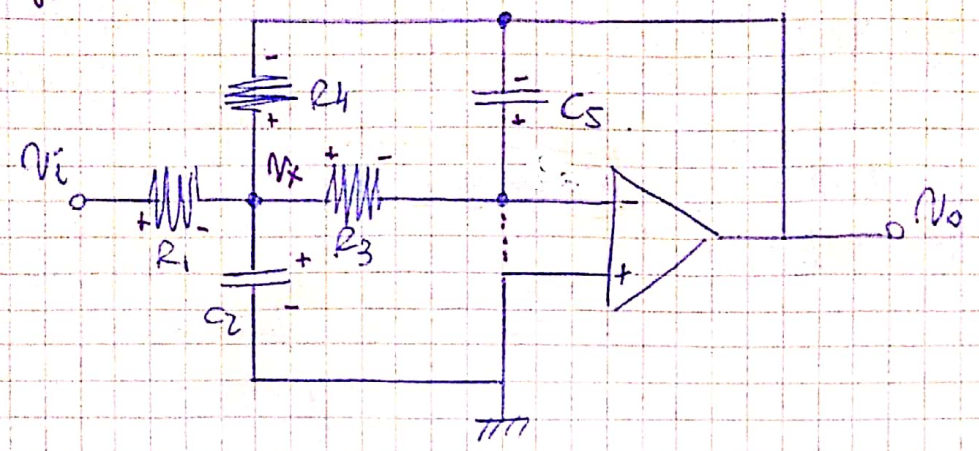
Ejercicio 9.



① $\frac{V_i - V_x}{R_1} = \frac{V_x - V_o}{R_4} + \frac{V_x - 0}{R_3} + \frac{V_x}{1/sC_2}$

② $\frac{V_o}{1/sC_5} = \frac{V_x}{R_3} \rightarrow V_o = -\frac{V_x}{sC_5 R_3} \rightarrow -sC_5 R_3 V_o = V_x$

$$\frac{V_i}{R_1} = +V_x(G_1 + G_4 + G_3 + sC_2) - V_o G_4$$

$$V_i G_1 = -V_o\, sC_5 R_3 (G_1 + G_4 + G_3 + sC_2) - V_o G_4$$

$$\frac{V_i}{V_o} = -\left(\frac{sC_5 R_3 (G_1 + G_4 + G_3)}{G_1} + \frac{s^2 C_2 C_5 R_3}{G_1}\right) - \frac{G_4}{G_1}$$

$$\frac{V_o}{V_i} = H(s) = \frac{-1}{s^2 \frac{C_2 C_5}{G_1 G_3} + s\frac{C_5}{G_1 G_3}(G_1 + G_4 + G_3) + \frac{G_4}{G_1}}$$

$$\frac{V_o}{V_i} = H(s) = \frac{-\frac{G_1 G_3}{C_2 C_5}}{s^2 + s\,\frac{G_1 + G_4 + G_3}{C_2} + \frac{G_3 G_4}{C_2 C_5}}$$

Datos: $R_1 = R_3 = R_4 = 1\Omega \rightarrow G_1 = G_3 = G_4 = 1S$.

$C_2 = 1F$

$C_5 = 0{,}01F$

$\therefore H(s) = \dfrac{-100Hz^2}{s^2 + 5Hz + 100Hz^2}$ Filtro Pasabajo.

$\omega_0 = 10Hz$ } Coinciden con el gráfico.

$Q = 10$.

(b)

$\omega_0 = \sqrt{\dfrac{G_3 G_4}{C_2 C_5}}$ $\qquad \dfrac{\omega_0}{Q} = \dfrac{(G_1 + G_4 + G_3)}{C_2}$

$\omega_0 = 1000\ r/s$.

$\omega_0^2 = \dfrac{G_3 G_4}{C_2 C_5} = 1E^6 Hz^2$

$G_3 G_4 = 1E^6 Hz^2 \cdot C_2 C_5$.

- Uso dos capacitores de 4700pF arbitrariamente.

$G_3 G_4 = G^2 = 2{,}209 \times 10^{-12} S = 22{,}09\ pS^2$

$G = 4{,}7\mu S \rightarrow R = 220k\Omega$

$R_1 = R_2 = R_3 = 220k\Omega \quad C_2 = C_5 = 4700pF$