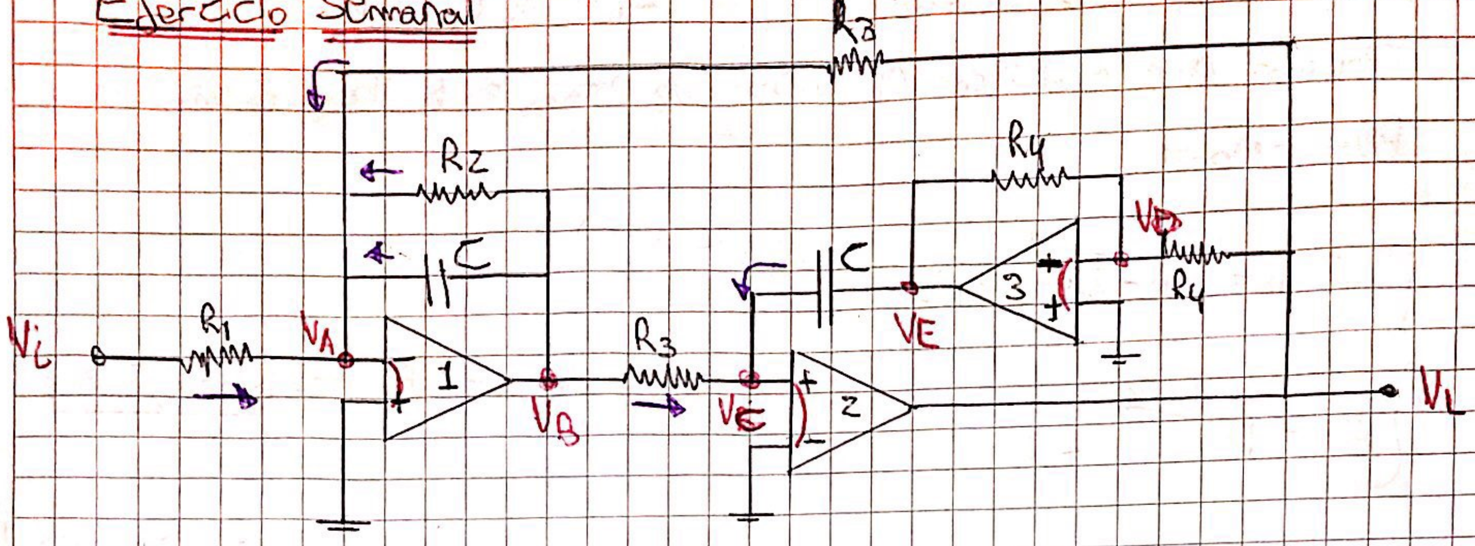
Ejercicio Semanal



Nodo Ⓐ:

$$V_i G_1 + V_B (G_2 + SC) + V_L \cdot G_3 = 0 \quad ①$$

> **Nota:** Supongo correcta realimentación (+) y (−) en todos los OPAMP

Nodo Ⓒ: $V_B \cdot G_3 + V_E \cdot SC = 0 \quad ②$

Ecuación inversor ③: $V_E = -V_L \quad ③$

③ → ②

$$V_B \cdot G_3 = V_L\, SC \Rightarrow \boxed{V_B = V_L \cdot \frac{SC}{G_3}} \quad ④$$

④ → ①

$$V_i G_1 + V_L \frac{SC}{G_3}(G_2 + SC) + V_L G_3 = 0$$

$$V_i G_1 + V_L \cdot \left(\frac{S^2C^2 + SCG_2 + G_3^2}{G_3} \right) = 0$$

$$\boxed{\frac{V_L}{V_i} = -\frac{G_1 G_3}{S^2C^2 + SCG_2 + G_3^2} = \frac{-\frac{1}{R_1R_3C^2}}{S^2 + S \cdot \left(\frac{1}{R_2C}\right) + \frac{1}{R_3^2C^2}}}$$

(A) Retomando, se puede escribir la Transferencia como:

$$\boxed{T_L(s) = \frac{V_L}{V_i} = -\frac{R_3}{R_1}\cdot\frac{1/R_3^2C^2}{s^2 + s\left(\frac{1}{R_2C}\right) + \frac{1}{R_3^2C^2}}}$$

donde $\omega_0^2 = \frac{1}{R_3^2C^2} \Rightarrow \boxed{\omega_0 = \frac{1}{R_3C}}$

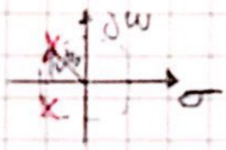
R_4 No afecta en la Transferencia ideal

$$\frac{\omega_0}{Q} = \frac{1}{R_2C} \Rightarrow \boxed{Q = \omega_0 \cdot R_2C = \frac{R_2}{R_3}}$$

$$\boxed{K = -\frac{R_3}{R_1}}$$

$$\boxed{T_L = K\,\frac{\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}}$$ → Pasa Bajos segundo orden

$Q = \frac{\omega_0}{2\cos\psi}$



(B) $\omega_0 = 1 = \frac{1}{R_3C} \Rightarrow$ Tomando $\boxed{R_3 = 1K\Omega} \Rightarrow \boxed{C = 1mF}$

$$Q = 10 = \frac{R_2}{R_3} \Rightarrow \boxed{R_2 = 10K\Omega}$$

(C) Si quiero $K = 20dB = +20\log\left(+\frac{R_3}{R_1}\right) \Rightarrow \log\left(+\frac{R_3}{R_1}\right) = +1$

$$\frac{R_3}{R_1} = 10 \Rightarrow R_1 = \frac{R_3}{10} \Rightarrow \boxed{R_1 = 0{,}1K\Omega = 100\Omega}$$

Tomamos arbitrariamente $R_4 = 1K\Omega$

Si quisieramos obtener una salida pasa banda es tan simple como calcular la transferencia de $\frac{V_B}{V_i}$

$$T_B(s) = \frac{V_B}{V_i} = \frac{V_L}{V_i} \cdot s R_3 C = K R_3 C \cdot \frac{s\, \omega_0^2}{s^2 + s \frac{\omega_0}{Q} + \omega_0^2}$$

Sensibilidades

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

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

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

Normalización

$\Omega_W = w_0 = \frac{1}{R_3 C}$ $\qquad$ $\Omega_Z = R_3$

Si $\begin{cases} R_1 = 100\Omega \\ R_2 = 10k\Omega \\ R_3 = 1K\Omega \end{cases}$ y $C = 1mF$

$$C^\circ = C \cdot \frac{\Omega_Z}{\Omega_W} = C^2 R_3^2 = 1F$$

$$R_1^\circ = \frac{R_1}{R_3} = 0{,}1\,\Omega$$

$$R_2^\circ = \frac{R_2}{R_3} = 10\,\Omega$$

$$R_3^\circ = 1\,\Omega$$

$$R_4^\circ = 1\,\Omega$$