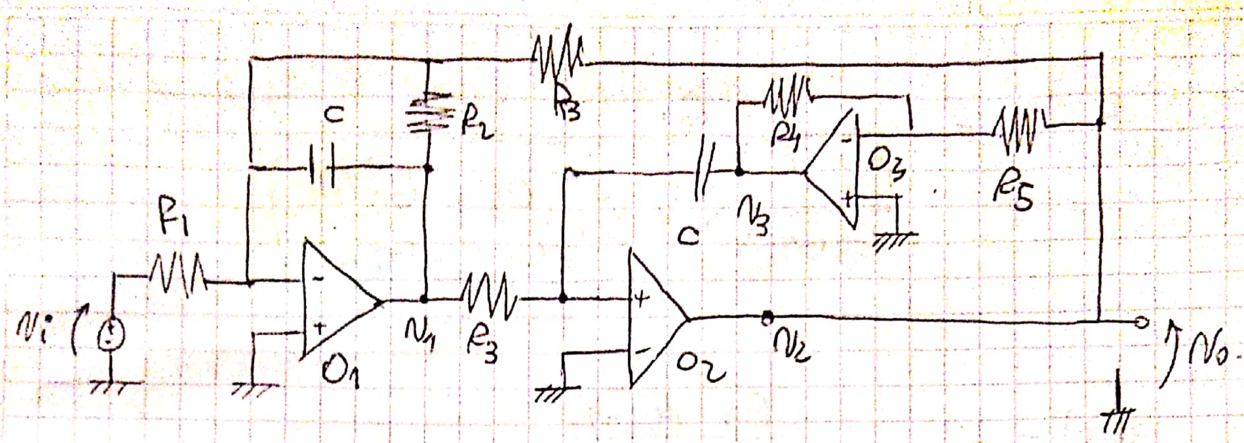


$$\bullet\ V_i G_1 + V_1 \cdot SC + V_1 \cdot G_2 + V_0 \cdot G_3 = 0$$

$$\bullet\ V_1 \cdot G_3 + V_3 \cdot SC = 0 \rightarrow V_1 = -V_3 \frac{SC}{G_3}$$

$$\bullet\ V_0 \cdot G_5 + V_3 \cdot G_4 = 0 \rightarrow V_3 = -V_0 \frac{G_5}{G_4}$$

$$\therefore\ V_1 = -V_3 \frac{SC}{G_3} = V_0 \frac{G_5}{G_4} \frac{SC}{G_3}$$

$$\boxed{V_3 = -V_0 \frac{G_5}{G_4}} \qquad \boxed{V_1 = V_0 \frac{G_5 SC}{G_4 G_3}}$$

$$V_i G_1 + V_1 SC + V_1 G_2 + V_0 G_3 = 0$$

$$V_i G_1 + V_0 \frac{G_5 SC}{G_4 G_3} SC + V_0 \frac{G_5 SC}{G_4 G_3} G_2 + V_0 G_3 = 0$$

$$V_0 \left(\frac{G_5 (SC)^2}{G_4 G_3} + \frac{G_5 G_2}{G_4 G_3} SC + G_3 \right) = -V_i G_1$$

$$\therefore\ H(S) = -\frac{G_1}{\frac{G_5 (SC)^2}{G_3 G_4} + \frac{G_5 G_2}{G_4 G_3} SC + G_3}$$

→ Busco la forma mónica.

$$H(s) = -\frac{G_1}{\frac{G_5 C^2}{G_3 G_4}\left(s^2 + s\cdot\frac{G_2}{C} + \frac{G_3^2 G_4}{G_5 C^2}\right)}$$

$$H(s) = -\frac{\frac{G_3 G_4 G_1}{G_5 C^2}}{s^2 + s\, G_2/C + \frac{G_3^2 G_4}{G_5 C^2}}$$

$$H(s) = -\frac{G_1}{G_3}\cdot\frac{\omega_0^2}{s^2 + s\,\frac{\omega_0}{Q} + \omega_0^2}$$

$$\omega_0^2 = \frac{G_3^2 G_4}{G_5 C^2} \qquad \frac{\omega_0}{Q} = \frac{G_2}{C} \rightarrow Q = \frac{\omega_0 C}{G_2}$$

$$Q = \frac{G_3}{\cancel{C}}\sqrt{\frac{G_4}{G_5}}\,\frac{\cancel{C}}{G_2}$$

$$Q = \frac{G_3}{G_2}\sqrt{\frac{G_4}{G_5}}$$

(b) Obtener el valor de los componentes.

$\omega_0 = 1$ y $Q = 3$. $\quad \omega_0^2 = 1 = \frac{G_3^2 G_4}{G_5 C^2}$

$$Q = 3 = \frac{G_3}{G_2}\sqrt{\frac{G_4}{G_5}}$$

$\therefore\ G_3 = G_4 = G_5 = 1S \qquad G_2 = 1/3\, S$

$C = 1F$

ⓒ Ajustar R_1 p/q $|T(0)| = 20\,dB$.

$$|T(0)| = 20 \log\left(\frac{G_1}{G_3}\right) = 20\,dB.$$

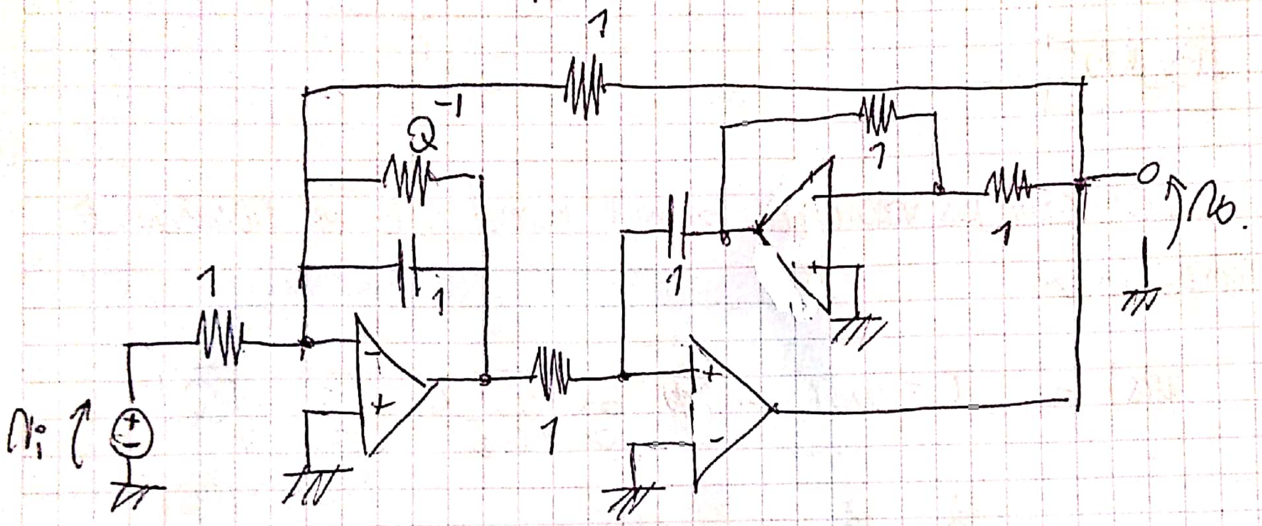
$$G_1 = 10^{1}\,S.$$

BONUS:

• Obtener los valores de la red normalizada en frecuencia e impedancia.

$\boxed{C=1}$ $\boxed{G_1 = G_3 = G_4 = G_5 = 1}$

$\boxed{G_2 = \frac{1}{Q}}$



• Sensibilidad

$$S^{\omega_0}_{C} = \frac{C}{\omega_0}\frac{\partial \omega_0}{\partial C} = \frac{\cancel{C}}{\frac{\cancel{G_3}}{\cancel{C}}\sqrt{\cancel{\frac{G_4}{G_5}}}}\cdot(-1)\frac{\cancel{G_3}}{\cancel{C^2}}\sqrt{\cancel{\frac{G_4}{G_5}}}$$

$$S^{\omega_0}_{C} = -1$$

$$S^{Q}_{R_2} = \frac{R_2}{Q}\frac{\partial Q}{\partial R_2} = \frac{\cancel{R_2}}{\cancel{G_3}\cancel{R_2}\sqrt{\cancel{\frac{G_4}{G_5}}}}\cancel{G_3}\sqrt{\cancel{\frac{G_4}{G_5}}} = 1$$

$$S^{Q}_{R_3} = \frac{R_3}{Q}\frac{\partial Q}{\partial R_3} = \frac{\cancel{R_3}}{\sqrt{\cancel{\frac{G_4}{G_5}}}\cdot\frac{\cancel{1}}{G_2\cancel{R_3}}}\sqrt{\cancel{\frac{G_4}{G_5}}}\frac{\cancel{1}}{\cancel{G_2}}(-1)\frac{\cancel{1}}{R^3} = -1$$

Rta: $S^{\omega_0}_{C} = -1$ $\quad S^{Q}_{R_2} = 1$ $\quad S^{Q}_{R_3} = -1$

• ~~Recalcular para Butterworth.~~

~~Butterworth de segundo orden:~~

$$\cancel{|H(\omega)|^2 = \frac{1}{1+\varepsilon^2\omega^{2n}} = \frac{1}{1+\varepsilon^2\omega^4}}$$

$$\cancel{|H(\omega)| = \frac{1}{(j\omega)^2 + \frac{j\omega}{Q} + 1} = \frac{1}{-\omega^2 + \frac{j\omega}{Q} + 1}}$$

$$\cancel{|H(\omega)|^2 = \frac{1}{-\omega^2 + \frac{j\omega}{Q} + 1} \cdot \frac{1}{-\omega^2 - \frac{j\omega}{Q} + 1}}$$

• Recalcular para Butterworth

$$|H(\omega)|^2 = H(\omega) \cdot H^*(\omega) = \left| \frac{1}{-\omega^2 + \frac{j\omega}{Q} + 1} \right|^2 = \left(\frac{1}{\sqrt{\left(\frac{\omega}{Q}\right)^2 + (1-\omega^2)^2}} \right)^2$$

$$|H(\omega)|^2 = \frac{1}{\frac{\omega^2}{Q^2} + 1^2 - 2\omega^2 + \omega^4} = \frac{1}{1 + \omega^4 + \omega^2\left(\frac{1}{Q^2} - 2\right)}$$

Para ser Butterworth $\boxed{1/Q^2 - 2 = 0}$

$$Q^{-1} = 4 \rightarrow \boxed{Q = 1/4} \quad \text{graficar}$$

- Recalcular para Band Pass:
- Las ecuaciones son las mismas.

- $v_i G_1 + v_1 SC + v_1 G_2 + v_2 G_3$
- $v_1 G_3 + v_3 SC = 0$.
- $v_2 G_5 + v_3 G_4 = 0$

- Ahora nuestra salida es v_1 ∴

- $v_i G_1 + v_o SC + v_o G_2 + v_2 G_3 = 0$
- $v_o G_3 + v_3 SC = 0 \rightarrow v_3 = -\frac{v_o G_3}{SC}$
- $v_2 G_5 + v_3 G_4 = 0 \rightarrow v_2 = -v_3 \frac{G_4}{G_5} = v_o \frac{G_3}{SC} \frac{G_4}{G_5}$.

$$\therefore v_i G_1 + v_o SC + v_o G_2 + v_o \frac{G_3^2}{SC} \cdot \frac{G_4}{G_5} = 0$$

$$v_i G_1 = -v_o \left(SC + G_2 + \frac{G_3^2}{SC} \cdot \frac{G_4}{G_5} \right)$$

$$H(s) = \frac{-G_1}{SC + G_2 + \frac{G_3^2 G_4}{SCG_5}} = \frac{-SG_1/C}{S^2 + S\frac{G_2}{C} + \frac{G_3^2 G_4}{C^2 G_5}}.$$

$$w_o = \sqrt{\frac{G_3^2 G_4}{C^2 G_5}} = \frac{G_3}{C}\sqrt{\frac{G_4}{G_5}} \qquad \frac{w_o}{Q} = \frac{G_2}{C} \rightarrow Q = \frac{w_o C}{G_2}$$

$$Q = \frac{G_3 \cancel{C}}{G_2 \cancel{C}} \sqrt{\frac{G_4}{G_5}} = \frac{G_3}{G_2}\sqrt{\frac{G_4}{G_5}}$$

→ Manteniendo los mismos componentes se mantienen Q y w_o, debido que sus expresiones son las mismas.