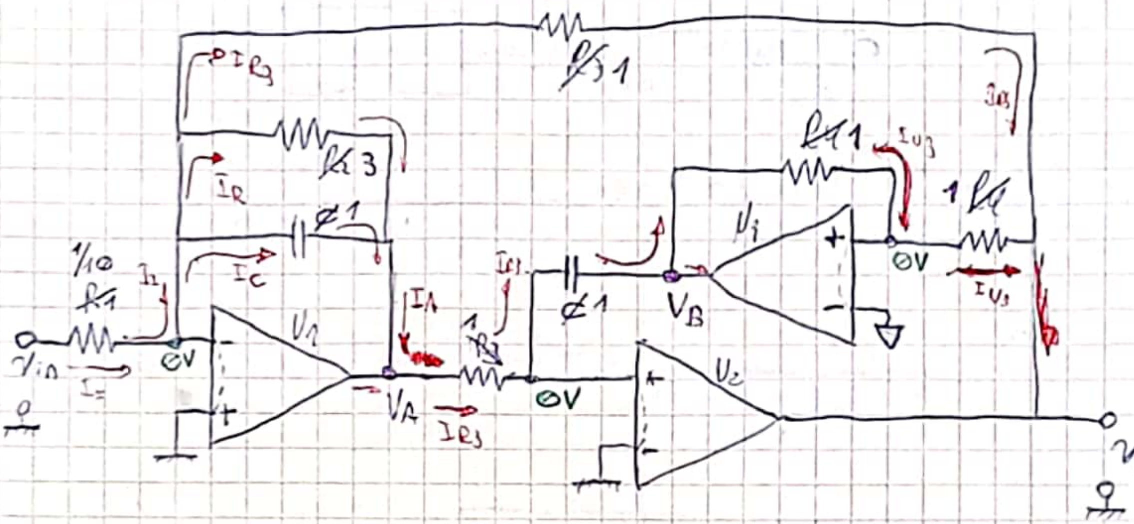
Tarea Semanal 2



$$I_A = \frac{0V - V_A}{\frac{1}{sC + \frac{1}{R_2}}} = -V_A \cdot \frac{(sCR_2+1)}{R_2}$$

$$I_I = \frac{V_i}{R_1} = I_A + I_{R3} = I_A + \frac{0V - V_o}{R_3} \Rightarrow \frac{V_i}{R_1} = -V_A\frac{(sCR_2+1)}{R_2} - \frac{V_o}{R_3}$$

$$\frac{V_A}{R_3} = -V_B \cdot sC \Rightarrow V_A = -V_B \cdot sCR_3 \; ; \; \frac{V_B}{R_4} = \frac{-V_o}{R_4}$$

$$V_A = V_o \cdot sCR_3$$

$$\frac{V_i}{R_1} = -\frac{V_o \cdot sCR_3(sCR_2+1)}{R_2} - \frac{V_o}{R_3}$$

$$\frac{V_i}{R_1} = -V_o\left(\frac{s^2C^2R_2R_3^2}{R_2R_3} + \frac{sCR_3^2}{R_2R_3} + \frac{R_2}{R_3}\right)$$

$$T(s) = \frac{V_o}{V_i} = \frac{-R_2R_3}{s^2C^2R_1R_2R_3^2 + sCR_1R_3^2 + R_1R_2}$$

$$T(s) = \frac{\frac{1}{C^2R_1R_3}}{s^2 + s\cdot\frac{1}{R_2C} + \frac{1}{C^2R_3^2}} = \frac{\overbrace{\frac{R_3}{R_1}\cdot\frac{1}{C^2R_3^2}}^{K \quad \omega_0^2}}{s^2 + s\underbrace{\frac{1}{CR_2}}_{\omega_0/Q} + \underbrace{\frac{1}{C^2R_3^2}}_{\omega_0^2}}$$

$$\omega_0^2 = \frac{1}{C^2R_3^2} \; ; \; Q = \omega_0 C R_2$$

NOTA $\boxed{\omega_0 = \frac{1}{CR_3}} \Rightarrow Q = \frac{R_2}{R_3}$

Ahora:

$$\omega_0 = 1 \Rightarrow \quad 1 = \frac{1}{CR_3} \Rightarrow \boxed{C = \frac{1}{R_3}}$$

$$Q = 3 \Rightarrow \quad 3 = \frac{R_2}{R_3} \Rightarrow \frac{R_2}{R_3} = 3 \Rightarrow \boxed{R_2 = 3R_3}$$

$$|T(0)|_{dB} = 20\,dB \Rightarrow |T(0)| = 10 \Rightarrow \left.\frac{k\,\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}\right|_{s=0} = 10$$

$$\frac{k\,\omega_0^2}{(0)^2 + (0)\frac{\omega_0}{Q} + \omega_0^2} = 10 \Rightarrow \frac{k\,\omega_0^2}{\omega_0^2} = 10 \Rightarrow k = 10$$

$$k = \frac{R_3}{R_1} = 10 \Rightarrow \boxed{R_1 = \frac{R_3}{10}}$$

Tomando como norma de impedancia $\Omega_z = R_3$

$$R_1' = \frac{R_1}{R_3} = \frac{1}{10} \qquad C' = \frac{1}{R_3} R_3 = 1 \qquad R_4' = \frac{R_4}{R_3} = 1 \,*$$

$$R_2' = \frac{3R_3}{R_3} = 3 \qquad R_3' = \frac{R_3}{R_3} = 1$$

(*) Como R_4 No influye en la transferencia, la igualo a R_3 para simplificar

$$S_C^{\omega_0} = \frac{C}{\omega_0} \cdot \frac{\partial \omega_0}{\partial C} = \frac{C}{\frac{1}{CR_3}} \cdot \frac{\partial\left(1/CR_3\right)}{\partial C} = C^2 R_3 \cdot \frac{-R_3}{C^2 R_3^2} = -1$$

$$S_{R_2}^{Q} = \frac{R_2}{Q} \cdot \frac{\partial Q}{\partial R_2} = \frac{R_2}{R_2/R_3} \cdot \frac{1}{R_3} = 1$$

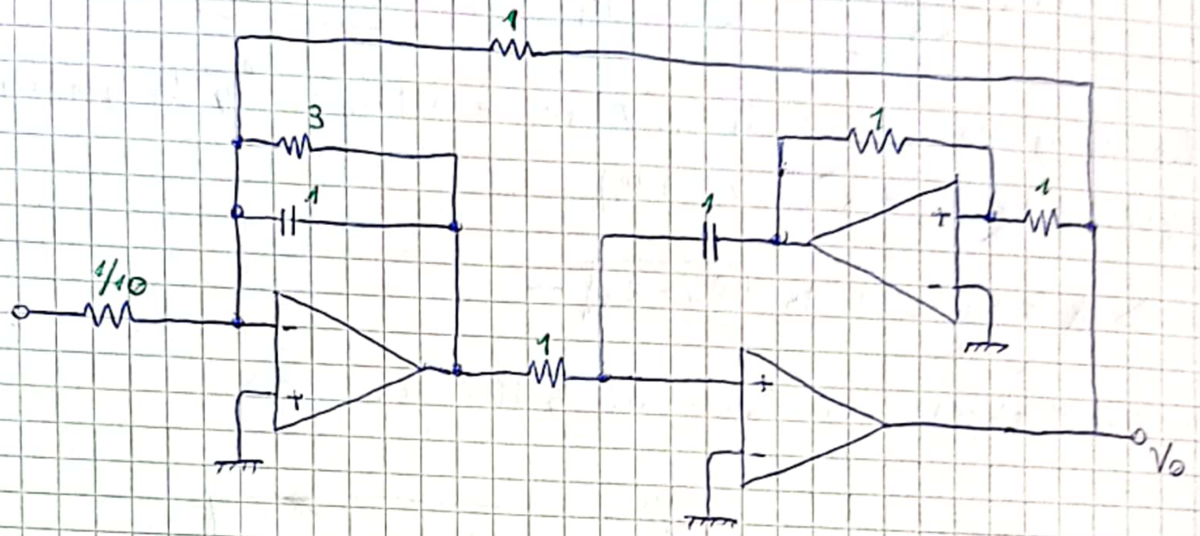
$$S_{R_3}^{Q} = \frac{R_3}{Q} \cdot \frac{\partial Q}{R_3} = \frac{R_3}{\frac{R_2}{R_3}} \cdot \left(\frac{-R_2}{R_3^2}\right) = -1$$

NOTA

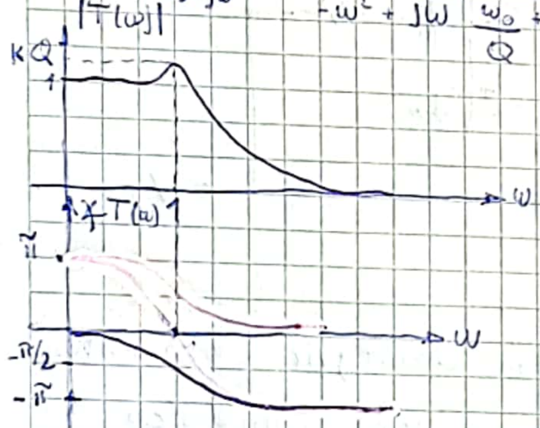
HOJA N°

FECHA

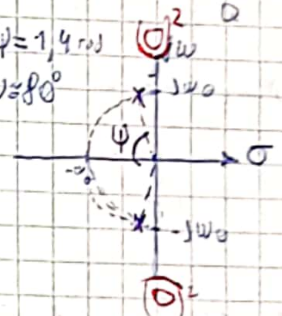
La red normalizada resulta:



$$T(s)\Big|_{s=j\omega} = \frac{k\,\omega_0^2}{-\omega^2 + j\omega\,\frac{\omega_0}{Q} + \omega_0^2} \xrightarrow{\text{Normalizando}} T(s)\Big|_{s=j\omega} = \frac{k}{-\omega^2 + j\omega\,\frac{1}{Q} + 1}$$



$$\text{Si } Q=3 \Rightarrow Q = \frac{1}{2\cos(\varphi)} \Rightarrow \varphi = 1{,}4\text{ rad}$$
$$\varphi \approx 80^\circ$$

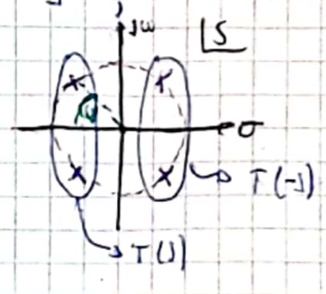


Para que la red cumpla con una transferencia butterworth:

$$|T_{b2}(\omega)|^2 = \frac{1}{1+\omega^4} \Rightarrow |T(s)|^2 = T(s)\cdot T(-s) = |T_{b2}(\omega)|^2\Big|_{\omega=\frac{s}{j}}$$

$$|T(s)|^2 = \frac{1}{1+\left(\frac{s}{j}\right)^4} = \frac{1}{1+s^4}$$

$$s^4 = -1 \Rightarrow s = 1e^{j\frac{\pi+2k\pi}{4}}$$



$$T(s) = \frac{1}{s^2 + s\,\frac{1}{Q} + 1} \qquad Q = \frac{1}{2\cos\varphi} = \frac{1}{2\cos(\pi/4)} = \frac{1}{\sqrt{2}}$$

NOTA

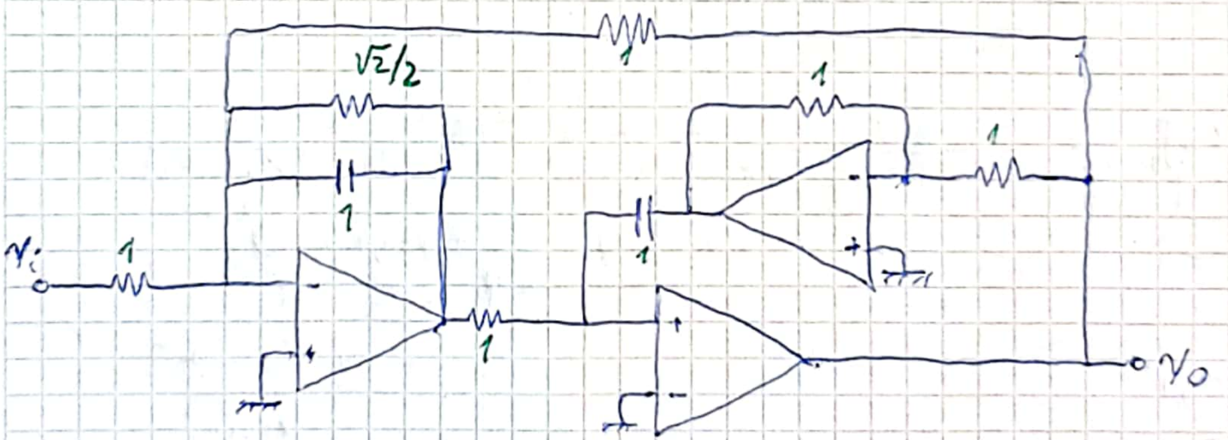
En Nuestro circuito:

$$Q = \frac{R_2}{R_3} \Rightarrow \frac{\sqrt{2}}{2} = \frac{R_2}{R_3} \Rightarrow \boxed{R_2 = R_3 \frac{\sqrt{2}}{2}}$$

La norma de Frecuencia NO se ve alterada ~~y~~ pero la ganancia Si (se desea que sea de 0dB)

$$\Rightarrow K = \frac{R_3}{R_1} = 1 \Rightarrow \boxed{R_1 = R_3}$$

Ackerberg-Mosberg con transferencia butterworth



Una especie de circuito se podría conseguir aumentando considerablemente el Q, generando un gran sobrepico cerca de w_0, Se comprobará en simulaciones

NOTA