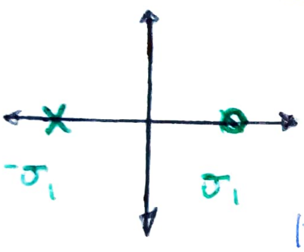
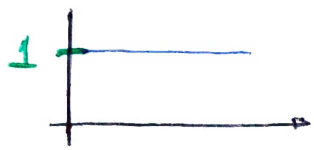
TAREA semanal 4

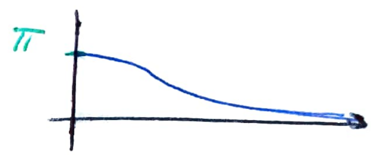
La T.F de 1° orden que permite rotar la fase sin alterar el módulo es... ~~una TF que~~

$$T(s) = K \cdot \frac{s - z_1}{s + p_1} \qquad \text{donde } p_1 = z_1 = \sigma$$

$$\boxed{T(s) = K \cdot \frac{s - \sigma}{s + \sigma}}$$







$$|T| = \left| \, K \cdot \frac{s - \sigma_1}{s + \sigma_1} \bigg|_{s = j\omega} \right|$$

$$\sqrt{\frac{\omega^2 + (-\sigma_1)^2}{\omega^2 + \sigma_1^2}}$$

$$|T| = 1 \quad \forall \omega$$

$$\varphi = \operatorname{arctg}(-\omega/\sigma_1) - \operatorname{arctg}(\omega/\sigma_1)$$

$$\varphi \Big|_{\omega \to 0} = \pi - 0$$

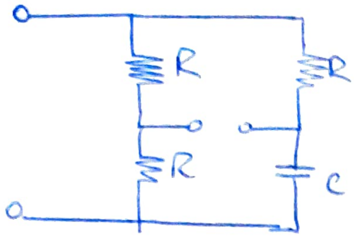
$$\varphi \Big|_{\omega \to \infty} = 0$$

$$\tau(\omega) = -\frac{\partial \varphi}{\partial \omega} = -\frac{\partial}{\partial \omega}\left[\operatorname{arctg}(-\omega/\sigma_1) - \operatorname{arctg}(\omega/\sigma_1) \right]$$

$$\tau(\omega) = = -\left[\frac{-1/\sigma_1}{1 + \left(\frac{-\omega}{\sigma_1}\right)^2} - \frac{1/\sigma_1}{1 + \left(\frac{\omega}{\sigma_1}\right)^2} \right] = \boxed{\frac{2/\sigma_1}{1 + (\omega/\sigma_1)^2} = \tau(\omega)}$$

Implementación Pasiva

$T(\$) = V_R - V_C \rightsquigarrow$ son 2 divisores



$$T(\$) = \frac{1}{2} - \frac{1/\$C}{R + 1/\$C}$$

$$T(\$) = \frac{1}{2} \cdot \frac{\$ - 1/CR}{\$ + 1/CR}$$

$$\boxed{T(\$) = 1/2 \cdot \frac{\$ - \sigma_1}{\$ + \sigma_1} \; ; \; \sigma_1 = 1/CR}$$

$$\varphi\Big|_{\omega=0} = 180° = \pi$$

$$\varphi\Big|_{\omega=1} = \operatorname{arctg}(-1/\sigma) - \operatorname{arctg}(1/\sigma) = 165° = \frac{11 \cdot \pi}{12}$$

$$= -2 \operatorname{arctg}(1/\sigma_1) = \frac{11 \cdot \pi}{12} \Rightarrow 1/\sigma_1 = \left| tg\left(\pi \cdot \frac{11}{12 \cdot 4}\right) \right|$$

$$1/\sigma_1 = 7{,}595 \quad \wedge \quad \sigma_1 = 1/CR$$

$$\Rightarrow C \cdot R = 7{,}595$$

$C_n = 1$
$R_n = 7{,}595$

$\Omega_z = 100k$
$\Omega_\omega \rightarrow$ carece de sentido en un All-Pass

$\Rightarrow R = 100k$

$C = 75{,}95\ \mu f$

$\downarrow$

Veo en spice que está al revés el CR

efectivamente con estos valores tengo 15°, debería tener 165°

En realidad debo diseñar para 15° no para 165° porque matemáticamente la calculadora no usa atan2 y no se da cuenta del ángulo

$$\Rightarrow \quad 1/\sigma_1 = tg\left(\frac{\pi}{2 \cdot 12}\right) \quad \rightarrow 15°$$

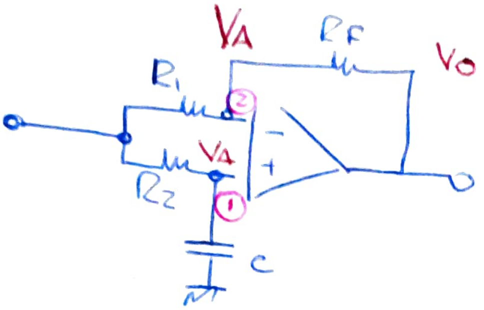
$1/\sigma_1 = 0{,}1316 \quad \therefore \quad C.R = 0{,}1316 \Rightarrow$ Adopto

Uso $\Omega_Z = 100k$ $\begin{cases} R = 0{,}5 \\ C = 0{,}26 \end{cases}$

$R = 50k$

$C = 2{,}632 \ \mu F$

Implementación Activa



① $$V_A = V_i \cdot \frac{1/\$C}{1/\$C + R_2}$$

② $$V_A\left(\frac{1}{R_1} + \frac{1}{R_F}\right) = \frac{V_i}{R_1} + \frac{V_o}{R_F}$$

$$V_i\left(\frac{1/\$C}{1/\$C + R_2}\left(\frac{1}{R_1} + \frac{1}{R_F}\right) - \frac{1}{R_1}\right) = \frac{V_o}{R_F}$$

$$\frac{V_o}{V_i} = R_F\left(\frac{1}{\$\cdot C\cdot R_2 + 1}\,\frac{R_F + R_1}{R_1\cdot R_F} - \frac{1}{R_1}\right) = \cancel{R_F}\,\frac{(R_F + R_1)R_1 - \$\cdot C\cdot R_2\cdot R_1\cdot R_F - R_1\cdot R_F}{\$\cdot C\cdot R_2\cdot R_1^2\cdot \cancel{R_F} + R_1^2\,\cancel{R_F}}$$

$$T(\$) = \frac{-\$\cdot C\cdot R_2\cdot \cancel{R_1}\cdot R_F + R_F\cancel{R_1} + R_1^{\cancel{2}} - \cancel{R_1 R_F}}{\$\cdot C\cdot R_2\cdot R_1^{\cancel{2}} + R_1^{\cancel{2}}}$$

$$T(\$) = -\frac{\$\cdot C\cdot R_2\,R_F + R_1}{\$\cdot C\cdot R_2\cdot R_1 + R_1} = \frac{-\cancel{C}.\cancel{R_2}.R_F}{\cancel{C}.\cancel{R_2}.R_1}\;\frac{\$ - R_1/C.R_2.R_F}{\$ + \cancel{R_1}/C.R_2.\cancel{R_1}}$$

$$T(\$) = -\underbrace{\frac{R_F}{R_1}}_{K}\;\frac{\$ - \frac{R_1}{C.R_2.R_F}}{\$ + 1/C.R_2} = -K\,\frac{\$ - 1/C.R_2.K}{\$ + 1/C.R_2}$$

Me veo obligado a $K = 2 \Rightarrow R_1 = R_F = 1\Omega$, C ∧ R mantienen el valor de antes.

$$T(s) = K \cdot \frac{s^2 + s \cdot \omega_n/q_n + \omega_n^2}{s^2 + s \cdot \omega_p/q_p + \omega_p^2}$$

Si el denominador responde a un Butter de 2º ORDEN

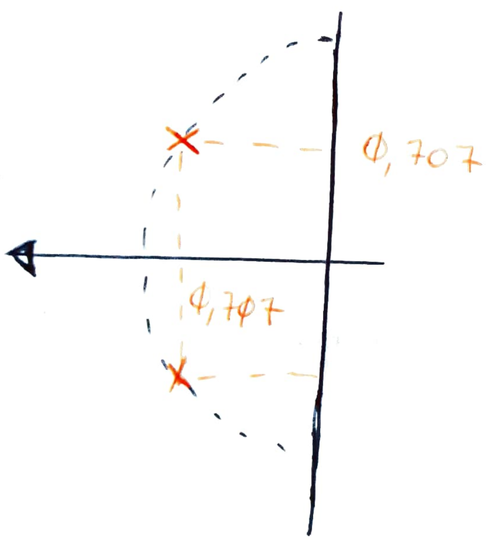
- $\omega_0 = \omega_0^2 = 1$
- $1/Q = 2 \cos(\overset{45^\circ}{\pi/4})$

} YA conozco un montón de cosas

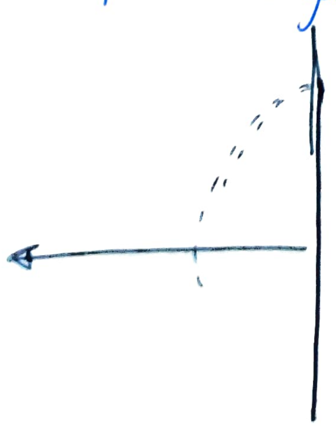
$1/Q = \sqrt{2}$

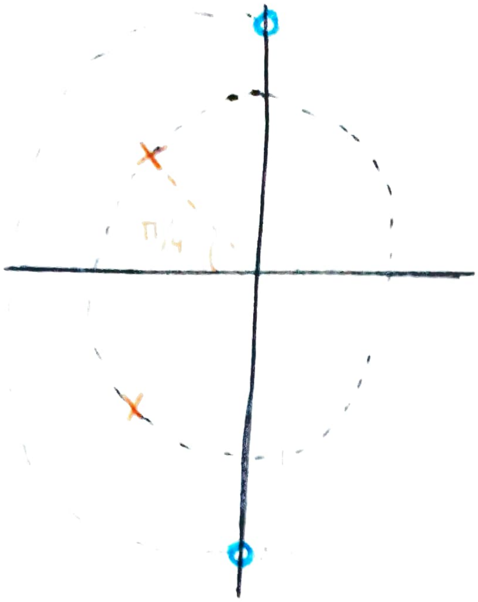
=> Den = $s^2 + \sqrt{2} \cdot s + 1$ => Polo en $s = -0{,}707 \pm j\, 0{,}707$

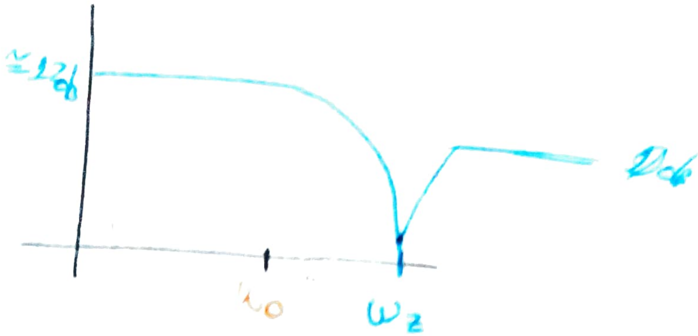
$= -\frac{\sqrt{2}}{2} \pm j \frac{\sqrt{2}}{2}$

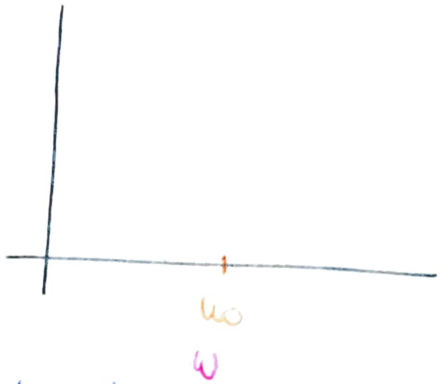


Lo que me piden lo logro con la ubicación de los Z o









$$\boxed{T_N = \frac{s^2 + z^2}{s^2 + s\sqrt{2} + 1}}$$ → Veo que el ω_z se da en "z" => la fórmula sale sola

$$T_{EB} = \frac{?}{s^2 + s\sqrt{2} + 1}$$

$$|T_{EB}|\Big|_{\omega=1} = -6\text{dB} = 0{,}5$$

$$\frac{s^2 + s\,\omega_z/Q_z + \omega_z^2}{s^2 + s\,\omega_0/Q + \omega_0^2}\Bigg|_{s=j\omega} = \frac{-\omega^2 + j\omega \cdot \omega_z/Q_z + \omega_z^2}{-\omega^2 + j\omega \cdot 1/Q + 1}$$

Adopto $\omega_z = 1$ => $$\frac{\sqrt{(\omega/Q_z)^2 + (1-\omega^2)^2}}{\sqrt{(\omega/Q)^2 + (1-\omega^2)^2}}\Bigg|_{\omega=1} \sqrt{\frac{(1/Q_z)^2}{(1/Q)^2}} = 0{,}5$$

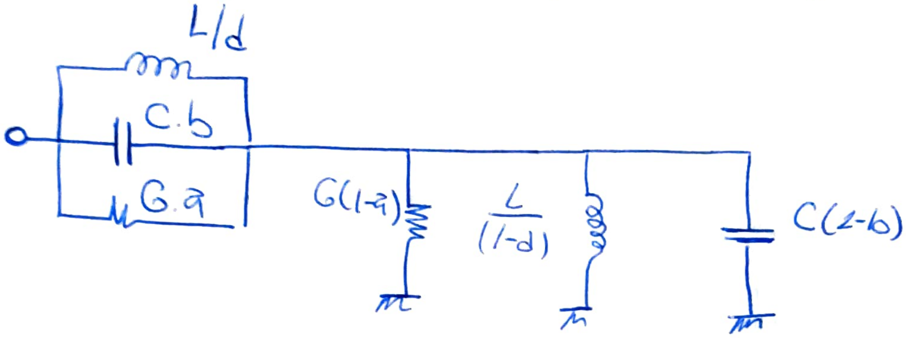
$$1/Q_z = 0{,}5 \cdot 1/Q \cdot \sqrt{2} \Rightarrow 1/Q_z = \frac{\sqrt{2}}{2} \cdot 2\cos(\psi)$$

$$\psi = 1{,}209 \cong 69°$$

$$\boxed{TEB(\$) = \frac{\$^2 + \$ \cdot \sqrt{2}/2 + 1}{\$^2 + \$ \cdot \sqrt{2} + 1}}$$

Implementación

Pasiva es posible?? → Sí porque es de $\emptyset$ dB



$$T(\$) = b \cdot \frac{\$^2 + \$ \cdot \frac{G \cdot a}{C \cdot b} + \frac{d}{C \cdot b \cdot L}}{\$^2 + \$ \cdot \frac{G}{C} + 1/LC}$$

$$T(\$) = \frac{\$^2 + \$ \sqrt{2}/2 + 1}{\$^2 + \$\sqrt{2} + 1} \Rightarrow$$

- $b = 1$ → $\emptyset$ dB
- $\frac{G}{C} = \sqrt{2}$
- $\frac{G}{C} \cdot \frac{a}{b} = \frac{\sqrt{2}}{2} \Rightarrow \frac{a}{b} = \frac{1}{2} \therefore a = 1/2$
- $1/LC = 1 \therefore \frac{d}{b} = 1$

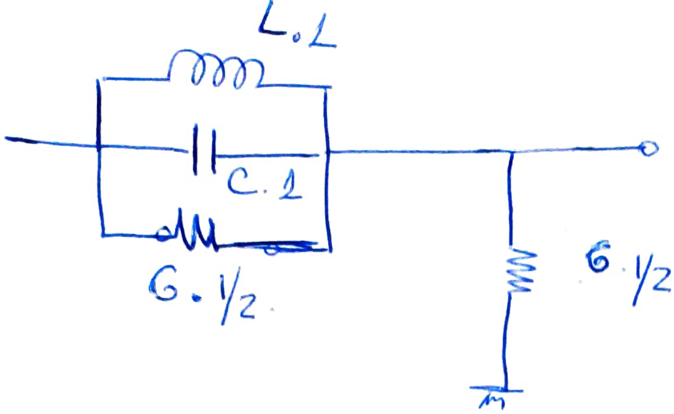
$\Rightarrow a = 1/2$

$b = 1$

$d = 1$

$L = C = 1$

$\frac{1}{RC} = \sqrt{2} \Rightarrow R = 1/\sqrt{2} \Rightarrow G = \sqrt{2}$



$$\Rightarrow \frac{V_o}{V_i} = T(\$) = \frac{\$C + \frac{1}{\$L} + \frac{G}{2}}{\$C + \frac{1}{\$L} + G} = \frac{\$^2 LC + \$.L.\frac{G}{2} + 1}{\$^2 LC + \$LG + 1}$$

$$T(\$) = \frac{\$^2 + \$\,\frac{G}{C.2} + 1/LC}{\$^2 + \$\,\frac{G}{C} + 1/LC} \quad ; \quad \begin{array}{l} G = \sqrt{2} \\ L = 1 \\ C = 1 \end{array} \Rightarrow \boxed{\frac{\$^2 + \$\,\frac{\sqrt{2}}{2} + 1}{\$^2 + \$\sqrt{2} + 1}}$$

Cumple impecable

$\Omega z = \cancel{10k}\ 2k$

$\Omega w = 2\pi.\,1KHz$

$R_n = 1/\sqrt{2}$

$C_n = 1$

$L_n = 1$

$$\boxed{\begin{array}{l} R = 1/\sqrt{2} \cdot 10k = \cancel{7{,}07}\ 1414\,k \\ C = \frac{1}{10k.2\pi.1k} = \cancel{15{,}9}\,nf \\ L = \frac{1.\,10k}{2\pi.1k} = \cancel{159{,}15}\ 318{,}3\ mHy \end{array}}$$

$= 1414\ \Omega$

$= 79{,}57\ nf$

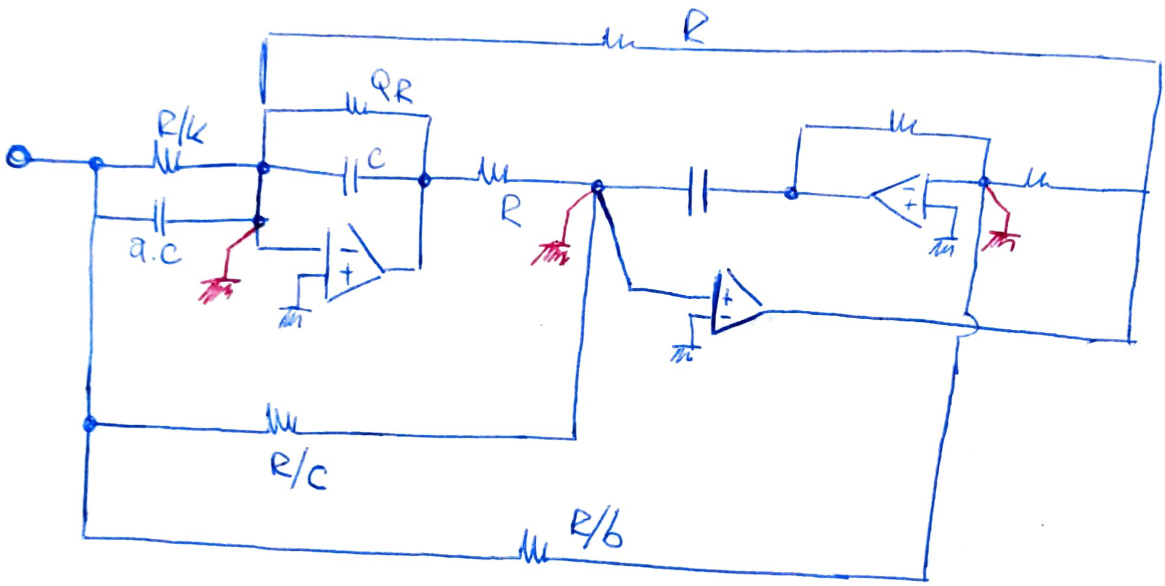
$318{,}3\ mHy$

Implementación

$$\frac{s^2+4}{s^2+s\sqrt{2}+1} = \frac{s^2+2^2}{s^2+s\sqrt{2}+1} \rightarrow \text{ESTO NO Tiene } \emptyset \text{ dB}$$

$\Rightarrow$ Activo

Uso un ACK-Moss levantado



Considerando $T(s) = -\dfrac{a.s^2 + s.\omega_0(k-b) + c.\omega_0^2}{s^2 + s.\omega_0/q + \omega_0^2}$; $CR = 1/\omega_0$

No estoy normalizado así que $\omega_0 = 1$ ∴ $C.R = 1 \Rightarrow C = 1$
$R = 1$

$a = 1$ $q = 1/\sqrt{2}$

$k - b = \emptyset$

$c = 4$

$$\Rightarrow T(s) = -\frac{s^2+4}{s^2+s.\sqrt{2}+1}$$

$\Omega_z = \cancel{2k}\ 1K$

$\Omega_w = 2\pi \cdot \cancel{2}kHz$

$\Rightarrow$ $R = 1$ $\longrightarrow$ $\cancel{2k}$ $1k$

$C = 1$ $\longrightarrow$ $\cancel{39{,}87}\,nf$ $79{,}57\,nf$

$q = 1/\sqrt{2}$

$a = 1$

$k = b = \emptyset$

$c = 4$

esto no cumple

$\Omega_w = 2\pi \cdot 1kHz$

no $2\pi \cdot 2kHz$

porque yo en el circuito debo considerar que siempre me referencié a ω_o y no ω_z

$\omega_z = c\ \omega_o^2$

1kHz

~~Sato~~

$\not{}$ $\Theta(\omega) = \frac{\pi}{2} - \operatorname{arctg}\left(\frac{6\omega}{-\omega^2+4}\right)$

Por simple inspeccioń veo que corresponde con un FBP ⇒ por arrancar en $+\pi/2$

$$\Theta'(\omega) = -\operatorname{arctg}\left(\frac{6\omega}{-\omega^2+4}\right) = \operatorname{arctg}\left(-\frac{6\omega}{-\omega^2+4}\right)$$

$$\frac{F(j\omega)}{F(-j\omega)} = \frac{1 + j\,tg(\Theta'(\omega))}{1 - j\,tg(\Theta'(\omega))} = \frac{1 \mp \frac{j\omega \cdot 6}{4-\omega^2}}{1 + \frac{j\omega 6}{4-\omega^2}}$$

$$\frac{F(j\omega)}{F(-j\omega)} = \left.\frac{1 - \frac{j\omega 6}{4-\omega^2}}{1 + \frac{j\omega 6}{4-\omega^2}}\right|_{\$=j\omega} = \frac{1 - \frac{\$ \cdot 6}{4+\$^2}}{1 + \frac{\$ 6}{4+\$^2}} = \frac{F(\$)}{F(-\$)}$$

$$\frac{F(\$)}{F(-\$)} = \frac{\$^2 - \$6 + 4}{\$^2 + \$6 + 4} = \frac{(\$ - (3+\sqrt{5}))(\$ - (3-\sqrt{5}))}{(\$ - (-3+\sqrt{5}))(\$ - (-3-\sqrt{5}))}$$

$$\frac{F(\$)}{F(-\$)} = \frac{(\$ - 5{,}23)(\$ - 0{,}76)}{(\$ + 5{,}23)(\$ + 0{,}76)}$$ → ~~Brune~~ no

$\cancel{\frac{\$ - 5{,}23}{\$ + 5{,}23}}$ → no!!

Debo adoptar tal que sea Estable

$$F'(s) = \frac{1}{s^2 + s \cdot 6 + 4}$$ → le agrego el polo que me aporta $\pi/2$

$$F(s) = \frac{s}{s^2 + s \cdot 6 + 4}$$

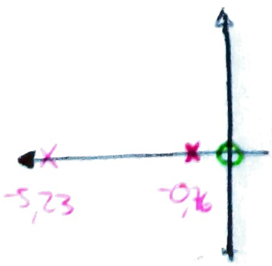
$$F(s)\Big|_{s=j\omega} = \frac{j\omega}{j\,6\omega + 4 - \omega^2}$$

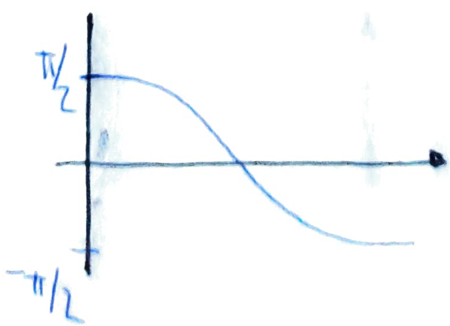
$$\Theta(\omega) = \operatorname{arctg}(\omega/\phi) - \operatorname{arctg}\left(\frac{6\omega}{-\omega^2+4}\right)$$

$$\underbrace{\operatorname{arctg}\left(\frac{>0}{\phi}\right)}_{\infty}$$

$$\boxed{\pi/2 - \operatorname{arctg}\left(\frac{6\omega}{-\omega^2+4}\right)} \Rightarrow \boxed{F(s) = \frac{s}{s^2 + s \cdot 6 + 4}}$$

$$F(s) = \frac{s}{(s+5{,}23)(s+0{,}76)}$$





$\varphi_z - \varphi_p$ → Polo en origen => $+\pi/2$ y cada polo resta $\pi/2$

$$T(\$) = \frac{\$}{\$^2 + \$ \cdot 6 + 4} \longrightarrow$$ normalizo $$\cdot \frac{\$}{\$^2 + \$ \cdot \frac{\omega_0}{Q} + \omega_0^2}$$

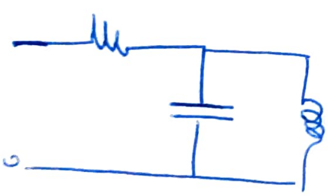
$$\omega_0^2 = 4 \therefore \omega_0 = 2 = \Omega_\omega$$

$$\frac{\omega_0}{Q} = 6 \therefore Q = 1/3$$

$$\frac{\$ \cdot 1}{\$^2 + \$ \cdot 1/Q + 1}$$ ⤳ No es un FBP de Ø dB

$$1/Q \cdot H = 1 \Rightarrow H = 1/3$$

$$H \cdot \frac{\$ \cdot 1/Q}{\$^2 + \$ \cdot 1/Q + 1} = 1/3 \cdot \frac{\$ \cdot 3}{\$^2 + \$ \cdot 3 + 1} \rightarrow$$ Pero lo implemento Así porque sólo me importa la FASE y no el módulo



$$T(\$) = \frac{G}{\$C + \frac{1}{\$L} + G} = \frac{\$LG}{\$^2 LC + \$LG + 1}$$

$$\frac{\cancel{L}G}{\cancel{L}C} \; \frac{\$}{\$^2 + \$\frac{\cancel{L}G}{\cancel{L}C} + 1} = \frac{\$ \cdot \overbrace{(G/C)}^{1/Q}}{\$^2 + \$ \cdot \underbrace{(G/C)}_{1/Q} + 1}$$

Necesito

$L = 1$, $C = 1$ $\Rightarrow$ $G = 1/Q \Rightarrow R = Q \therefore R = 1/3$

desnormalizo

$\Omega_Z = 1k$

$\Omega_\omega = 2\pi \cdot 1k$

$\Rightarrow$ $R = 333\Omega$

$L = 159{,}15\ mHy$

$C = 159{,}15\ nF$