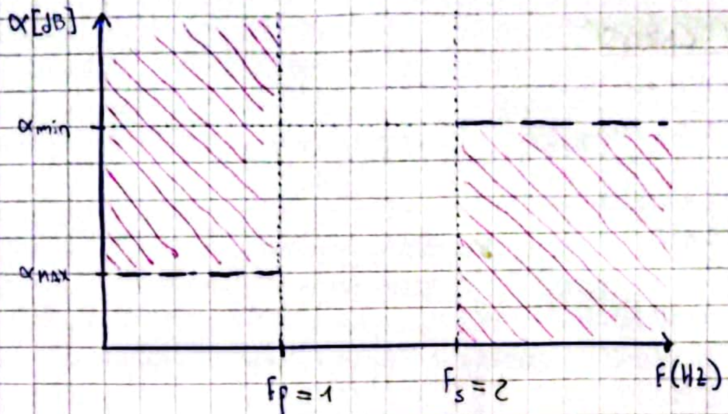
## TP SEMANAL N°3

Plantilla:




| $\alpha_{MAX}$ | $\alpha_{min}$ | $F_p$ | $F_s$ |
| --- | --- | --- | --- |
| 1 dB | 12 dB | 1500 Hz | 3000 Hz |

1 → Este análisis es la versión larga: tengo una norma $\Omega_\omega$ que no tiene en cuenta los $\varepsilon$ y por ende los valores del componentes del circuito quedan normalizados **solo** según $\Omega_z$ y $\Omega_\omega$. Además, según quedan en función de $\varepsilon$

$$|T(j\omega)|^2 = \frac{1}{1+\varepsilon_1^2\omega^{2n}} \Rightarrow |\alpha(j\omega)|^2 = 1 + \varepsilon_1^2\omega^{2n}$$

$$\alpha(j\omega)_{dB} = 20\log(1+\varepsilon_1^2\omega^{2n})^{\frac{1}{2}}$$

$$\alpha(j\omega)_{dB} = 10\log(1+\varepsilon_1^2\omega^{2n})$$

$$\alpha_{min} = 10\log(1+\varepsilon_1^2 2^{2n})$$

$$\alpha_{MAX} = 10\log(1+\varepsilon_1^2 \cdot 1)$$

$$\varepsilon_1^2 = 10^{\alpha_{MAX}/10} - 1$$

$$\varepsilon_1^2 = 0{,}259 \Rightarrow \varepsilon = 0{,}51$$

$\boxed{n=1}$ ✗

$$\alpha_{min} = 10\log(1+\varepsilon_1^2 \cdot 2^2) = 3{,}08\,dB$$

$\boxed{n=2}$ ✗

$$\alpha_{min} = 10\log(1+\varepsilon_1^2 \cdot 2^4) = 7{,}11\,dB$$

$\boxed{n=3}$ ✓

$$\alpha_{min} = 10\log(1+\varepsilon_1^2 \cdot 2^6) = 12{,}45\,dB$$

→ TEORICAMENTE CUMPLE LA CONDICIÓN $\alpha_{min} \geq 12dB$ AUNQUE SEA UN VALOR CERCANO Y ARRIESGADO

HOJA N°

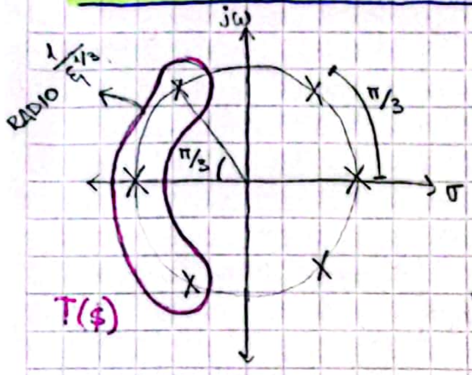
FECHA

NOTA

$$|T(s)|^2 = |T(j\omega)|^2\Big|_{\omega=\frac{s}{j}} = \frac{1}{1+\varepsilon_1^2\left(\frac{s}{j}\right)^6} = \frac{1}{1-\varepsilon_1^2 s^6} = \frac{1/\varepsilon_1^2}{1/\varepsilon_1^2 - s^6} \cong \frac{3,86}{3,86 - s^6}$$

$$\left[|T(s)|^2 = \frac{3,86}{3,86-s^6}\right] \quad 0 = \frac{1}{\varepsilon_1^2} - s^6 \Rightarrow s = \frac{1}{\varepsilon_1^{1/3}} \cong 1,2525 \cdot e^{j\frac{2k\pi}{6}} \quad \begin{cases} 1,2525\, e^{j0} \\ 1,2525\, e^{j\pi/3} \\ 1,2525\, e^{j2\pi/3} \\ 1,2525\, e^{j\pi} \\ 1,2525\, e^{j4\pi/3} \\ 1,2525\, e^{j5\pi/3} \end{cases}$$

## DIAGRAMA POLOS Y CEROS




$$|T(s)|^2 = T(s) \cdot T(-s)$$

$$|T(s)|^2 = \frac{C^2}{(s^3 + s^2 A + sB + C)\,(-s^3 + s^2 A - sB + C)}$$

$$= \frac{C^2}{-s^6 + \cancel{(A-A)s^5} + (A^2-2B)s^4 + \cancel{(C-AB+AB-C)s^3} + (2AC-B^2)s^2 + \cancel{(BC-BC)s} + C^2}$$

$$= \frac{C^2}{-s^6 + (A^2-2B)s^4 + (2AC-B^2)s^2 + C^2}$$

$$C^2 = 1/\varepsilon_1^2 \qquad 2AC - B^2 = 0 \qquad A^2 - 2B = 0$$

$$\boxed{C = 1/\varepsilon_1} \qquad 2A\cdot\varepsilon_1^{-1} - \frac{A^{4}}{4} = 0 \qquad B = \frac{A^2}{2}$$

$$A^3 = 2\cdot\varepsilon_1^{-1}\cdot 4 \qquad B = \frac{4}{2}\cdot\varepsilon_1^{-2/3}$$

$$\boxed{A = 2\cdot\varepsilon_1^{-\frac{1}{3}}} \qquad \boxed{B = 2\cdot\varepsilon_1^{-2/3}}$$

$$\left[T(s) = \frac{\overbrace{1/\varepsilon_1}^{\omega_0^3}}{s^3 + s^2\cdot 2\cdot\varepsilon_1^{-\frac{1}{3}} + s\cdot 2\cdot\varepsilon_1^{-2/3} + 1/\varepsilon_1}\right]$$

$$\left[T_1(s) = \frac{\overbrace{1/\varepsilon_1^{1/3}}^{\omega_0}}{s + 1/\varepsilon_1^{1/3}}\right]$$

$$T_2(s) = \frac{\overbrace{1/\varepsilon_1^{2/3}}^{\omega_0^2}}{s^2 + s\,\frac{1/\varepsilon_1^{1/3}}{Q} + 1/\varepsilon_1^{2/3}}$$

$$s\,\frac{1}{\varepsilon_1^{1/3}Q} + s\,\frac{1}{\varepsilon_1^{2/3}} = s\,2\,\frac{1}{\varepsilon_1^{2/3}}$$

$$\frac{1}{Q}\quad\frac{2}{\varepsilon_1^{2/3}} = \frac{2}{\varepsilon_1^{2/3}}$$

$$\boxed{Q = 1}$$

$$\left[T_2(s) = \frac{1/\varepsilon_1^{2/3}}{s^2 + s\,\frac{1}{\varepsilon_1^{1/3}} + 1/\varepsilon_1^{2/3}}\right]$$

NOTA

Este análisis separa una norma $\omega_B = \Omega\omega \cdot \xi^{-\frac{1}{n}}$
Esto me simplifica un montón el análisis y el circuito en cuanto a valores de componentes.

## UTILIZANDO $\omega_B$

$$\Omega_\omega = 2\pi\ 1500Hz \qquad \omega_p = 1 \qquad \omega_s = 2$$

SACO N y ξ

$$|\alpha(j\omega)|^2 = 1 + \xi^2 \omega^{2n}$$

$$\alpha_{dB} = 10 \log\left(1 + \xi^2 \omega^{2n}\right)$$

$$\alpha_{max} = 1dB = 10 \log\left(1 + \xi^2 1^{2n}\right)$$

$$\xi^2 = 10^{1/10} - 1$$

$$\xi = 0,509$$

$$\alpha_{min} = 12dB = 10 \log\left(1 + \xi^2 \cdot 2^{2n}\right)$$

$\boxed{n=2}$

$$10\log\left(1+\xi^2 2^4\right) = 7,11dB \quad X$$

$\boxed{n=3}$

$$10\log\left(1+\xi^2 2^6\right) = 12,45dB \quad \checkmark$$

$$\xi = 0,509 \qquad n = 3$$

NORMA DE BUTTER

$$|T(j\omega)|^2 = \frac{1}{1+\xi^2 \cdot \omega^{2n}} = \frac{1}{1+\left(\xi^{\frac{1}{n}} \omega\right)^{2n}} = \frac{1}{1+\left(\xi^{\frac{1}{n}} \cdot \frac{\omega}{\Omega\omega}\right)^{2n}}$$

$$= \frac{1}{1+\left(\frac{\omega}{\Omega_\omega \cdot \xi^{-\frac{1}{n}}}\right)^{2n}} = \frac{1}{1+\left(\frac{\omega}{\omega_B}\right)^{2n}} = \frac{1}{1+\omega^{2n}}$$

$$\left[\omega_B = \Omega\omega \cdot \xi^{-\frac{1}{3}} = \frac{2\pi\ 1500Hz}{\sqrt[3]{\xi}} = 11809,07\ Hz\right]$$

términos impares negativos

CALCULO DE T(s)

$$|T(s)|^2 = |T(\omega)|^2\Big|_{\omega=\frac{s}{j}} = \frac{1}{1-s^6} \qquad T(s) \cdot T(-s) = \frac{1}{(s^3+as^2+bs+c)(-s^3+as^2-bs+c)}$$

$$T(s) = \frac{1}{-s^6 + \cancel{(a-a)s^5} + (a^2-2b)s^4 + \cancel{(c-ab+ab-c)}s^3 + (2ac-b^2)s^2 + \cancel{(bc-bc)}s + c^2}$$

$$T(s) = \frac{1}{-s^6 + (a^2-2b)s^4 + (2ac-b^2)s^2 + c^2}$$

$$C = 1$$

$$2a - b^2 = 0$$

$$a = \frac{b^2}{2}$$

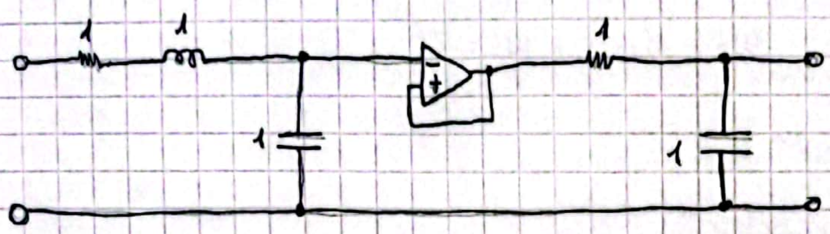
$$\frac{b^4}{4} - 2b = 0$$

$$b = \sqrt[3]{8} = 2 \qquad a = 2$$

NOTA

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

**CIRCUITO NORMALIZADO POR $\omega_B$**




$$T_2(s) = \frac{\frac{1}{sC}}{R+sL+\frac{1}{sC}} = \frac{1}{s^2LC+sRC+1} = \frac{1/LC}{s^2+s\,R/L+1/LC} = \frac{\omega_0^2}{s^2+s\,\frac{\omega_0}{Q}+\omega_0^2}$$

$$\omega_0 = \sqrt{\frac{1}{LC}} \qquad Q = \omega_0 \frac{L}{R}$$

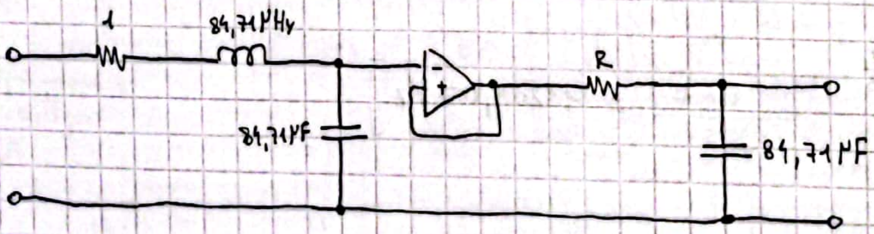
$$1 = \frac{1}{LC} \qquad 1 = \frac{L}{R} \qquad L = 1 \qquad C = 1 \qquad R = 1$$

$$T_1(s) = \frac{1/RC}{s+1/RC} \qquad \frac{1}{RC} = 1 \Rightarrow R = 1 \quad C = 1$$

**DESNORMALIZACIÓN**

$$\omega_B = \Omega_\omega \cdot \varepsilon^{-\frac{1}{3}} = 3757{,}351\,\pi \qquad C = \frac{1}{\omega_B} = L = 84{,}74\,\mu$$

$$R = 1$$

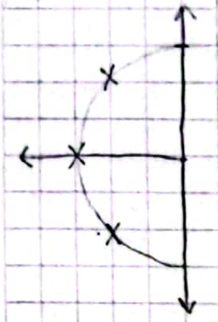


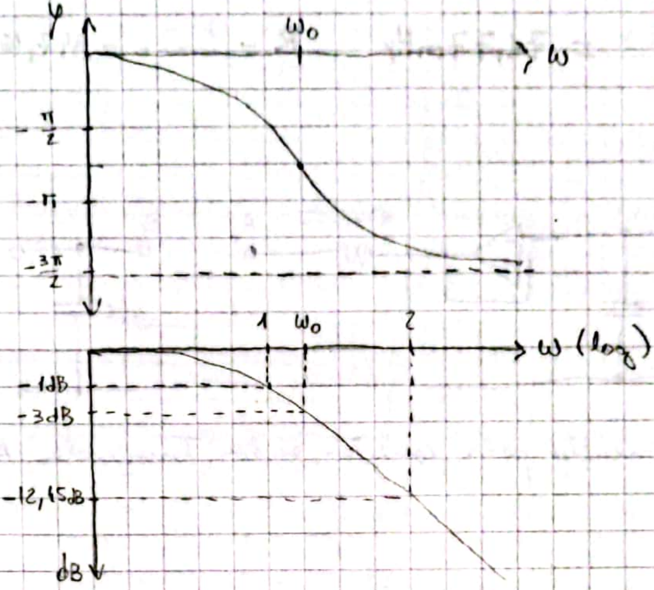

NOTA

HOJA N°

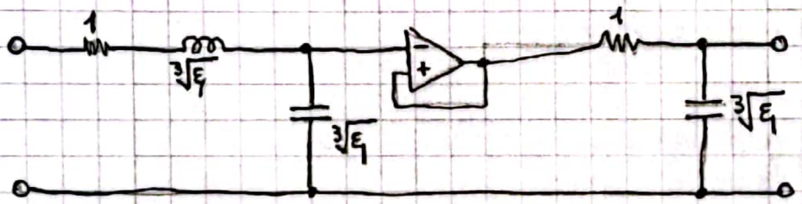
FECHA

## ② POLOS, CEROS Y RTA FREC.






## ③ CIRCUITO NORMALIZADO POR $\Omega_\omega$




$$T_2(s) = \frac{1/LC}{s^2 + s\frac{R}{L} + 1/LC} \qquad T_1(s) = \frac{\frac{1}{RC}}{s + \frac{1}{RC}}$$

$$T_2(s) = \frac{1/\varepsilon_1^{2/3}}{s^2 + s\frac{1}{\varepsilon_1^{1/3}} + \frac{1}{\varepsilon_1^{2/3}}} \qquad T_1(s) = \frac{1/\varepsilon_1^{1/3}}{s + 1/\varepsilon_1^{1/3}}$$

$LC = \varepsilon_1^{\frac{2}{3}}$

$\varepsilon_1^{\frac{1}{3}} C = \varepsilon_1^{2/3}$

$\boxed{C = \varepsilon_1^{\frac{1}{3}}}$

$\frac{R}{L} = \frac{1}{\sqrt[3]{\varepsilon_1}} \rightarrow \boxed{R = 1}$

$\boxed{L = \varepsilon_1^{\frac{1}{3}}}$

$RC = \sqrt[3]{\varepsilon_1} \rightarrow \boxed{R = 1}$

$\rightarrow \boxed{C = \varepsilon_1^{\frac{1}{3}}}$

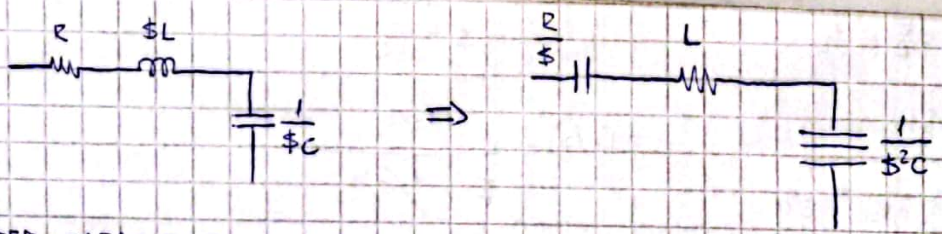
NOTA

(4)

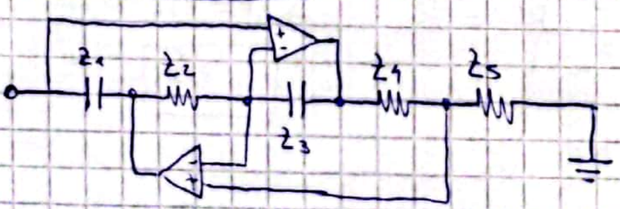
$$C = 100\,nF = \frac{1}{\omega_B \cdot \Omega_z} \Rightarrow \boxed{\Omega_z = 847{,}16\ \Omega}$$

$$L = \frac{1 \cdot \Omega_z}{\omega_B} = 71{,}77\ mHy \qquad R = 1 \cdot \Omega_z = 847{,}16\ \Omega$$

(5)




SUPER CAPACITOR




$$\frac{Z_1 Z_3 Z_5}{Z_2 Z_4} \qquad Z_1 = \frac{1}{s} \qquad Z_3 = \frac{1}{s}$$

$$Z_4 = 1\,\Omega \quad Z_2 = 1\,\Omega \quad Z_5 = 0{,}798\,\Omega$$

$$T(s) = \frac{\frac{1}{sC}\cdot\frac{1}{s}}{\frac{R}{s} + \frac{sL}{s} + \frac{1}{sC}\cdot\frac{1}{s}} = \frac{1/s^2C}{L + \frac{R}{s} + \frac{1}{s^2C}} = \frac{1/LC}{s^2 + s\frac{R}{L} + 1/LC}$$

NOTA