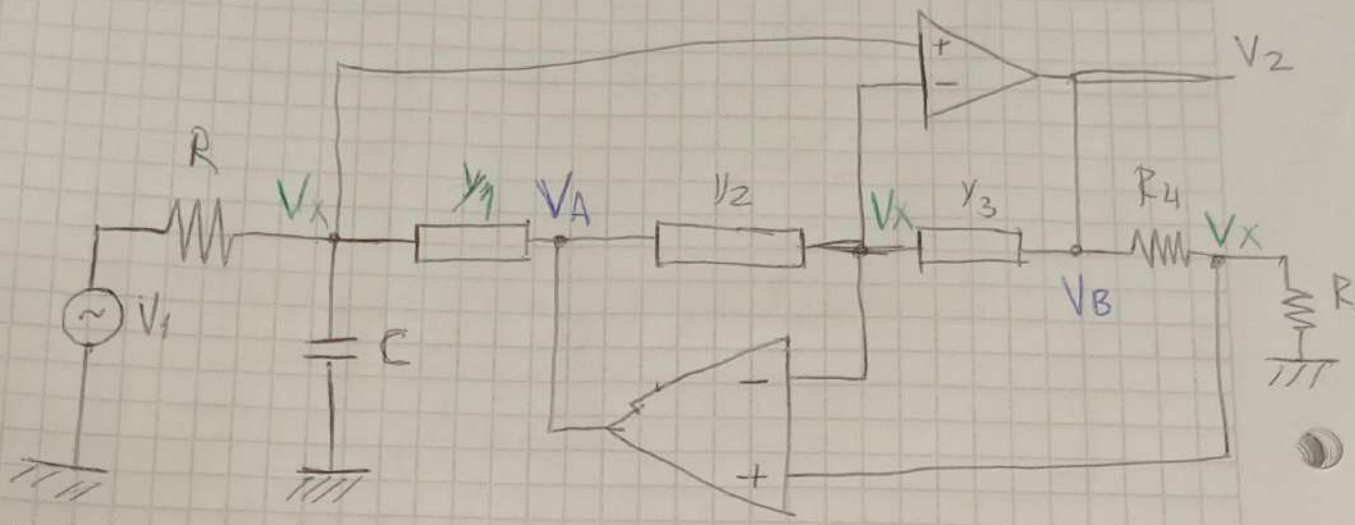
Tarea Semanal #1



1) Analizo impedancia desde el nodo Vx e ignorando el capacitor porque estaría en paralelo a la impedancia del girador

$$V_X(Y_2+Y_3) - V_A Y_2 - V_B Y_3 = 0$$

$$V_X(G5+G4) - V_B G4 = 0 \rightarrow V_B = V_X \frac{(G5+G4)}{G4}$$

$$V_X \cdot Y_1 - V_A Y_1 = I_X \quad (2)$$

$$\rightarrow V_X(Y_2+Y_3) - V_A Y_2 - V_X \frac{(G5+G4)Y_3}{G4} = 0$$

$$V_A = \frac{(Y_2+Y_3)G4 - (G5+G4)Y_3}{Y_2 G4} V_X \quad (1)$$

① en ②

$$V_x \left[\frac{Y_1 Y_2 G_4 - Y_1 Y_2 G_4 - Y_1 Y_3 G_4 + Y_1 Y_3 G_5 + Y_1 Y_3 G_4}{Y_2 G_4} \right] = I_x$$

$$\frac{V_x}{I_x} = Z_x = \frac{Y_2 G_4}{Y_1 Y_3 G_5} = \frac{Z_1 Z_3 R_5}{Z_2 R_4}$$

$$Z_2 = \frac{1}{C F \cdot S} \rightarrow C = 10nF$$

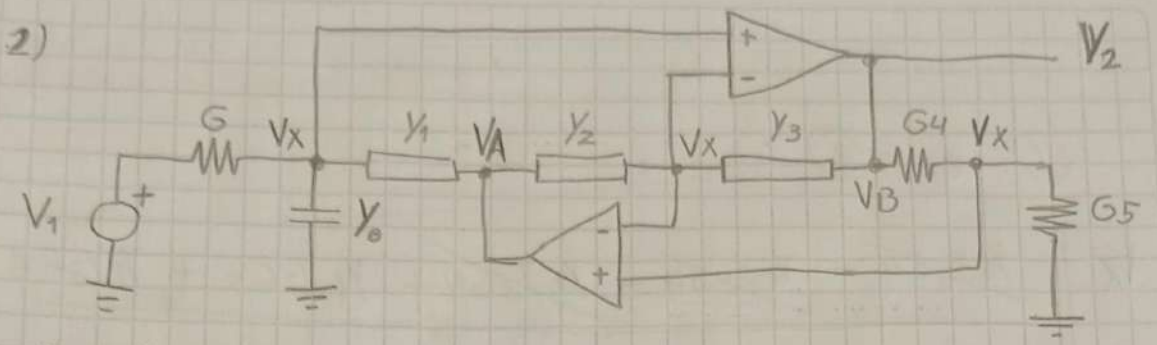
$$Z_x = \underbrace{\frac{Z_1 . Z_3 . R_5}{R_4} . C . S}_{Leq}$$

$$Leq = \frac{Z_1 . Z_3 . R_5}{R_4} \cdot C \cdot S$$

$$C = 10nF$$

$$Z_1 = Z_3 = R_3 = R_4 = 10K\Omega$$

2)



$V_3 = V_2$

$$V_x(G + Y_0 + Y_1) - V_1 G - V_A Y_1 = 0$$

$$V_x(Y_2 + Y_3) - V_A Y_2 - V_2 Y_3 = 0$$

$$V_x(G_4 + G_5) = V_2 G_4 \rightarrow V_x = V_2 \cdot \frac{G_4}{G_4 + G_5}$$

$$V_2\left[\frac{G_4(Y_2+Y_3)}{G_4+G_5} - Y_3\right] = Y_2 V_A \rightarrow V_A = V_2 \frac{G_4(Y_2+Y_3) - Y_3(G_4+G_5)}{(G_4+G_5)Y_2}$$

$$V_A = \frac{G_4 Y_2 - G_5 Y_3}{(G_4+G_5)Y_2} \cdot V_2$$

$$V_2\left[\frac{G_4(G + Y_0 + Y_1)}{G_4+G_5} - \frac{(G_4 Y_2 - G_5 Y_3)Y_1}{(G_4+G_5)Y_2}\right] = V_1 \cdot G$$

$$V_2\left[\frac{G_4 G Y_2 + G_4 Y_0 Y_2 + G_4 Y_1 Y_2 - G_4 Y_2 Y_1 + G_5 Y_3 Y_1}{(G_4+G_5)Y_2 G}\right] = V_1$$

$$T(s) = \frac{V_2}{V_1} = \frac{(G_4+G_5)G Y_2}{G_4 G Y_2 + G_4 Y_0 Y_2 + G_5 Y_3 Y_1}$$

$$T(s) = \frac{(G_4+G_5)G\,sC_2}{CC_2G_4s^2 + G_4GC_2s + G_5G_3G_1}$$

$$T(s) = \frac{\frac{(G_4+G_5)G}{G_4C}}{s^2 + \frac{G}{C}s + \frac{G_1G_3G_5}{G_4C\cdot C_2}}$$

$$T(s) = \frac{\left(1+\frac{R_4}{R_5}\right)\frac{1}{RC}s}{s^2 + \frac{1}{RC}\cdot s + \frac{R_4}{R_1R_3R_5C\cdot C_2}}$$

$$T(s) = \frac{H\cdot\frac{\omega_0}{Q}s}{s^2 + \frac{\omega_0}{Q}\cdot s + \omega_0^2} \qquad s\zeta\omega = \omega_0$$

$$\omega_0 = \sqrt{\frac{R_4}{R_1R_3R_5C\cdot C_2}}$$

$$T(\$) = \frac{\frac{H}{Q}\cdot\$}{\$^2 + \frac{\$}{Q} + 1}$$

$$T(\$) = \frac{\left(1+\frac{R_4}{R_5}\right)\frac{1}{R\not{C}}\$}{\$^2 + \frac{1}{R\not{C}}s + \frac{R_4}{R_1R_3R_5\not{C}\not{C}_2}}$$

$s\zeta = R_5$

$R_4' = \frac{R_4}{R_5}$ $\quad R' = \frac{R}{R_5}$

$R_3' = \frac{R_3}{R_5}$ $\quad H = \omega_0\cdot R_5C$

$R_1' = \frac{R_1}{R_5}$ $\quad H_2 = \omega_0\cdot R_5C_2$

$$T(s) = \frac{(1 + R_4')\frac{1}{R'\#}\,s}{s + \frac{s}{R'\#} + \frac{R_4'}{R_3' R_1' R_3' \# \#_2}}$$

$C = C_2 = 10nF$ $\quad$ $\omega_0 = 2\pi \cdot 10K\,Hz$

$R5 = 1K\Omega$ $\quad$ BONUS #1

$20\,dB \rightarrow 10$

$10 = (1 + R_4') \rightarrow R_4' = 9 \rightarrow R_4 = 9K\Omega$

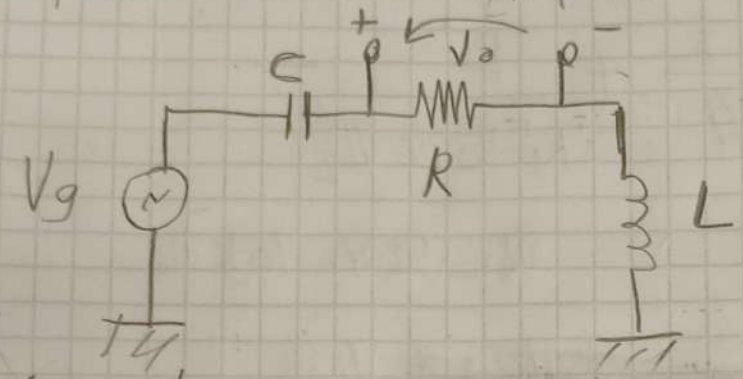
$R'\# = Q = 20 \rightarrow R = \frac{20}{\omega_0 \cdot C} = 31{,}83K\Omega$

SI $R_1 = R_4$

$$\omega_0^2 = \frac{1}{R_3' \# \#_2} \rightarrow R_3' = \frac{1}{\omega_0^2 \# \#_2}$$

$$R_3 = \frac{R_5}{\omega_0^2 \cdot R_5^2 \cdot \omega_0^2 \cdot C^2} = 2{,}533\,K\Omega$$

Bonus #2. Se puede conectar el inductor conformado por el girador, lo unico hay que modificar un poco la figura



Las limitaciones son:

- Rango de frecuencias aceptado por el girador (Recordemos OPAM reales)
- Variaciones indeseadas de L en función de la frecuencia
- Cambio el factor de calidad del inductor

Bonus #3

$$T(s) = \frac{\frac{10 \cdot 2\pi \cdot 10k}{20} s}{s^2 + \frac{2\pi \cdot 10k}{20} s + (2\pi \cdot 10k)^2}$$

$$T(j\omega) = \frac{j\, 10000\pi\omega}{(2\pi \cdot 10000)^2 - \omega^2 + j 1000\pi\omega}$$

GANANCIA en ω_0

$$|T(\omega)| = \frac{10000\pi \cdot \omega}{\sqrt{\left[(2\pi \cdot 10000)^2 - \omega^2\right]^2 + (1000\pi\omega)^2}} = \frac{10}{\sqrt{2}}$$

$$\frac{10^2}{2}\left(\left[2\pi \cdot 10000\right]^2 - \omega^2\right)^2 + (1000\pi\omega)^2 = (10000\pi \cdot \omega)^2$$

CALCULADORA

$\omega_1 = 60660 \frac{rad}{s}$

$\omega_2 = 65981 \frac{rad}{s}$

$f_1 = 9,65\,kHz$

$f_2 = 10,36\,kHz$

$BW = f_2 - f_1 = 710\,Hz$

$f_0 = \frac{f_2 + f_1}{2} = 10,005\,kHz$ ✓

Resultados SPICE

$f_2 = 10,167\,kHz$ $\quad BW = 411\,Hz$

$f_1 = 9,756\,kHz$ $\quad f_0 = 9,9615\,kHz$ ✓

Los resultados pueden variar por el redondeo de las resistencias, de los calculos y el modelo del OPAM