*Bonus: Obtener los valores de la red normalizados en frecuencia e impedancia

$$T(\$) = -\frac{\frac{1}{R_1R_3C^2}}{\$^2 + \$\frac{1}{R_2C} + \frac{1}{R_3^2C^2}} \quad ; \quad \$ = \frac{\$}{\Omega\omega} \quad ; \quad \Omega\omega = \omega_0 = \frac{1}{R_3C}$$

$$T(\$) = -\frac{\omega_0 \frac{1}{R_1C}}{\$^2 + \$\frac{\omega_0}{Q} + \omega_0^2} \rightarrow T(\$) = -\frac{\omega_0 \frac{1}{R_1C}}{\omega_0^2\$^2 + \$\frac{\omega_0^2}{Q} + \omega_0^2}$$

$$T(\$) = -\frac{\frac{1}{\omega_0}\frac{1}{R_1C} = \left(\frac{R_3}{R_3}\right)}{\$^2 + \$\frac{1}{Q} + 1}$$

$$\Rightarrow T(\$) = -\frac{\frac{R_3}{R_1}}{\$^2 + \$\frac{1}{Q} + 1}$$

Tarea semanal 2

HOJA Nº 2

FECHA 17/4/23

$$\Omega_\omega = \omega_0 = \frac{1}{R_3 C} = 1 \rightarrow C = \frac{1}{R_3}$$

$$\Omega_z = R_3 \rightarrow \boxed{C' = C\,\Omega_z\,\Omega_\omega = \frac{1}{R_3} R_3\, 1 = 1}$$

$$\boxed{R_1' = \frac{R_1}{\Omega_z} = \frac{R_3}{10}\frac{1}{R_3} = \frac{1}{10}}$$

$$\boxed{R_2' = \frac{R_2}{\Omega_z} = \frac{3R_3}{R_3} = 3}$$

$$\boxed{R_3' = \frac{R_3}{\Omega_z} = 1}$$

$$\boxed{R_4' = \frac{R_4}{\Omega_z} = \frac{R_4}{R_3} = 1}$$

$\boxed{R_3 = R_4}$ → lo impongo yo

* Para poder simular desnormalicé con los siguientes valores:

$$\begin{cases} \omega_0 = 100 \text{ rad/seg} \\ R_3 = 1\,K\Omega \end{cases} \Rightarrow \begin{cases} R_1 = 100\,\Omega \\ R_2 = 3\,k\Omega \\ R_3 = 1\,k\Omega \\ R_4 = 1\,k\Omega \\ C = 10\,\mu F \end{cases}$$

$$\omega_0 = 2\pi f$$

$$f = \frac{\omega_0}{2\pi} = 15{,}915\ Hz$$

* Bonus: cálculo de las sensibilidades

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

$$S_{R_2}^{Q} = \frac{R_2}{Q}\frac{\partial Q}{\partial R_2} \;;\; Q = R_2 C \omega_0 \;;\; \omega_0 = \frac{1}{R_3 C} \Rightarrow Q = R_2 C \frac{1}{R_3 C}$$

$$Q = \frac{R_2}{R_3}$$

$$\Rightarrow \boxed{S_{R_2}^{Q} = \frac{R_2}{\frac{R_2}{R_3}}\frac{\partial}{\partial R_2}\left\{\frac{R_2}{R_3}\right\} = \cancel{R_3}\frac{1}{\cancel{R_3}} = 1}$$

NOTA

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

Si el resultado de la sensibilidad es 1 o >0 es directamente proporcional, mientras que si es -1 o <0 es inversamente proporcional.

* Bonus: Butterworth

$$T(s) = -\frac{\omega_0 \frac{1}{R_1C}}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$$T(s) = -\frac{\frac{R_3}{R_1}}{s^2 + s\frac{1}{Q} + 1}$$

La transferencia de un Butterworth de orden 2 es:

$$T_{B_2}(s) = \frac{1}{s^2 + s\,2\cos(\pi/4) + 1}$$

$$T_{B_2}(s) = \frac{1}{s^2 + s\sqrt{2} + 1}$$

Entonces: $\frac{\omega_0}{Q} = \sqrt{2}$, pero $\omega_0 = 1 \rightarrow Q = \frac{1}{\sqrt{2}}$

$$\begin{cases} \frac{\omega_0}{Q} = \frac{1}{R_2C} \xrightarrow{\omega_0=1} R_2C = Q\ ; \quad C = \frac{1}{\sqrt{2}R_2} \\ \omega_0^2 = \frac{1}{R_3^2C^2} \xrightarrow{\omega_0=1} 1 = \frac{1}{R_3C} \rightarrow \boxed{C = \frac{1}{R_3}} \end{cases} \rightarrow \boxed{R_3 = \sqrt{2}R_2}$$

$\Omega_Z = R_3$: $\begin{cases} C' = 1 \\ R_3' = 1 \\ R_2' = 1/\sqrt{2} \\ R_1' = 1/10 \\ R_4' = 1 \end{cases}$ Con $\omega_0 = 100$ rad/seg y $R_3 = 1K\Omega$ $\begin{cases} C = 10\mu F \\ R_3 = 1K\Omega \\ R_2 = 707{,}106\ \Omega \\ R_1 = 100\ \Omega \\ R_4 = 1K\Omega \end{cases}$

* Bonus: Pasabanda

Tomando como salida V_x $\quad T_{PB} = \frac{V_x}{V_i}$

De un paso anterior:

$$-V_i = V_0\,\frac{sCR_1R_3^2 + s^2C^2R_1R_2R_3^2 + R_1R_2}{R_2R_3}\ ; \quad V_x = V_0\,sCR_3 \rightarrow V_0 = \frac{V_x}{sCR_3}$$

$$-V_i = V_x\,\frac{sCR_1R_3^2 + s^2C^2R_1R_2R_3^2 + R_1R_2}{sCR_2R_3^2}$$

$$T_{PB}(s) = -\frac{CR_2R_3^2}{C^2R_1R_2R_3^2}\,\frac{s}{s^2 + \frac{1}{R_2C}s + \frac{1}{R_3^2C^2}} = -\frac{1}{CR_1}\,\frac{s}{s^2 + \frac{1}{R_2C}s + \frac{1}{R_3^2C^2}}$$

NOTA

Tarea semanal 2

HOJA Nº 3

FECHA

Los parámetros serían iguales $\omega_0 = 1$ y $Q = 3$

Me interesa saber su amplitud en la banda de paso

$$|T_{PB}(\omega_0)| = \frac{\frac{1}{CR_1}}{\frac{1}{CR_2}} = \frac{R_2}{R_1} = \frac{3R_3}{\frac{R_3}{10}} = 30$$

$$|T_{PB}(\omega_0)|_{dB} \approx 29{,}54\ dB \quad a \quad f = \frac{\omega_0}{2\pi} = \frac{1}{2\pi} = 159{,}14\ mHz$$