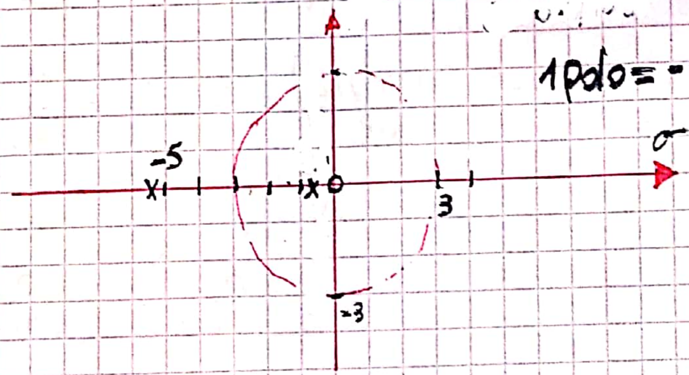
∴ Polos: $6wi - w^2 + 4 = 6s + s^2 + 4$

Ceros: → Uno solo en el origen.

ⓐ $F(s) = \frac{s}{s^2+6s+4} \cdot 6$ → supongo para normalizar

ⓑ

1 polo = −0,76   2 polo = −5,23



Circuito pasivo: $\frac{\frac{R}{L}s}{s^2+\frac{R}{L}s+\frac{1}{LC}}$

$\frac{R}{L} = 6$ $\frac{1}{LC} = 4$ Si $R=1$

↳ $L = \frac{1}{6}$ $C = \frac{6}{4}$

→ Simulación Spice + python.

NOTA