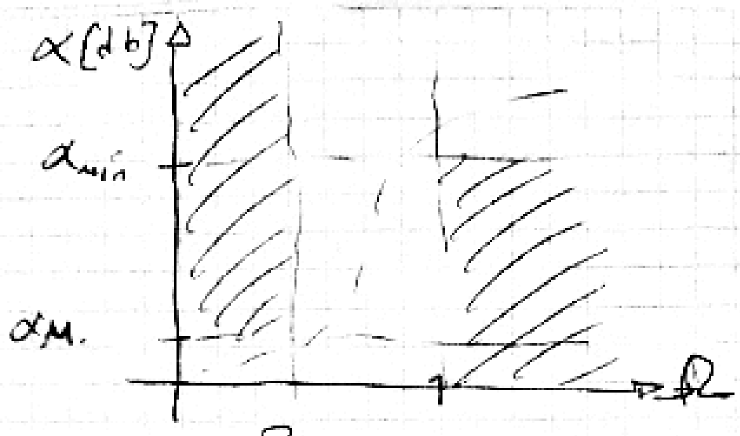
TS3



$\Omega_p = \frac{\omega_p}{\omega_p} = 1$

$\Omega_s = \frac{\omega_s}{\omega_p} = 2$

$\Omega_p \quad \Omega_s$

$\alpha_M = 1db$

$\alpha_m = 12db$

$$\frac{1}{1+\varepsilon^2\omega^{2n}} = |T(j\omega)|^2 = T(s)\,T(-s)$$

Primero, a partir de máx. planteados calculamos el ε y n.

$\Omega_p = 1 \Rightarrow \quad 1\,db = 10 \log(1+\varepsilon^2)$

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

$$\boxed{\varepsilon^2 = 0{,}258}$$

Y luego a $\quad n / \ \alpha_m = 10 \log(1+\varepsilon^2\Omega_s^{2n})$

$n = 2, \quad \alpha_m = 7{,}8\,db$ ✗

$n = 3, \quad \alpha_m = 12{,}4\,db$ ✓

luego

$$|T(j\omega)|^2 = \frac{1}{1+\varepsilon^2\omega^{2n}}$$

$$|T(j\omega)|^2 = \frac{1}{1+\varepsilon^2\omega^6}$$

$$|T(j\omega)|^2_{\left(\omega=\frac{s}{j}\right)} = \frac{1}{1+\varepsilon^2\left(\frac{s}{j}\right)^6}$$

$$|T(s)|^2 = \frac{1}{1 - \varepsilon^2 s^6}$$

$$|T(s)|^2 = T(s)\,T(-s) \Rightarrow$$

$$\frac{1}{1-\varepsilon^2 s^6} = \frac{1/\varepsilon^2}{\frac{1}{\varepsilon^2} - s^6}$$

$$\frac{1/\varepsilon^2}{\frac{1}{\varepsilon^2} - s^6} = T(s)\,T(-s).$$

Hacemos:

$$\underbrace{\frac{1/\varepsilon^2}{1/\varepsilon^2 - s^6}}_{C(s)} = \underbrace{\frac{1}{as^3+bs^2+cs+d}\;\frac{1}{-as^3+bs^2-cs+d}}_{D(s)}$$

de aquí para que $C(s) = D(s) \Rightarrow$

$a = \varepsilon \qquad b^2 = 2ac \Rightarrow \quad c = \frac{b^2}{2a}$

$d = 1 \qquad c^2 = 2bd.$

$$\left(\frac{b^2}{2a}\right)^2 = 2bd \Rightarrow \frac{b^{\cancel{4}\,3}}{4a^2} = 2\cancel{b}d.$$

$$\frac{b^3}{8a^2} = 1$$

$$\boxed{b = \sqrt[3]{8\varepsilon^2}} \leftarrow b = \sqrt[3]{8a^2}$$

$$\boxed{b = 2\sqrt[3]{\varepsilon^2}}$$

$$c = \sqrt{2b} \Rightarrow \boxed{c = 2\sqrt[3]{\varepsilon}}$$

$$\boxed{T(s) = \frac{1}{\varepsilon s^3 + 2\sqrt[3]{\varepsilon^2}\,s^2 + 2\sqrt[3]{\varepsilon}\,s + 1}}$$

$$y \quad \boxed{T(s) = \frac{d}{s+1} \cdot \frac{1}{(as^2+bs+c)}}$$

$$\boxed{T(s) = \frac{1/\varepsilon}{s^3 + \frac{2}{\sqrt[3]{\varepsilon}} s^2 + \frac{2}{\sqrt[3]{\varepsilon^2}} s + 1/\varepsilon}}$$

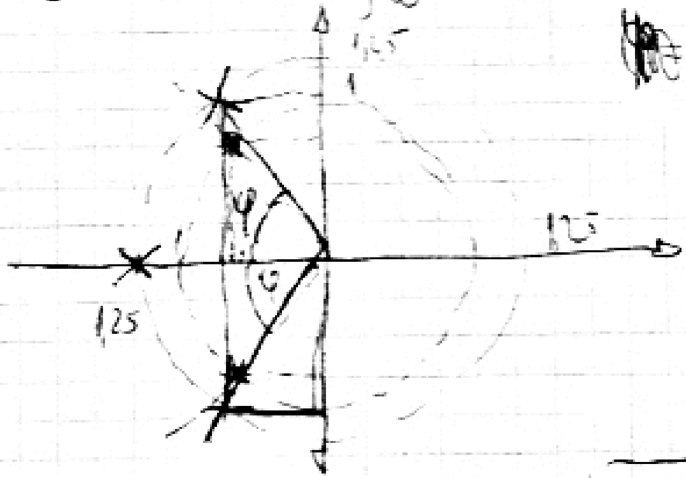
Reemplazando por valores numéricos y buscando raíces:

$$s^3 + \frac{2}{\sqrt[3]{\varepsilon}} s^2 + \frac{2}{\sqrt[3]{\varepsilon^2}} + 1/\varepsilon = s^3 + 2{,}506\, s^2 + 3{,}146\, s + 1{,}968$$

1 raíz real $(s = -1{,}25124) \Rightarrow (s + 1{,}25124)$

2 Raíces complejas $\left.\begin{matrix}(-0{,}626 - 1{,}086) \\ (-0{,}626 + 1{,}086)\end{matrix}\right\} \Rightarrow (s^2 + 1{,}253\, s + 1{,}57)$

Con lo cual



$$tg^{-1}\varphi = \left(\frac{1{,}086}{0{,}626}\right)$$

$$\boxed{\varphi = 60^\circ}$$

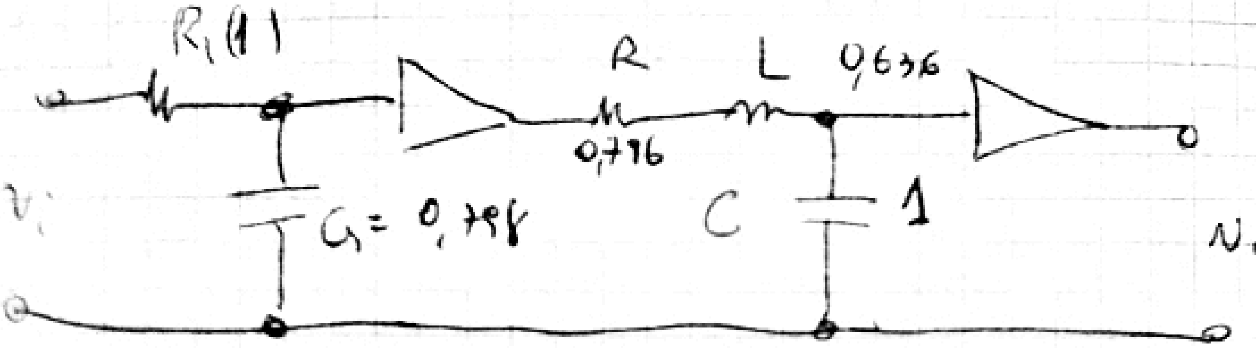
Butterworth

$$\boxed{\omega_0 = 1{,}252}$$

$$Q_1 = \frac{1}{2}$$

$$Q_2 = \frac{1}{2\cos\varphi} = \underline{\underline{1}}$$

$$\boxed{T(s) = \frac{1{,}252}{s + 1{,}252} \cdot \frac{1{,}57}{s^2 + 1{,}253\, s + 1{,}57}}$$



CIRCUITO 1

$$\omega_{0_1} = \frac{1}{R_1 C_1} \Rightarrow \boxed{R_1 = 1} \Rightarrow \boxed{C_1 = 0,798}$$

$$\omega_{0_2} = \sqrt{1,57} \Rightarrow 1,57 = \frac{1}{LC} \text{ con } \boxed{C = 1} \Rightarrow$$

$$L = 1/1,57$$

$$\boxed{L = 0,636}$$

$$\frac{R}{L} = \frac{\omega_0}{Q}$$

$$R = \frac{L\,\omega_0}{Q}$$

$$R = \frac{0,636 \cdot 1,252}{Q}$$

$$\boxed{R = 0,796}$$

Renormalización por Abutterworth

$$\omega_B = 1 \cdot \varepsilon^{-1/3}$$

$$\boxed{\omega_B = 1{,}252}$$

$Z_1 = 1$

Etapa 1

$$L_1 = \frac{L\, Z_1}{\omega_B} = 0{,}798$$

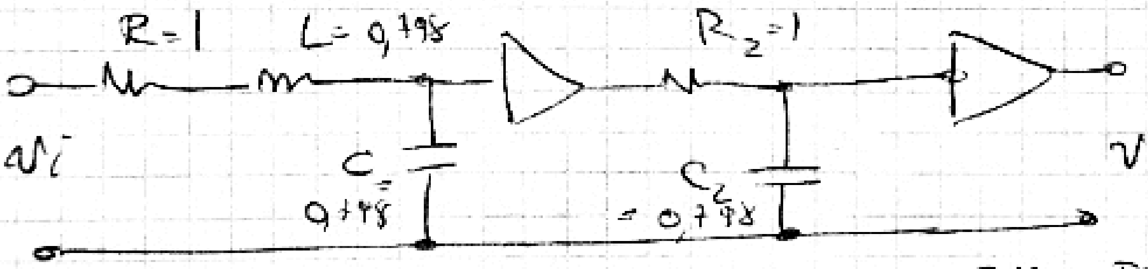
$$C_1 = \frac{C}{Z_1\, \omega_B} = 0{,}798$$

$$R = 1$$

Etapa 2

$$R = 1$$

$$C = \frac{C}{\omega_B} = 0.$$



CIRCUITO 2

Verificaremos este ~~[illegible]~~ circuito mediante LTSPICE y comprobaremos que obtenemos la misma F. transferencia que en el circuito 1 y ambos cumplen la plantilla