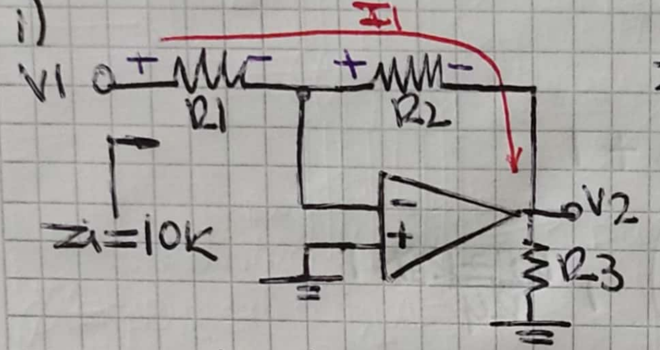
TRABAJO PRÁCTICO N° 1

1)



$Z_i = 10k\Omega$

$A_V = -3000$

$$I_1 = \frac{V_1 - V_2}{R_1 + R_2} = \frac{-V_2}{R_2} \Rightarrow V_1 R_2 - \cancel{V_2 R_2} = \cancel{-V_2 R_2} - V_2 R_1$$

$$\boxed{\frac{V_2}{V_1} = -\frac{R_2}{R_1}}$$

$$I_1 = \frac{V_1}{R_1}$$

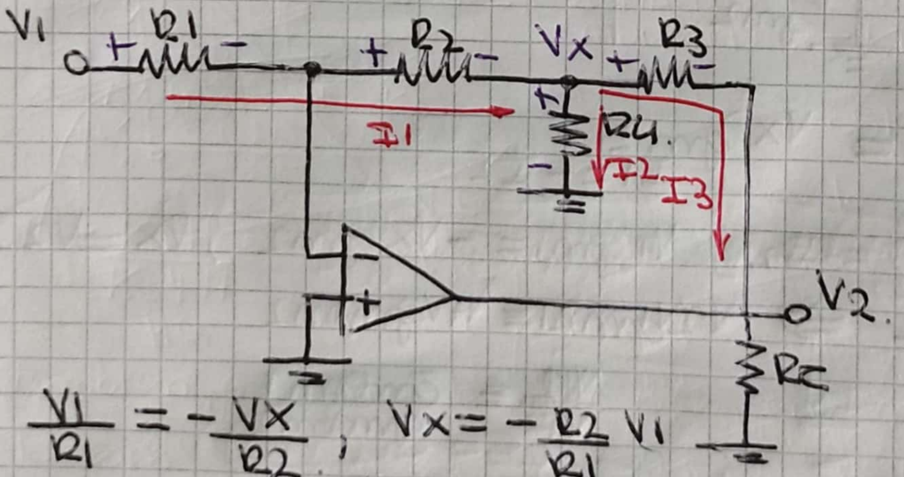
$$\frac{V_1}{I_1} = R_1$$

$$\boxed{Z_i = R_1}$$

$$Z_i = \boxed{R_1 = 10K}$$

$$\Rightarrow R_2 = 3000\, R_1$$

$$\boxed{R_2 = 30M\Omega}$$



$$\frac{V_1}{R_1} = -\frac{V_x}{R_2}, \quad V_x = -\frac{R_2}{R_1} V_1$$

$$\frac{V_1}{R_1} = \frac{V_x}{R_4} + \frac{V_x - V_2}{R_3} = -\frac{R_2}{R_1 R_4} V_1 - \frac{R_2}{R_1 R_3} V_1 - \frac{V_2}{R_3}$$

$$V_1 \left(\frac{1}{R_1} + \frac{R_2}{R_1 R_4} + \frac{R_2}{R_1 R_3} \right) = -\frac{V_2}{R_3}$$

$$V_1 \frac{1}{R_1} \left[1 + R_2 \left(\frac{1}{R_4} + \frac{1}{R_3} \right) \right] = -\frac{V_2}{R_3}$$

NOTA

$$\boxed{T = -\frac{R3}{R1}\left[1 + R2\left(\frac{1}{R4} + \frac{1}{R3}\right)\right]}$$

$Z_1 = \boxed{R1 = 10K}$

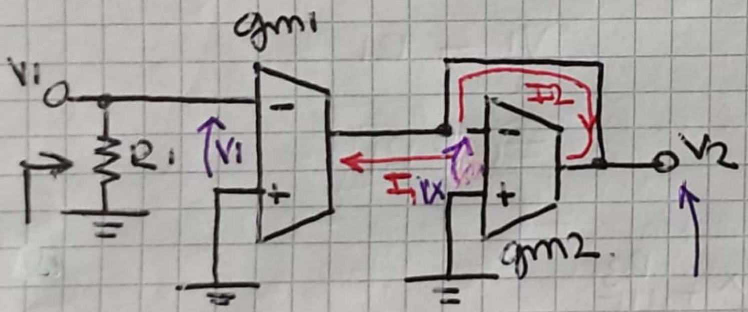
$$30M = R3 + \frac{R2}{R4} R3 + 1$$

$$30M \cong R3\left(1 + \frac{R2}{R4}\right)$$

$\frac{R2}{R4} = 100 \Rightarrow R3 = 297K\Omega$

$\boxed{R3 = 300K\Omega}$, $\boxed{R2 = 100K}$ $\boxed{R4 = 1K}$

$T = -3040$



$$\left.\begin{array}{l} I_1 = V1\, gm1 \\ +Vx\, gm2 = I_2 \end{array}\right\} \begin{array}{l} I1 = -I2 \\ V1\, gm1 = -Vx\, gm2 \;,\; Vx = V2 \\ V1\, gm1 = -V2\, gm2 \end{array}$$

$$\frac{V2}{V1} = -\frac{gm1}{gm2}$$

$$\boxed{T = -\frac{gm1}{gm2}}$$

$Z_1 = \boxed{R1 = 10K}$

$\frac{gm1}{gm2} = 3K$, $\boxed{gm2 = 0{,}1mS} \Rightarrow \boxed{gm1 = 0{,}3\ S.}$

NOTA

HOJA Nº 2

FECHA

Circuito 1 → Ventaja: simple de armar, Zi definida por R1

→ Desventaja: si quiero Zi alto y mucha AV, R2 debe ser muy alta.

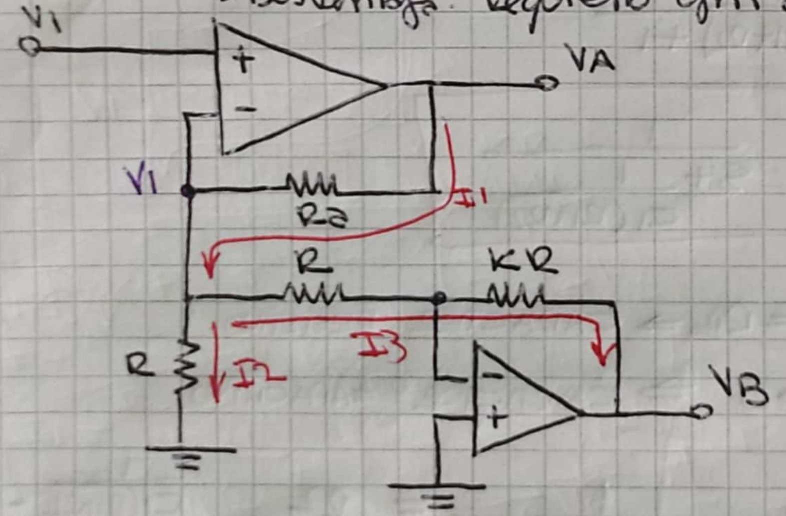
Circuito 2 → Ventaja: Zi definido por R1, puedo obtener Ri alto y mucha AV con resistencias normales no tan altas

→ Desventaja: MÁS DIFICIL DE CALCULAR.

Circuito 3 → Ventaja: Zi y AV independientes entre si

→ Desventaja: Requiero gm alto para AV alto.

2)



$$\frac{VB}{V1} = -\frac{KR}{\cancel{R}} \Rightarrow VB = -K\,V1$$

$$I1 = I2 + I3$$

$$\frac{VA - V1}{Ra} = \frac{V1}{R} + \frac{V1 - VB}{R + KR} = \frac{V1}{R} + \frac{V1 + KV1}{R(K+1)}$$

$$VA - V1 = \frac{Ra}{R} V1 + V1 \frac{Ra}{R} \frac{\cancel{K+1}}{\cancel{K+1}}$$

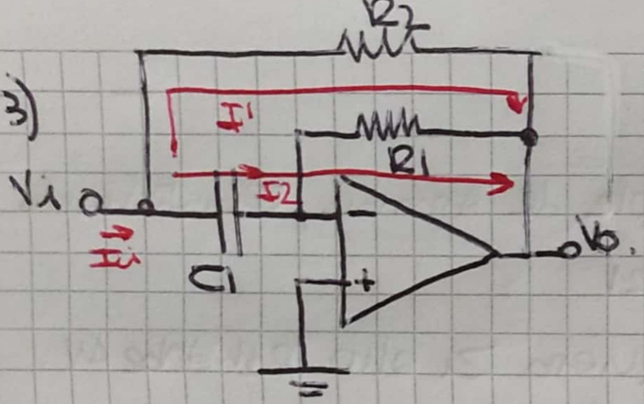
$$VA = V1 + \frac{\cancel{2R}}{\cancel{2R}}(K-1)V1 = V1(\cancel{1} + K \cancel{-1})$$

$$VA = V1K \Rightarrow VA - VB = V1K + KV1$$

$$\boxed{VA - VB = 2K\,V1}$$

NOTA

3)



$$I_i = I_1 + I_2 = \frac{V_i - V_o}{R_2} + V_i s C_1 \; ; \qquad \frac{-V_o}{R_1} = V_i s C_1$$

$$I_i = \frac{V_i + sC_1R_1 V_i}{R_2} + V_i s C_1 \qquad V_o = -sC_1R_1V_i$$

$$I_i = V_i \left(\frac{1 + sC_1R_1}{R_2} + sC_1 \right)$$

$$I_i = V_i \; \frac{sC_1(R_1+R_2)+1}{R_2}$$

$$\frac{V_i}{I_i} = \frac{R_2}{sC_1(R_1+R_2)+1}$$

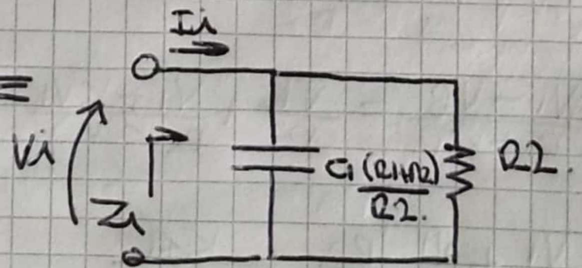
$$\boxed{Z_i = \frac{R_2}{(R_1+R_2)C_1} \; \frac{1}{s + \frac{1}{C_1(R_1+R_2)}}}$$

- Si $\omega = 0$. $Z_i = R_2 \Rightarrow$ CARÁCTER RESISTIVO

  Si $\omega \to +\infty$. $Z_i \to 0 \Rightarrow$ CARÁCTER CAPACITIVO.

$$Z_i(\omega) = \frac{1}{j\omega \frac{C_1(R_1+R_2)}{R_2} + \frac{1}{R_2}}$$

$Z_i(\omega) \equiv$

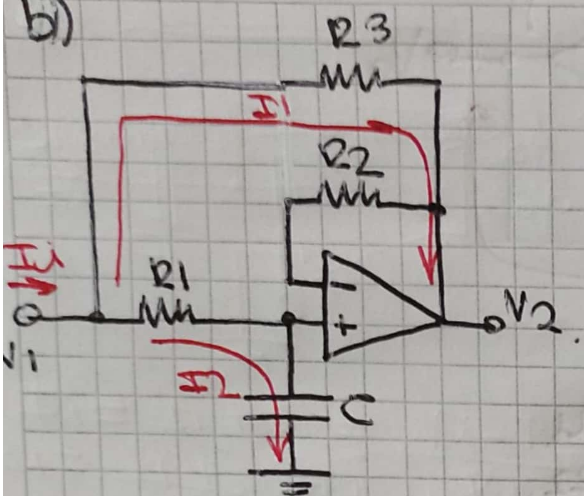


$$C = C_1 \frac{(R_1+R_2)}{R_2}$$

LA Z_i es un capacitor con una resistencia en PARALELO

NOTA

b)



$$I_i = I_1 + I_2 = \frac{V_1 - V_2}{R_3} + \frac{V_1}{R_1 + \frac{1}{sC}} \quad , \quad I_2 = V_2 sC$$

$$I_i = \frac{V_1}{R_3} - \frac{V_1}{sCR_1R_3 + R_3} + \frac{V_1}{R_1 + \frac{1}{sC}} \qquad \frac{V_1}{R_1 + \frac{1}{sC}} = V_2 sC$$

$$I_i = \frac{V_1}{R_3} - \frac{V_1}{R_3(sCR_1 + 1)} + \frac{sC\,V_1}{sCR_1 + 1} \qquad \frac{V_1}{sCR_1 + 1} = V_2$$

$$I_i = V_1 \left(\frac{sCR_1 + \cancel{1} - \cancel{1} + sCR_3}{R_3\,(sCR_1 + 1)} \right) = V_1 \frac{sC(R_1 + R_3)}{(sCR_1 + 1)} \frac{1}{R_3}$$

$$Z_i = R_3 \frac{sCR_1 + 1}{sC(R_1 + R_3)} = \frac{R_3 R_1}{R_1 + R_3} \frac{s + \frac{1}{CR_1}}{s}$$

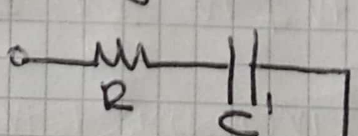
$$\boxed{Z_i = R_3 // R_1 \frac{s + \frac{1}{CR_1}}{s}}$$

- Si $\omega \Rightarrow 0$ $Z_i \rightarrow \infty$.
  $\Rightarrow$ CARACTER CAPACITIVO
- Si $\omega \rightarrow \infty$ $Z_i \rightarrow R_3 // R_1$
  $\Rightarrow$ CARACTER RESISTIVO

$$Z_i = R_3 // R_1 \left(1 + \frac{1}{j\omega C R_1} \right)$$

$$Z_i = R_3 // R_1 + \frac{R_3 // R_1}{j\omega C R_1} = R_3 // R_1 + \frac{1}{j\omega C \frac{R_1}{R_3 // R_1}}$$

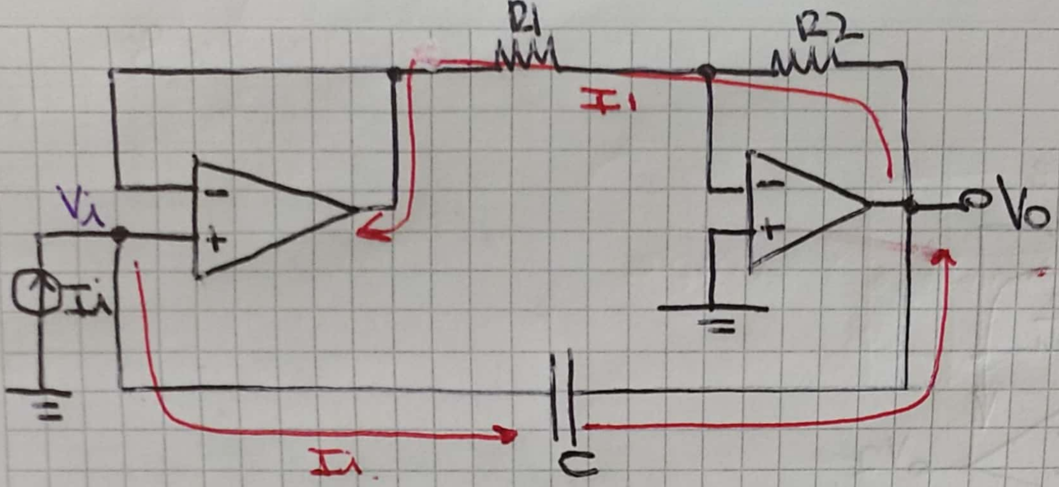
$Z_i \equiv$



$$R = R_3 // R_1$$

$$C' = C \frac{R_1}{R_3 // R_1}$$

LA Z_i es un capacitor con una resistencia en PARALELO



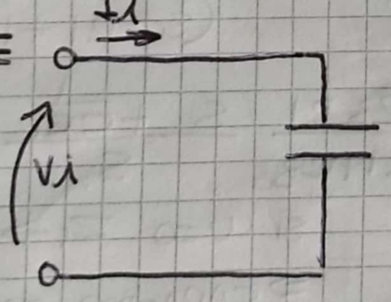
$$\frac{V_i - V_O}{\frac{1}{sC}} = I_i \qquad V_o = -\frac{R_2}{R_1} V_i$$

$$\left(V_i + \frac{R_2}{R_1} V_i\right) sC = I_i$$

$$V_i \left(1 + \frac{R_2}{R_1}\right) sC = I_i$$

$$\boxed{Z_i = \frac{1}{sC\left(1 + \frac{R_2}{R_1}\right)}}$$ ⇒ CARACTER CAPACITIVO

$Z_i \equiv$

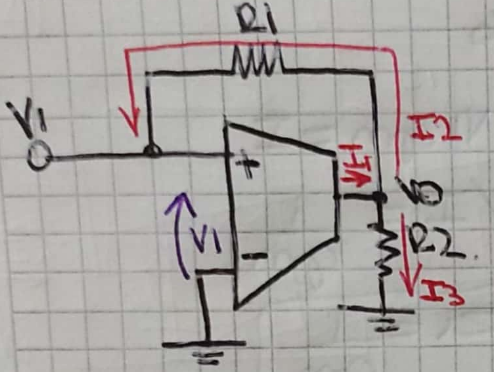


$$C' = C\left(1 + \frac{R_2}{R_1}\right)$$

NOTA

HOJA Nº 4

FECHA



$$I_i = I_2 = I_1 - I_3 = V_1 g_m - \frac{V_o}{R_2}$$

$$I_i = V_1 g_m - \frac{V_o}{R_2} \quad ; \quad I_2 = \frac{V_o - V_i}{R_1}$$

$$\frac{V_o - V_i}{R_1} = V_1 g_m - \frac{V_o}{R_2}$$

$$V_o - V_i = V_1 g_m R_1 - \frac{R_1}{R_2} V_o$$

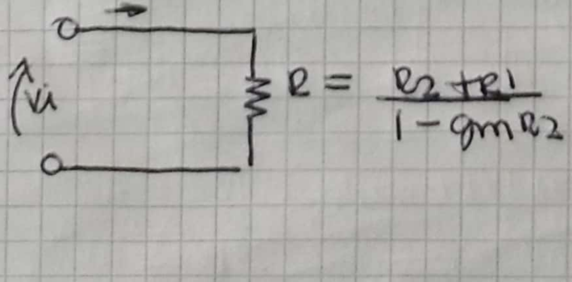
$$V_o\left(1 + \frac{R_1}{R_2}\right) = V_i (1 + g_m R_1)$$

$$V_o = V_i \frac{(1 + g_m R_1)}{1 + \frac{R_1}{R_2}}$$

$$I_i = \left[V_i g_m - \frac{V_1}{R_2} \frac{1 + g_m R_1}{1 + \frac{R_1}{R_2}}\right] = V_1 g_m - V_1 \frac{(1 + g_m R_1)}{R_2 + R_1}$$

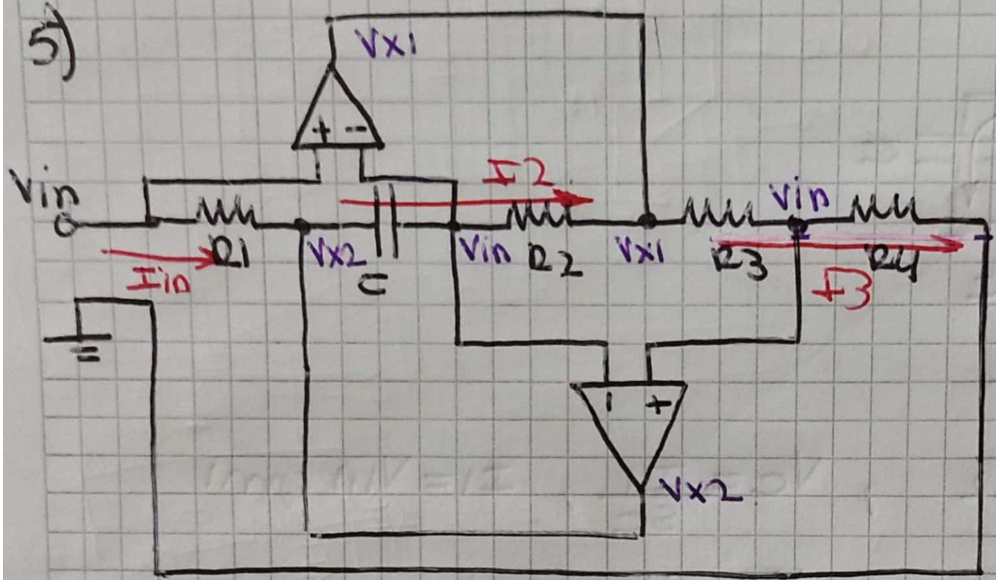
$$I_i = \left[V_1 \left(g_m - \frac{1 + g_m R_1}{R_2 + R_1}\right)\right] = V_i \left(\frac{g_m R_2 - 1}{R_2 + R_1}\right)$$

$$\boxed{Z_i = \frac{R_2 + R_1}{-g_m R_2 + 1}}$$ $\Rightarrow$ CARACTER RESISTIVO



NOTA

5)



$$I_{in} = \frac{V_{in} - V_{x2}}{R_1} \qquad (V_{x2} - V_{in})\, sC = \frac{(V_{in} - V_{x1})}{R_2}$$

$$V_{x2} = V_{in}\left(1 + \frac{1}{sCR_2}\right) - \frac{V_{x1}}{sCR_2} \qquad V_{x2} = \frac{V_{in} - V_{x1}}{sCR_2} + V_{in}$$

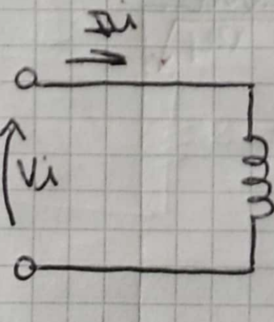
$$V_{x2} = V_{in}\left(1 + \frac{1}{sCR_2}\right) - \frac{\left(1 + \frac{R_3}{R_4}\right) V_{in}}{sCR_2} \qquad \frac{V_{x1} - V_{in}}{R_3} = \frac{V_{in}}{R_4}$$

$$V_{x2} = V_{in}\left(1 - \frac{R_3/R_4}{sCR_2}\right) \qquad V_{x1} = \frac{R_3}{R_4} V_{in} + V_{in}$$

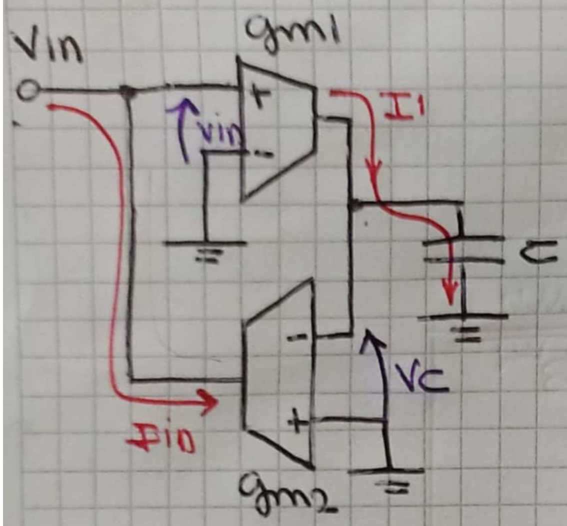
$$I_{in} = \frac{V_{in} - V_{in}\left(1 - \frac{\frac{R_3}{R_4}}{sCR_2}\right)}{R_1} \qquad V_{x1} = V_{in}\left(1 + \frac{R_3}{R_4}\right)$$

$$I_{in} = + V_{in} \frac{R_3}{R_4} \frac{1}{sCR_2R_1}$$

$$\boxed{Z_{in}(s) = \frac{R_4}{R_3}\; sCR_2R_1} \Rightarrow \text{INDUCTOR}$$



$$L = \frac{R_4}{R_3} C R_2 R_1$$

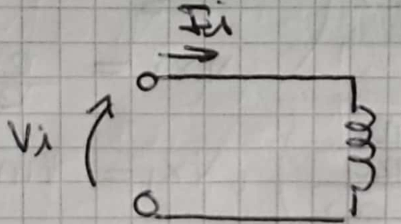


$I_{in} = V_C \cdot g_{m2}$, $V_C = \dfrac{I_1}{sC}$, $I_1 = V_{in}\, g_{m1}$

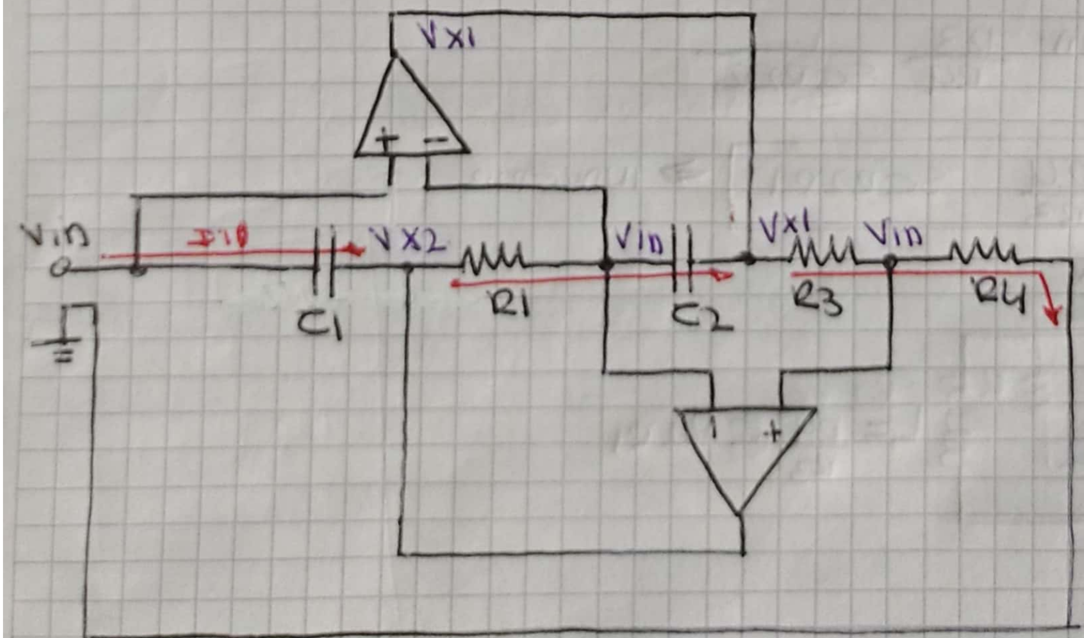
$$V_C = \frac{V_{in}\, g_{m1}}{sC}$$

$$I_{in} = V_{in}\, \frac{g_{m1}\, g_{m2}}{sC}$$

$$\boxed{Z_{in} = \frac{sC}{g_{m1}\, g_{m2}}} \Rightarrow \text{INDUCTOR}$$



$L = \dfrac{C}{g_{m1}\, g_{m2}}$



HOJA Nº 6

FECHA

$$I_{in} = (V_{in} - V_{x2}) sC_1 \qquad \frac{(V_{x2} - V_{in})}{R_1} = (V_{in} - V_{x1}) sC_2$$

$$V_{x2} = sC_2 R_1 \left[V_{in} - V_{in}\left(1 + \frac{R_3}{R_4}\right)\right] + V_{in}$$

$$V_{x2} = \left(-sC_2 R_1 \frac{R_3}{R_4} + 1\right) V_{in}$$

$$\begin{cases} V_{x2} = sC_2 R_1 (V_{in} - V_{x1}) + V_{in} \\ \frac{V_{x1} - V_{in}}{R_3} = \frac{V_{in}}{R_4} \\ V_{x1} = \left(1 + \frac{R_3}{R_4}\right) V_{in} \end{cases}$$

$$I_{in} = sC_1 V_{in} \left(sC_2 \frac{R_1 R_3}{R_4} \right)$$

$$I_{in} = s^2 \frac{C_1 C_2 R_1 R_3}{R_4} V_{in}$$

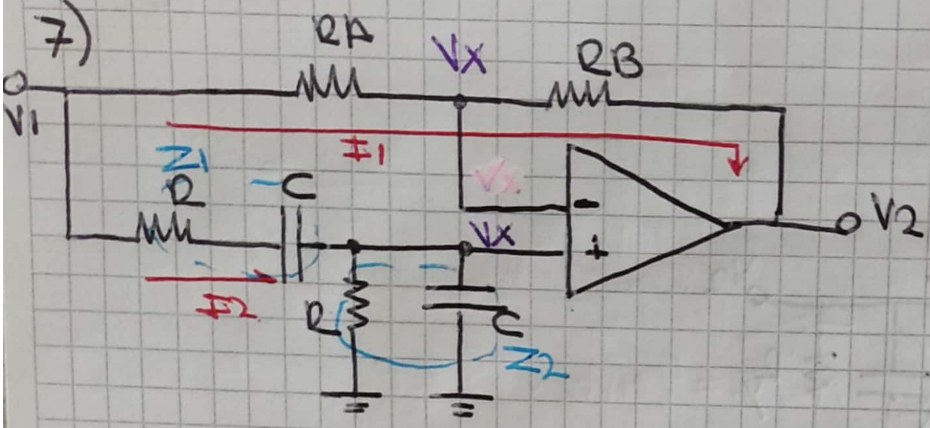
$$\frac{V_{in}}{I_{in}} = \frac{R_4}{s^2 C_1 C_2 R_1 R_3}$$

$$\boxed{Z_{in}(s) = \frac{R_4}{s^2 C_1 C_2 R_1 R_3}}$$

↳ si $s = j\omega$ $\quad Z_{in}(\omega) = \frac{-1}{\omega^2} \quad \frac{R_5}{C_1 C_3 R_2 R_4}$

RESISTOR NEGATIVO
DEPENDIENTE DE la FRECUENCIA

7)



$$\bullet\ \frac{V_1 - V_x}{R_A} = \frac{V_x - V_2}{R_B} \quad ; \quad V_x = V_1 \frac{Z_2}{Z_2 + Z_1}$$

$$V_x = V_1 \frac{\frac{1}{1/R_1 + sC}}{\frac{1}{1/R_1 + sC} + R + \frac{1}{sC}}$$

$$V_x = V_1 \frac{\frac{R_1}{sCR_1 + 1}}{\frac{R_1}{sCR_1+1} + \frac{sCR+1}{sC}}$$

$$V_x = V_1 \frac{\frac{R_1}{\cancel{sCR_1+1}}}{\frac{sCR_1 + s^2C^2RR_1 + sC(R+R_1)+1}{(\cancel{sCR_1+1})sC}}$$

$$\bullet\ V_x = V_1 \frac{sCR_1}{s^2C^2RR_1 + sC(R+2R_1)+1}$$

$$V_1 - V_x = \frac{R_A}{R_B}(V_x - V_2) \Rightarrow V_1 - V_1 A(s) = \frac{R_A}{R_B}\left(V_1 A(s) - V_2(s)\right)$$

$$V_1\left[1 - A(s) - \frac{R_A}{R_B}A(s)\right] = -\frac{R_A}{R_B}V_2(s)$$

$$V_1\left[1 - A(s)\left(1 + \frac{R_A}{R_B}\right)\right] = -\frac{R_A}{R_B}V_2(s)$$

$$\frac{V_2(s)}{V_1(s)} = -\frac{R_B}{R_A}\left[1 - A(s)\left(1 + \frac{R_A}{R_B}\right)\right]$$

NOTA

$$T(s) = -\frac{R_B}{R_A}\left[1 - \frac{sCR_1}{s^2C^2RR_1 + sC(R+2R_1)+1}\left(1+\frac{R_A}{R_B}\right)\right]$$

$$T(s) = -\frac{R_B}{R_A}\left[\frac{s^2C^2R^2 + sC3R + 1 - sCR\left(1+\frac{R_A}{R_B}\right)}{s^2C^2R^2 + sC3R + 1}\right]$$

$$T(s) = -\frac{R_B}{R_A}\;\frac{s^2 + s\frac{3}{CR} - s\frac{1}{CR}\left(1+\frac{R_A}{R_B}\right) + 1/C^2R^2}{s^2 + s\frac{3}{CR} + \frac{1}{C^2R^2}}$$

$$T(s) = -\frac{1}{5}\;\frac{s^2 + s\frac{3}{CR} - s\frac{1}{CR}(1+5) + 1/C^2R^2}{s^2 + s\frac{3}{CR} + 1/C^2R^2}$$

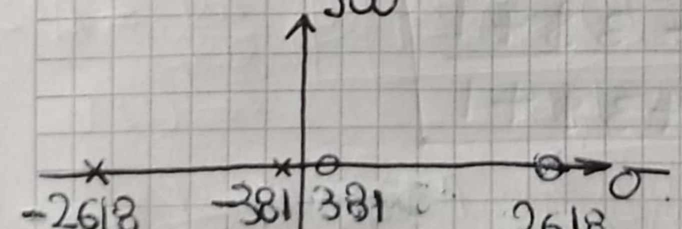
$$\boxed{T(s) = -\frac{1}{5}\;\frac{s^2 - s\frac{3}{CR} + \frac{1}{C^2R^2}}{s^2 + s\frac{3}{CR} + \frac{1}{C^2R^2}}}$$

$C = 1\mu F$, $R = 1k$.

$$T(s) = -\frac{1}{5}\;\frac{s^2 - 3000s + 1M}{s^2 + 3000s + 1M}$$

zeros = 2618, 381,97

polos = −2618, −381,97



$$|T(0)| = \frac{\cancel{2618 \cdot 381}}{\cancel{2618 \cdot 381}} \cdot \frac{1}{5}$$

$$|T(0)| = \frac{1}{5}$$

$$|T(\omega \to +\infty)| = \frac{+\infty \cdot +\infty}{+\infty \cdot +\infty} \quad 1/5$$

inf de misma MAG

$$|T(\omega \to +\infty)| = 1/5$$

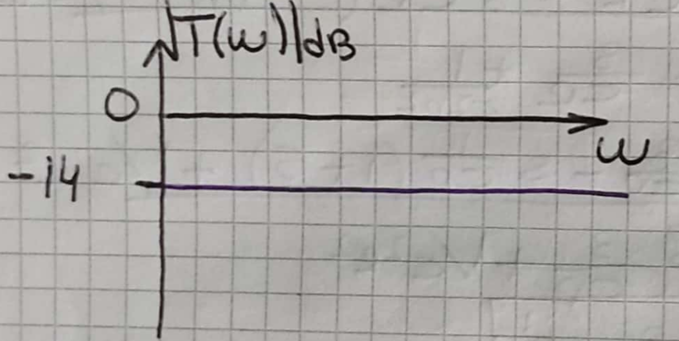
$$\theta(0) = (\pi + \pi - 0 - 0) - \pi$$

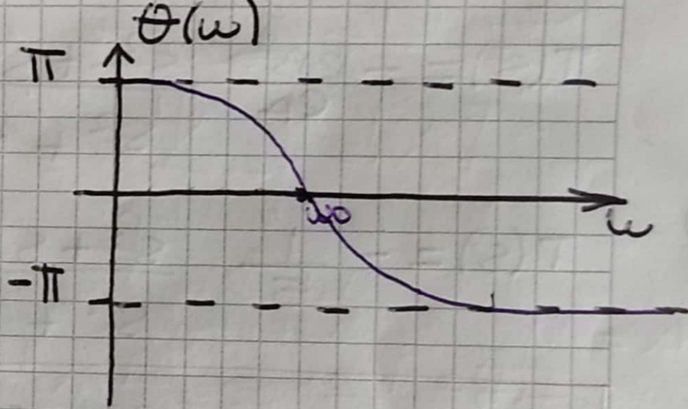
$$\theta(0) = \pi$$

$$\theta(\omega \to +\infty) = (\pi/2 + \pi/2 - \pi/2 - \pi/2) - \pi$$

$$\theta(\omega \to +\infty) = -\pi$$

$$\theta(\omega_0) = \pi - \pi = 0$$





b– $\omega_0 = \frac{1}{CR} \Rightarrow \Omega_\omega = \frac{1}{CR}, \quad \$ = \frac{s}{1/CR}$

$$\Rightarrow T(\$) = -\frac{1}{5} \frac{\$^2 \frac{1}{(CR)^2} - \$ \frac{1}{CR}\frac{3}{CR} + \frac{1}{(CR)^2}}{\$^2 \frac{1}{(CR)^2} + \$ \frac{1}{CR}\frac{3}{CR} + \frac{1}{(CR)^2}}$$

$$\boxed{T(\$) = -\frac{1}{5} \frac{\$^2 - 3\$ + 1}{\$^2 + 3\$ + 1}}$$

donde $\Omega_z = R_B$

$$\Rightarrow R_B' = 1$$

$$R_A' = \frac{R_A}{\Omega_z} = \frac{R_A}{R_B}$$

$$\Rightarrow \boxed{T(\$) = -\frac{1}{R_A'} \frac{\$^2 - \$(R_A' - 2) + 1}{\$^2 + \$\,3 + 1}}$$

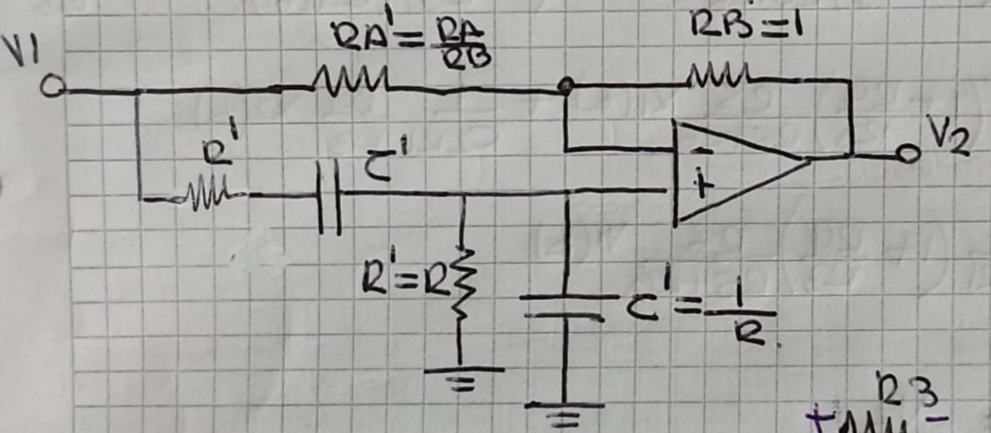
NOTA

HOJA Nº 10

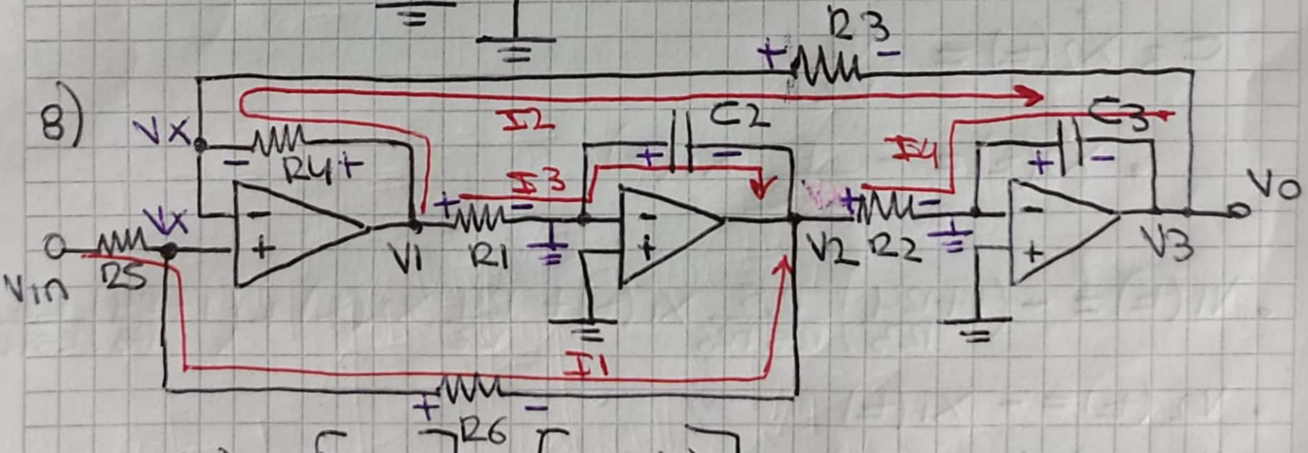
FECHA

$$\Rightarrow Z_C = \frac{1}{sC} = \frac{1}{s\frac{1}{\cancel{2}R}\cancel{2}} = \frac{1}{s\frac{1}{R}} \quad C'$$

$$\begin{cases} C' = \frac{1}{R} \\ R' = R \end{cases}$$



8)



$$X(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} V_{C2}(t) \\ V_{C3}(t) \end{bmatrix}$$

$$C_2\, \dot{x}_1(t) = \frac{V_1}{R_1}, \quad \frac{V_1 - V_x}{R_4} = \frac{V_x - V_3}{R_3}, \quad V_3 = -x_2(t).$$

$$\frac{V_1 - V_x}{R_4} = \frac{V_x + x_2(t)}{R_3}, \quad \frac{V_x - V_2}{R_6} = \frac{V_i - V_x}{R_5}$$

$$V_2 = -x_1(t).$$

$$V_x\left(1 + \frac{R_6}{R_5}\right) = \frac{R_6}{R_5} V_i - x_1(t)$$

$$V_x = \frac{R_6}{\cancel{R_5}} \frac{\cancel{R_5}}{R_5+R_6} V_i - \frac{R_5}{R_5+R_6} x_1(t)$$

$$V_x = \frac{R_6}{R_5+R_6} V_i(t) - \frac{R_5}{R_5+R_6} x_1(t).$$

NOTA

$$V_1 = \frac{R4}{R3}(Vx + x_2) + Vx$$

$$V_1 = Vx\left(1+\frac{R4}{R3}\right) + \frac{R4}{R3}x_2(t).$$

$$\dot{x}_1(t) = \frac{1}{C2R1}\left[Vx\left(1+\frac{R4}{R3}\right) + \frac{R4}{R3}x_2(t)\right]$$

$$\dot{x}_1(t) = \frac{1}{C2R1}\left[\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6}V_i(t) - \left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6}x_1(t) + \frac{R4}{R3}x_2(t)\right]$$

$$\bullet\ \dot{x}_1(t) = -\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6}x_1(t) + \frac{1}{C2R1}\frac{R4}{R3}x_2(t)$$

$$+\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6.}V_i(t)$$

$$C_3\dot{x}_2(t) = \frac{V2}{R2.}$$

$$\bullet\ \dot{x}_2(t) = -\frac{1}{C3R2}x_1(t).$$

$$\bullet\ V_1(t) = -\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6}x_1(t) + \frac{R4}{R3}x_2(t) + \left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6}V_i(t).$$

$$\bullet\ V2(t) = -x_1(t)$$

$$\bullet\ V3(t) = -x_2(t).$$

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix} = \begin{bmatrix}-\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} & \frac{1}{C2R1}\frac{R4}{R3}\\ -\frac{1}{C3R2} & 0\end{bmatrix} + \begin{bmatrix}\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6}\\ 0\end{bmatrix}$$

$$\begin{bmatrix}V_1(t)\\ V2(t)\\ V3(t)\end{bmatrix} = \begin{bmatrix}-\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} & \frac{R4}{R3}\\ -1 & 0\\ 0 & -1\end{bmatrix} + \begin{bmatrix}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6.}\\ 0\\ 0\end{bmatrix}V_i(t)$$

NOTA

HOJA Nº 11

FECHA

$$(sI-A)=\begin{bmatrix} s+\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} & -\frac{1}{C2R1}\frac{R4}{R3} \\ \frac{1}{C3R2} & s \end{bmatrix}$$

$$\det(sI-A)= s^2+s\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6}+\frac{1}{C_2C_3R_1R_2}\frac{R4}{R3}$$

$$(sI-A)^{-1}=\frac{1}{\det}\begin{bmatrix} s & +\frac{1}{C2R1}\frac{R4}{R3} \\ -\frac{1}{C3R2} & s+\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} \end{bmatrix}$$

$$(sI-A)^{-1}B=\frac{1}{\det}\begin{bmatrix} s & \frac{1}{C2R1}\frac{R4}{R3} \\ -\frac{1}{C3R2} & s+\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} \end{bmatrix}\begin{bmatrix} \frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \\ 0 \end{bmatrix}$$

$$=\frac{1}{\det}\begin{bmatrix} s\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \\ -\frac{1}{C2C3R1R2}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \end{bmatrix}$$

$$C(sI-A)^{-1}B=\frac{1}{\det}\begin{bmatrix} -\left(1+\frac{R4}{R3}\right)\frac{R5}{R5+R6} & \frac{R4}{R3} \\ -1 & 0 \\ 0 & -1 \end{bmatrix}\begin{bmatrix} s\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \\ -\frac{1}{C2C3R1R2}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \end{bmatrix}$$

$$=\frac{1}{\det}\begin{pmatrix} -s\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)^2\frac{R5R6}{(R5+R6)^2}-\frac{1}{C2C3R1R2}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6}\frac{R4}{R3} \\ -s\frac{1}{C2R1}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \\ +\frac{1}{C2C3R1R2}\left(1+\frac{R4}{R3}\right)\frac{R6}{R5+R6} \end{pmatrix}$$

NOTA

$$\boxed{T_2(s)=\frac{V_2}{V_{in}}=\frac{-s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}}{s^2+s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)\frac{R_5}{R_5+R_6}+\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}}$$

$$w_0=\sqrt{\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}$$

$$\left.\begin{aligned}|T_2(0)|&=0\\|T_2(w\to+\infty)|&=0.\\|T_2(w_0)|&=\frac{R_6}{R_5}.\end{aligned}\right\}\Rightarrow \text{FIltro PASABANDA}$$

$$T_3(s)=\frac{V_3}{V_{in}}=\frac{\frac{1}{C_2C_3R_1R_2}\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}}{s^2+s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)\left(\frac{R_5}{R_5+R_6}\right)+\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}$$

$$\boxed{T_3(s)=\frac{V_3}{V_{in}}=\frac{\left(\frac{R_3}{R_4}+1\right)\frac{R_6}{R_5+R_6}\cdot\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}{s^2+s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)\left(\frac{R_5}{R_5+R_6}\right)+\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}}$$

$$\left.\begin{aligned}|T(0)|&=\left(\frac{R_3}{R_4}+1\right)\frac{R_6}{R_5+R_6}\\|T_3(w\to+\infty)|&=0.\\|T_3(w_0)|&=\left(\frac{R_3}{R_4}+1\right)\frac{R_6}{R_5}.\end{aligned}\right\}\ \text{FIltro PASABAJOS}$$

NOTA

HOJA Nº 12

FECHA

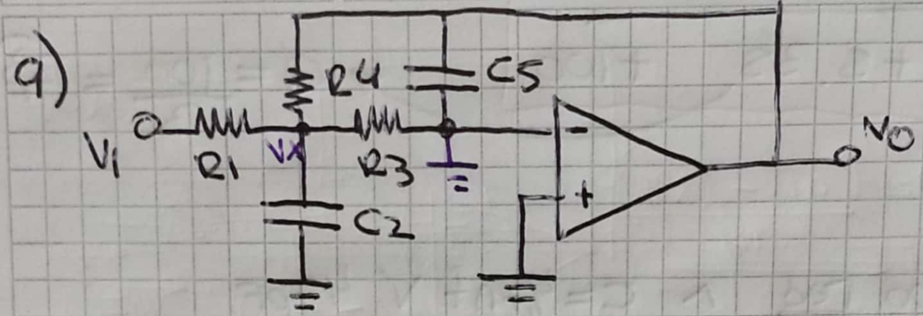
$$T_1(\omega)=\frac{V_1}{V_2}=\frac{\det\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}-s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)^2\frac{R_5R_6}{(R_5+R_6)^2}-\frac{1}{C_2C_3R_1R_2}\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}\frac{R_4}{R_3}}{\det}$$

$$T_1(\omega)=\frac{s^2\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}+\cancel{s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)^2\frac{R_5R_6}{(R_5+R_6)^2}}+\cancel{\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}\cdot\frac{1}{C_2C_3R_1R_2}\frac{R_4}{R_3}}-\cancel{s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)^2\frac{R_5R_6}{(R_5+R_6)^2}}-\cancel{\frac{1}{C_2C_3R_1R_2}\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}\frac{R_4}{R_3}}}{\det}$$

$$\boxed{T_1(\omega)=\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}\cdot\frac{s^2}{s^2+s\frac{1}{C_2R_1}\left(1+\frac{R_4}{R_3}\right)\left(\frac{R_5}{R_5+R_6}\right)+\frac{\frac{R_4}{R_3}}{C_2C_3R_1R_2}}}$$

$$\left.\begin{array}{l}|T_1(0)|=0\\ |T_1(\omega\to\infty)|=\left(1+\frac{R_4}{R_3}\right)\frac{R_6}{R_5+R_6}\\ |T_1(\omega_0)|=\omega_0\frac{R_6}{R_5}\frac{1}{C_2R_1}\end{array}\right\}\text{FILTRO PASAALTOS}$$

9)



$$\left(\frac{1}{R1}+\frac{1}{R4}+sC2+\frac{1}{R3}\right)Vx=\frac{V1}{R1}+\frac{Vo}{R4}$$

$$\frac{Vx}{R3}=-Vo\,sC5,\quad Vx=-sC5R3Vo.$$

$$-\left(\frac{R4R3+R1R3+sC2R1R4R3+R1R4}{R1R4R3}\right)sC5R3Vo=\frac{V1}{R1}+\frac{Vo}{R4}$$

$$-\frac{\left(s^2C2C5R1R4R3^2+sC5R3(R4R3+R1R3+R1R4)\right)Vo}{R1R4R3}-\frac{Vo}{R4}=\frac{V1}{R1}$$

$$-\frac{\left[s^2C2C5R1R4R3^2+sC5R3(R4R3+R1R3+R1R4)+R1R3\right]}{\cancel{R1}R4R3}Vo=\frac{V1}{\cancel{R1}}$$

$$\frac{Vo(s)}{V1(s)}=-\frac{R4R3}{s^2C2C5R1R4R3^2+sC5R3(R4R3+R1R3+R1R4)+R1R3}$$

$$T(s)=-\frac{\dfrac{1}{C2C5R1R3}}{s^2+s\left[\dfrac{1}{C2R1}+\dfrac{1}{C2R4}+\dfrac{1}{C2R3}\right]+\dfrac{1}{C2C5R4R3}}$$

$$\boxed{T(s)=-\frac{R4}{R1}\,\frac{\dfrac{1}{C2C5R4R3}}{s^2+s\left[\dfrac{1}{C2R1}+\dfrac{1}{C2R4}+\dfrac{1}{C2R3}\right]+\dfrac{1}{C2C5R4R3}}}$$

$$\omega o=\frac{1}{\sqrt{C2C5R4R3}}=10\,\frac{rad}{s}\qquad |T(0)|=\frac{R4}{R1}=1$$

NOTA

$$T(s) = -\frac{100}{s^2 + 3s + 100}$$

$$Q = \frac{100}{3} = 3{,}\overset{\frown}{3}$$

b) si $w_0 = 1000 \frac{rad}{s}$ $\wedge$ $C = 4{,}7nf \vee 47pF$.

$Q = 3{,}\overset{\frown}{3}$

$$\Rightarrow \frac{w_0}{Q} = \begin{cases} 300 = \frac{1}{C_2}\left(\frac{1}{R_1} + \frac{1}{R_4} + \frac{1}{R_3}\right) \\ 1M = \frac{1}{C_2 C_5 R_4 R_3} \end{cases} \wedge R_4 = R$$

Utilizo $C_2 = 4{,}7nf$ $C_1 = 47pf$.

$$\Rightarrow \begin{cases} 300 = \frac{1}{4{,}7nf}\left(\frac{2}{R_4} + \frac{1}{R_3}\right) \\ 1M = \frac{1}{4{,}7nf \cdot 47pf \cdot R_4 R_3} \end{cases}$$

$R_4 = R_3 = 2{,}12 M\Omega$

$\vee$

$R_4 = 4{,}25 M\Omega \wedge R_3 = 1{,}06 M\Omega$

$\Rightarrow \underline{R_4 = 4{,}3 M\Omega} \quad \underline{R_3 = 1 M\Omega}$

$$\boxed{\begin{array}{l} R_1 = 4{,}3M\ \Omega \\ R_3 = 1M\ \Omega \\ R_4 = 4{,}3M \\ C_1 = 47pf \\ C_2 = 4{,}7nf \end{array}}$$

$Q = 3{,}3$

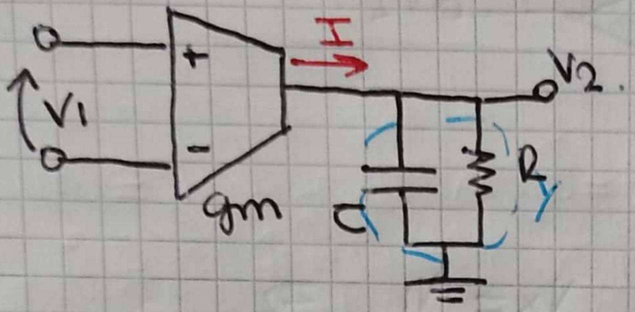
$W_0 = 1026{,}06 \frac{rad}{s}$

NOTA

HOJA Nº 8

FECHA

10)



$$I(s) = gm\, v_1(s)$$

$$I(s) \cdot \frac{1}{Y(s)} = gm\, v_1(s)\, \frac{1}{Y(s)}.$$

$$V_2(s) = gm\, V_1(s)\, \frac{1}{\frac{1}{R} + SC}$$

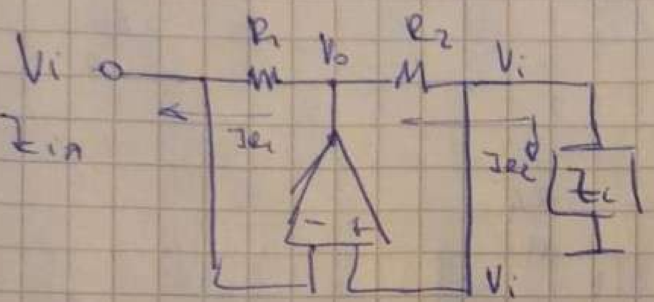
$$\frac{V_2(s)}{V_1(s)} = \frac{gm\, R}{SCR + 1}$$

$$T(s) = \frac{\frac{gm}{C}}{S + \frac{1}{CR}}$$

$$\boxed{T(s) = \frac{5 \times 10^{10}\, gm}{S + 5 \times 10^{6}}}$$

NOTA

6)



$$I_{R2} = I_{ZL}$$

$$\frac{V_0 - V_1}{R2} = \frac{V_1}{Z_L}$$

$$\cancel{\frac{V_0}{R2}} \quad V_0 - V_1 = V_1 \frac{R2}{Z_L}$$

$$V_0 = V_1\left(1 + \frac{R2}{Z_L}\right)$$

$$\boxed{\frac{V_0}{V_1} = 1 + \frac{R2}{Z_L}}$$

$$Z_{in} = \frac{V_1}{I_{R1}}$$

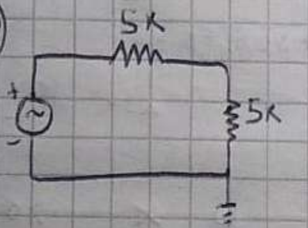
$$I_{R1} = \frac{V_0 - V_1}{R1}$$

$$I_{R1} = \frac{V_0}{R1} - \frac{V_1}{R1}$$

$$I_{R1} = \cancel{\frac{V_1}{R1}} + \frac{V_1 \cdot R2}{R1\, Z_L} - \cancel{\frac{V_1}{R1}}$$

$$\boxed{Z_{in} = \frac{V_1}{-I_{R1}} = -\frac{R1\, Z_L}{R2}}$$

4) a)



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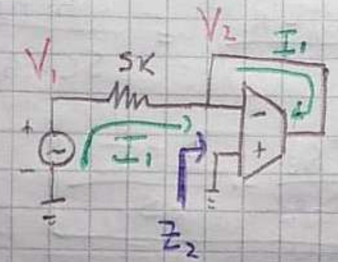
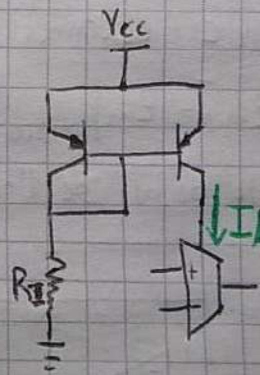


$$V_2 \cdot g_m = I_1$$

$$Z_2 = \frac{V_2}{I_1} = \boxed{\frac{1}{g_m}}$$

$$\therefore \; g_m = \frac{1}{5K} = 200\,\mu S \qquad V_2 = \frac{Z_2}{5K + Z_2} \cdot V_1 = \frac{1}{2} V_1$$

b) $T = 25^\circ C \Rightarrow I_{ABC} = 12\,\mu A$ aprox



$$\downarrow I_{ABC} \simeq \frac{V_{CC} - V_{BE}}{R_I}$$

$$I_{ABC} \simeq I_{RI} = \frac{V_{CC} - V_{BE}}{R_I}$$

$$V_{BE} \simeq 0{,}7V \Rightarrow \boxed{R_I = \frac{V_{CC} - 0{,}7V}{12\,\mu A}}$$

Si $V_{CC} = 9V \Rightarrow \underline{R_I \simeq 690K}$