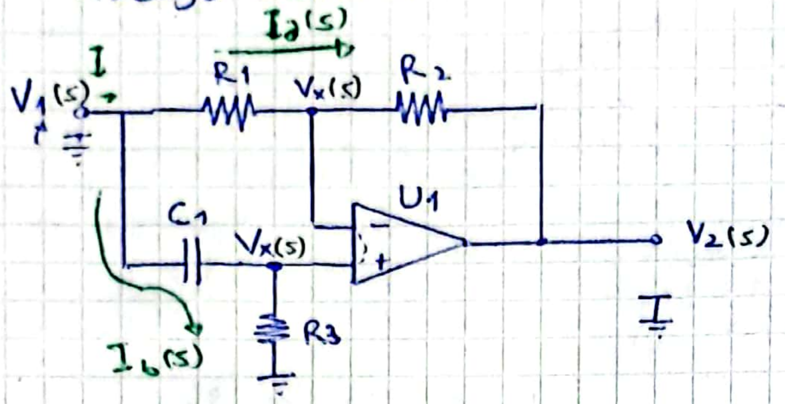
HOJA N°

FECHA

Trabajo semanal 1

Trabajo con OPAMP Ideal



$$\frac{V_x(s) - V_2(s)}{R_2} = \frac{V_1(s) - V_x(s)}{R_1}$$

$$\frac{V_x(s)}{R_2} + \frac{V_x(s)}{R_1} = \frac{V_1(s)}{R_1} + \frac{V_2(s)}{R_2}$$

$$V_x(s)\,\frac{R_1+R_2}{\cancel{R_1R_2}} = \frac{V_1(s)R_2 + V_2(s)R_1}{\cancel{R_1R_2}}$$

$$V_x(s) = \frac{V_1(s)\,R_2 + V_2(s)R_1}{R_1 + R_2} \;//$$

$$\frac{V_x(s)}{R_3} = [V_1(s) - V_x(s)]\,SC_1$$

$$V_x(s) + V_x(s)\,SC_1R_3 = V_1(s)\,SC_1R_3$$

$$V_x(s) = V_1(s)\,\frac{SC_1R_3}{1 + SC_1R_3}$$

$$\frac{V_1(s)R_2 + V_2(s)R_1}{R_1 + R_2} = V_1(s)\,\frac{SC_1R_3}{1 + SC_1R_3}$$

$$[V_1(s)R_2 + V_2(s)R_1](1 + SC_1R_3) = V_1(s)\,SC_1R_3(R_1+R_2)$$

$$V_1(s)\,R_2(1 + SC_1R_3) + V_2(s)R_1(1 + SC_1R_3) = V_1(s)\,SC_1R_3(R_1+R_2)$$

$$V_1(s)\left[R_2 + \cancel{SC_1R_2R_3} - SC_1R_3R_1 \cancel{- SC_1R_2R_3}\right] + V_2(s)R_1(1 + SC_1R_3) = \emptyset$$

$$V_1(s)\,[-SC_1R_1R_3 + R_2] = -V_2(s)\,R_1(1 + SC_1R_3)$$

$$\frac{V_2(s)}{V_1(s)} = \frac{-(-SC_1R_1R_3 + R_2)}{R_1 + SC_1R_1R_3}$$

NOTA

$$T(s) = \frac{V_2(s)}{V_1(s)} = \frac{s C_1 R_1 R_3 - R_2}{s C_1 R_1 R_3 + R_1}$$

$$T(s) = \frac{\cancel{C_1 R_1 R_3}}{\cancel{C_1 R_1 R_3}} \; \frac{s - \frac{R_2}{C_1 R_1 R_3}}{s + \frac{\cancel{R_1}}{C_1 \cancel{R_1} R_3}}$$

$$T(s) = \frac{s - \frac{R_2}{C_1 R_1 R_3}}{s + \frac{\cancel{R_1}\,1}{C_1 R_3}}$$

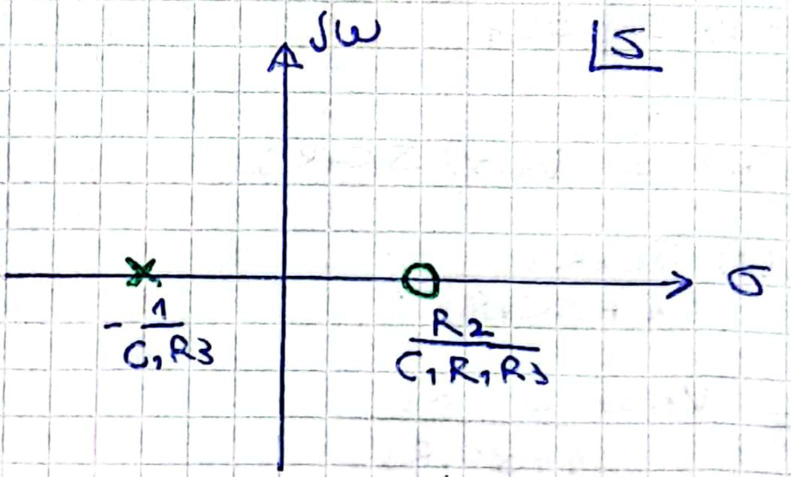
$$\boxed{T(s) = \frac{s - \frac{R_2}{C_1 R_1 R_3}}{s + \frac{1}{C_1 R_3}}}$$

Sistema de no mínima fase

- Diagrama de polos y ceros

Polo en $s = -\frac{1}{C_1 R_3}$ (semiplano izquierdo)

Cero en $s = \frac{R_2}{C_1 R_1 R_3}$ (semiplano derecho)



- Módulo

$$T(s) = \frac{s - \frac{R_2}{R_1}\cdot\frac{1}{R_3C_1}}{s + \frac{1}{R_3C_1}} = \frac{s - \frac{R_2}{R_1}\omega_0}{s + \omega_0} \quad ; \quad \omega_0 = \frac{1}{R_3C_1}$$

Si el sistema es estable:

$$T(\omega) = T(s)\Big|_{s=j\omega} = \frac{j\omega - \frac{R_2}{R_1}\omega_0}{j\omega + \omega_0}$$

$$\boxed{|T(\omega)| = \sqrt{\frac{\omega^2 + \left(\frac{R_2}{R_1}\right)^2 \omega_0^2}{\omega^2 + \omega_0^2}} \quad ; \quad \omega_0 = \frac{1}{R_3C_1}}$$

- Fase

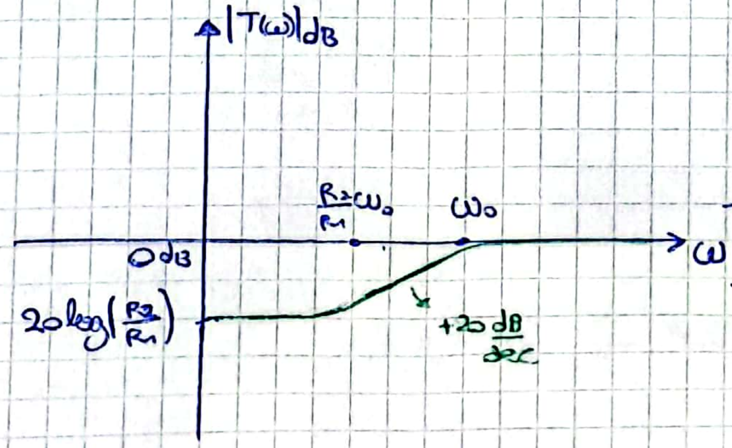
$$\theta_T(\omega) = \operatorname{arctg}\left(\frac{\omega}{-\frac{R_2}{R_1}\omega_0}\right) - \operatorname{arctg}\left(\frac{\omega}{\omega_0}\right)$$

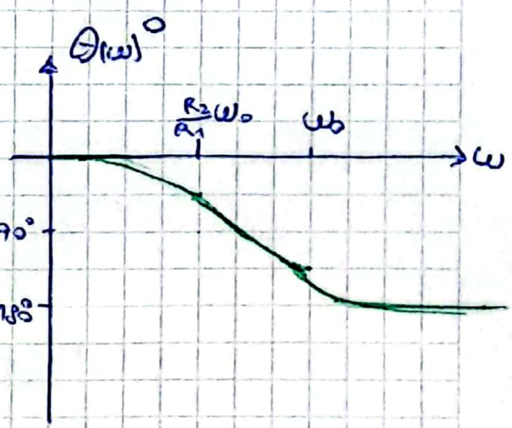
$$\theta_T(\omega) = -\operatorname{arctg}\left(\frac{\omega}{\frac{R_2}{R_1}\omega_0}\right) - \operatorname{arctg}\left(\frac{\omega}{\omega_0}\right)$$

$$\boxed{\theta_T(\omega) = -\left(\operatorname{arctg}\left(\frac{\omega}{\frac{R_2}{R_1}\omega_0}\right) + \operatorname{arctg}\left(\frac{\omega}{\omega_0}\right)\right) \quad ; \quad \omega_0 = \frac{1}{R_3C_1}}$$

2 - Caso 1:

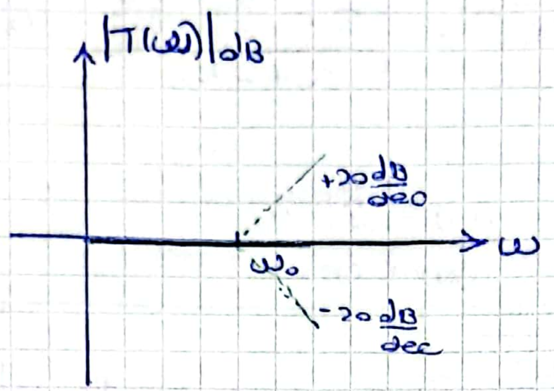
- Si $\frac{R_2}{R_1} < 1$ se tiene una atenuación en bajas frecuencias dado por $20\log\left(\frac{R_2}{R_1}\right)$ (en dB).





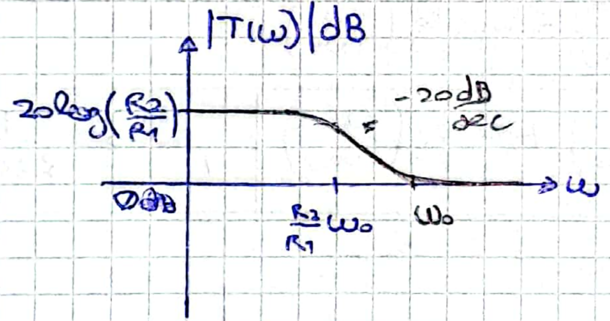
• Caso 2:

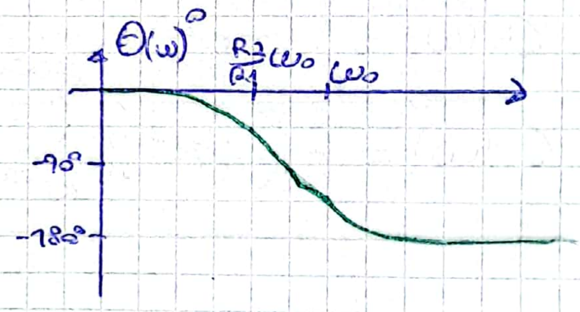
Si $\frac{R2}{R1} = 1$, se tiene entonces un filtro paso todo



• Caso 3:

Si $\frac{R2}{R1} > 1$, se logra una ganancia en baja frecuencia.





(3) $$T(s) = \frac{s - \frac{R_2}{R_1}\omega_0}{s + \omega_0} \quad ; \quad \omega_0 = \frac{1}{C_1 R_3}$$

> Normalización en frecuencia $\Omega_\omega = \omega_0$

$$\$ = \frac{s}{\omega_0}$$

$$T(\$) = \frac{\omega_0 \$ - \frac{R_2}{R_1}\omega_0}{\omega_0 \$ + \omega_0}$$

$$\boxed{T(\$) = \frac{\$ - \frac{R_2}{R_1}}{\$ + 1}}$$

> Normalización de impedancia

Elijo que mi norma de impedancia sea el valor de R_3.

Los componentes normalizados resultan

$$\begin{cases} R_{1n} = \frac{R_1}{R_3} \\ R_{2n} = \frac{R_2}{R_3} \\ R_{3n} = \frac{R_3}{R_3} = 1 \\ C_{1n} = C\,\omega_0 . R_3 = C . \frac{1}{CR_3} . R_3 = 1 \end{cases}$$

RED NORMALIZADA: (Bonus)