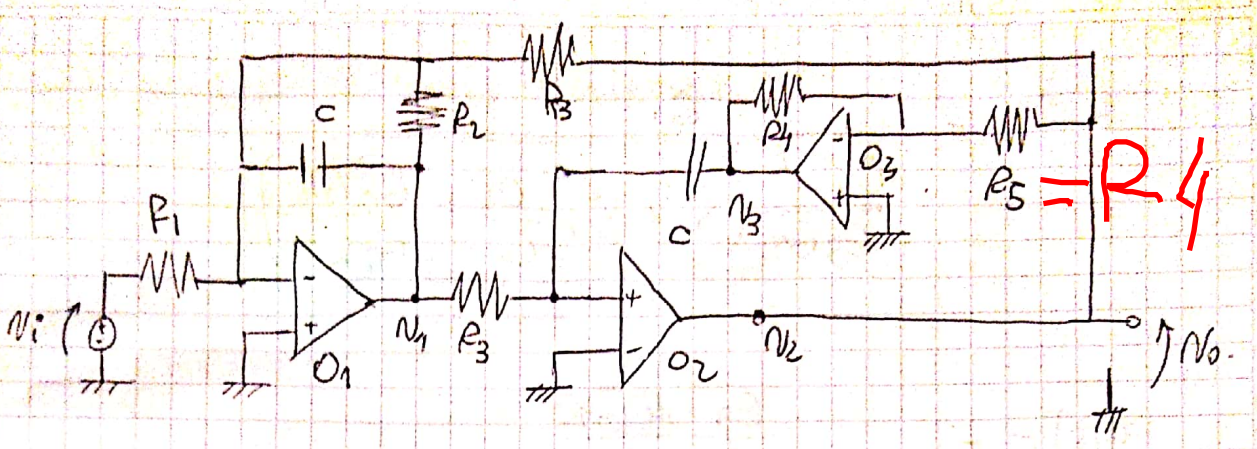


- $V_i G_1 + V_1 \cdot SC + V_1 \cdot G_2 + V_o \cdot G_3 = 0$

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

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

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

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

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

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

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

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

→ Busco la forma mónica

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

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

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

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

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

1

(b) Obtener el valor de los componentes.

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

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

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

$C = 1F$

NOTA

(c) Ajustar R_1 p/q $|T(0)| = 20\,dB$.

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

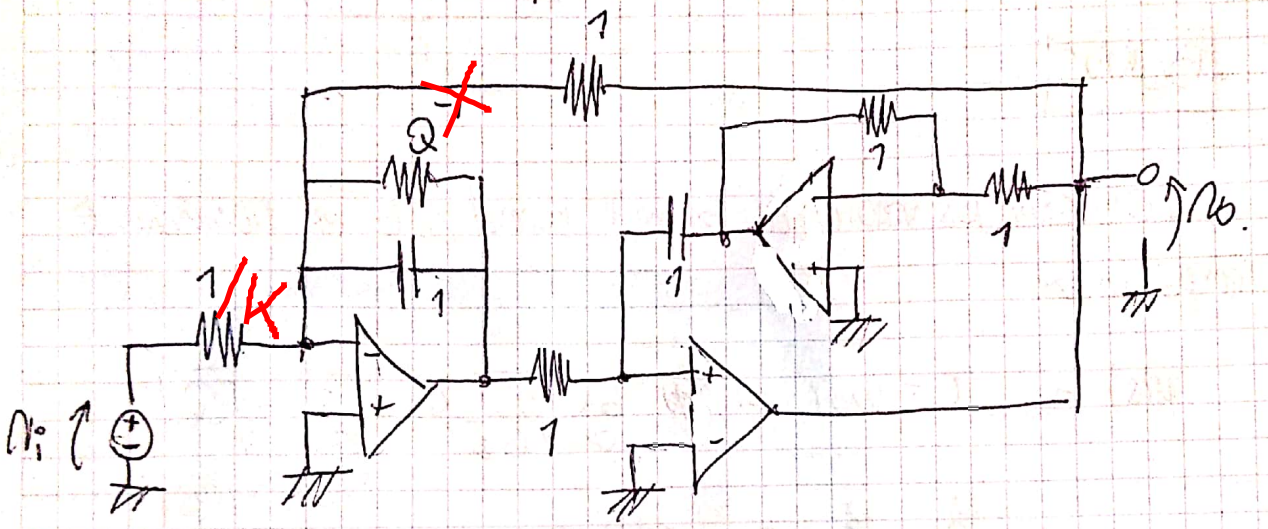
$$G_1 = 10^1\,S.$$

BONUS:

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

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

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



- Sensibilidad

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

$$S_C^{\omega_0} = -1$$

$$S_{R_2}^{Q} = \frac{R_2}{Q}\frac{\partial Q}{\partial R_2} = \frac{R_2}{G_3 R_2 \sqrt{\frac{G_4}{G_5}}} G_3 \sqrt{\frac{G_4}{G_5}} = 1$$

$$S_{R_3}^{Q} = \frac{R_3}{Q}\frac{\partial Q}{\partial R_3} = \frac{R_3}{\sqrt{\frac{G_4}{G_5}}\cdot\frac{1}{G_2 R_3}} \sqrt{\frac{G_4}{G_5}}\frac{1}{G_1}(-1)\frac{1}{R^3} = -1$$

NOTA

Rta: $S_C^{\omega_0} = -1$ $S_{R_2}^{Q} = 1$ $S_{R_3}^{Q} = -1$

- Recalcular para Butterworth.

Butterworth de segundo orden:

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

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

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

- Recalcular para Butterworth

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

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

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

~~$Q^{-1} - 4 \rightarrow \boxed{Q = 1/4}$. preferencia~~

- Recalculer para Band Pass:
- las ecuaciones son las mismas.

  - $V_1 G_1 + V_1 SC + V_1 G_2 + V_2 G_3$
  - $V_1 G_3 + V_3 SC = 0$
  - $V_2 G_5 + V_3 G_4 = 0$

- Ahora nuestro salida es V_1 ∴

  - $V_1 G_1 + V_0 SC + V_0 G_2 + V_2 G_3 = 0$
  - $V_0 G_3 + V_3 SC = 0 \rightarrow V_3 = -\frac{V_0 G_3}{SC}$
  - $V_2 G_5 + V_3 G_4 = 0 \rightarrow V_2 = -V_3 \frac{G_4}{G_5} = V_0 \frac{G_3}{SC} \frac{G_4}{G_5}$

∴ $V_1 G_1 + V_0 SC + V_0 G_2 + V_0 \frac{G_3^2}{SC} \cdot \frac{G_4}{G_5} = 0$

$V_1 G_1 = -V_0 \left(SC + G_2 + \frac{G_3^2}{SC} \cdot \frac{G_4}{G_5} \right)$

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

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

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

→ Manteniendo los mismos componentes se mantienen Q y ω_0, debido que sus expresiones son las mismas.