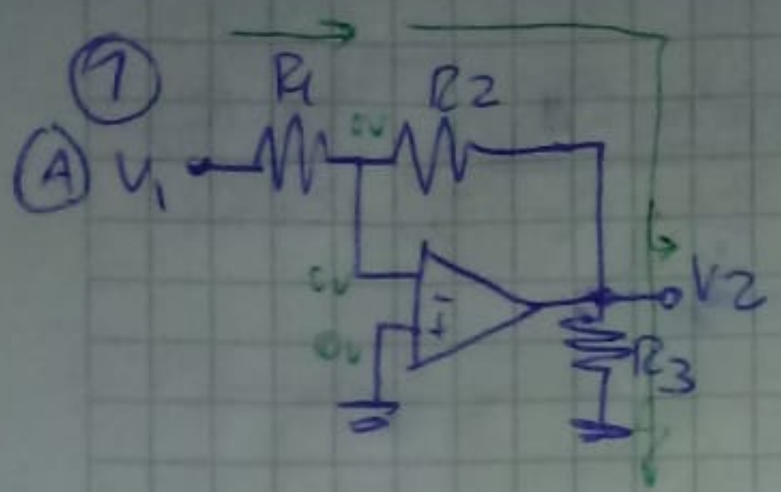
Trabajo práctico ①

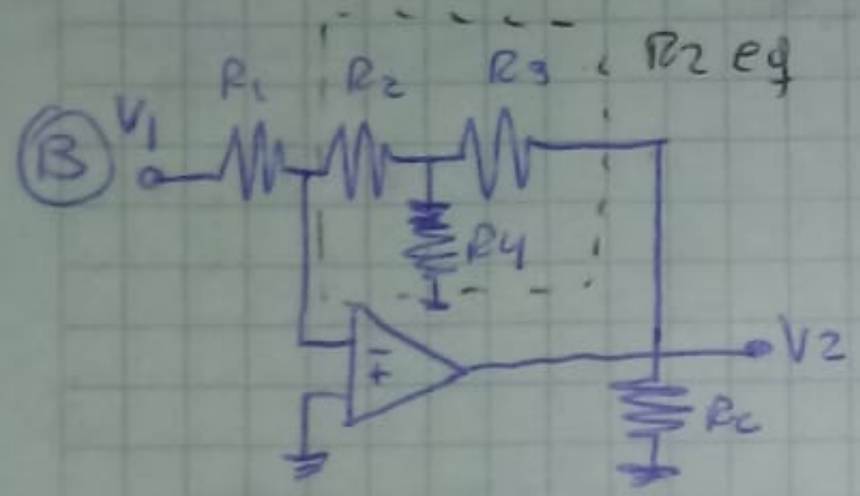


$$R_1 = \frac{V_I}{I_i} = \boxed{R_1}$$

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

R2 debe ser 3000 y R1 debe ser 10k

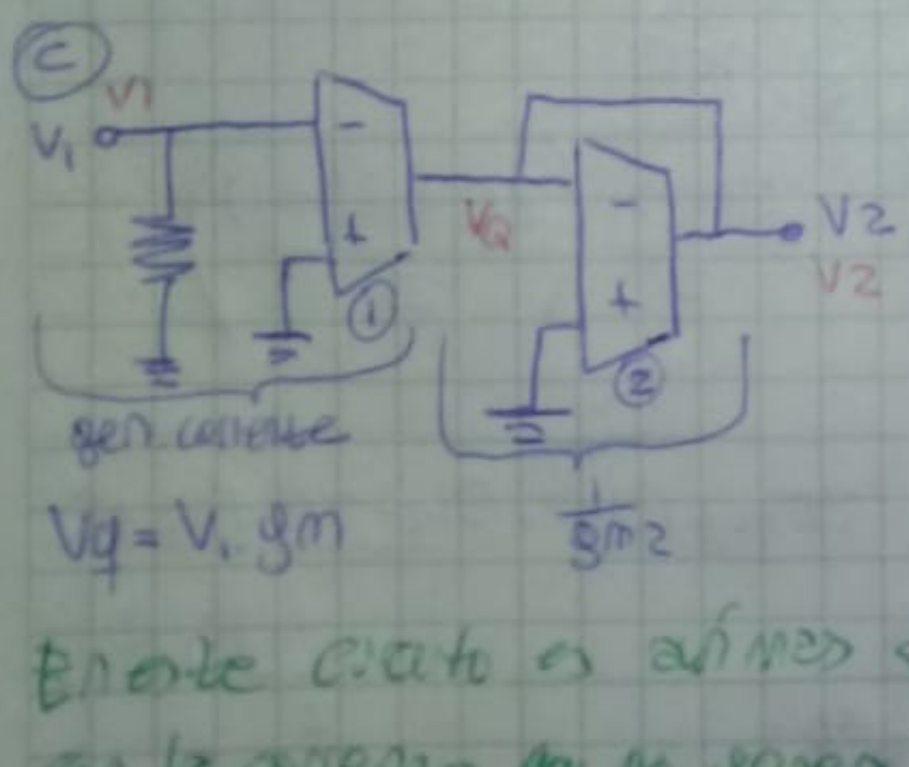
R1 $\boxed{R_2 = 30M}$ Demasiado grande
- Mucho ruido
- Valor complicado de manejar



$R_1 = R_i$

$$\frac{V_2}{V_1} = \frac{-R_{2eq}}{R_1}$$

En este caso, a diferencia del anterior, se puede reducir el valor de R2 en 3 veces (o más) de menor valor, facilitando así el diseño y minimizando el ruido.



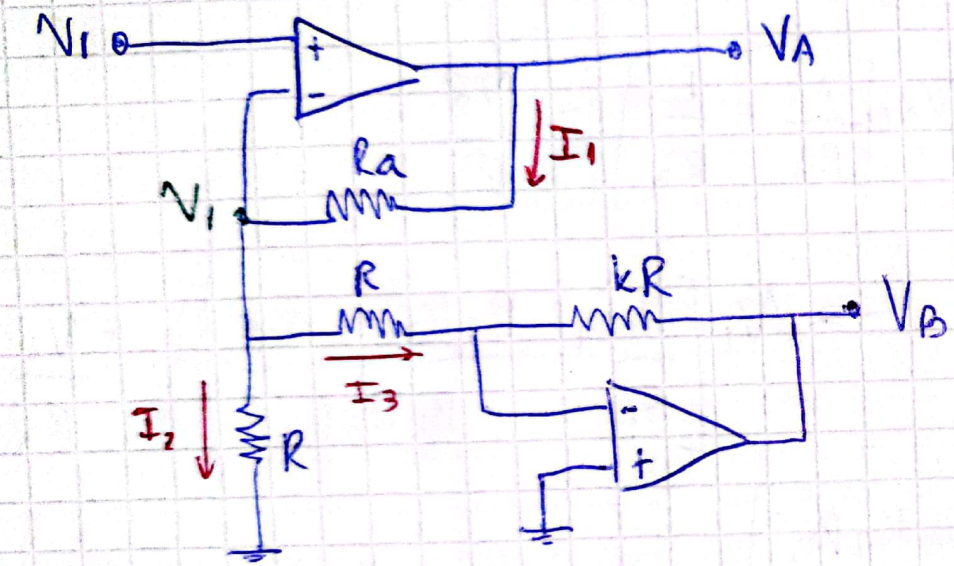
$$\frac{V_2}{V_g} = \frac{1}{g_{m2}}$$

$$\frac{V_2}{V_1 \cdot g_{m1}} = \frac{1}{g_{m2}} \rightarrow \boxed{\frac{V_2}{V_1} = \frac{g_{m1}}{g_{m2}}}$$

En este circuito, a diferencia del anterior, se genera la corriente que genera el 1° OTA.

NOTA

2)



$V_{AB} = ?$

$$R_a = \frac{R(k-1)}{2}$$

$$\frac{V_A - V_1}{R_a} = \frac{V_1}{R} + \frac{V_1}{R} = \frac{2V_1}{R}$$

$$V_A - V_1 = \frac{2R_a}{R} V_1$$

$$V_A = V_1\left(1 + \frac{2R_a}{R}\right) *$$

$$\frac{V_1}{R} = \frac{-V_B}{kR} \rightarrow V_B = -kV_1 *$$

$$V_{AB} = V_A - V_B = V_1\left(1 + \frac{2R_a}{R} - (-k)\right) = V_1\left(\frac{R + 2R_a}{R} + k\right)$$

NOTA

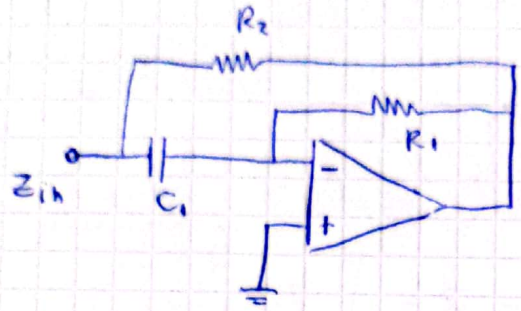
$$V_{AB} = V_1\left(\frac{R + 2R_A + kR}{R}\right) = \left(\frac{R + R(k-1) + kR}{R}\right)V_1$$

$$V_{AB} = (1 + k - 1 + k)V_1$$

$$\boxed{V_{AB} = 2kV_1}$$

3)

a)



$Z_{in} = \frac{V_1}{ie}$ → genérico

$$ie = V_1 \$C_1 + \frac{V_1 - V_2}{R_2}$$

$$V_1 \$C_1 = \frac{-V_2}{R_1}$$

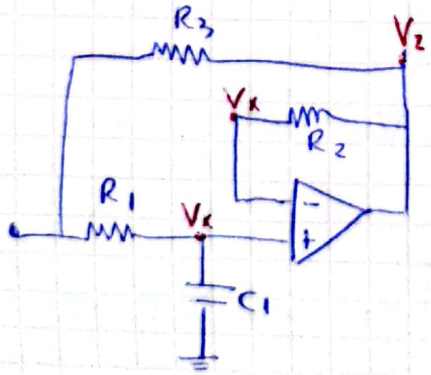
$$V_2 = -V_1 \$C_1 R_1$$

$$ie = V_1 \$C_1 + \frac{V_1}{R_2} + \frac{V_1 \$C_1 R_1}{R_2}$$

$$ie = V_1\left[\frac{\$C_1 R_2 + 1 + \$C_1 R_2}{R_2}\right] \rightarrow Z_{in} = \frac{R_2}{\$C_1(R_1+R_2) + 1}$$

↑ Desarrollo previo

b)



$$Z_{in} = \frac{V_1}{ie} =$$

$$ie = \frac{V_1 - V_2}{R_3} + \frac{V_x}{\frac{1}{\$C_1}}$$

$I_{R_2} = 0 \rightarrow V_x = V_2$

$$\frac{V_1 - V_2}{R_1} = V_2 \$C_1$$

$$V_1 = V_2(1 + \$C_1 R_1)$$

$$ie = \frac{V_1}{R_3} - \frac{V_1}{(1+\$C_1R_1)R_3} + \$C_1 \frac{V_1}{(1+\$C_1R_1)}$$

$$ie = V_1\left[\frac{1}{R_3} - \frac{1}{R_3 + \$C_1R_1R_3} + \frac{\$C_1}{1+\$C_1R_1}\right]$$

$$i_e = V_1 \left[\frac{\not{4} C_1 R_1}{R_3 + \not{4} C_1 R_1 R_3} + \frac{\not{4} C_1 + \not{4}^2 C_1^2 R_1 - \not{4} C_1}{1 + \not{4} C_1 R_1} \right]$$

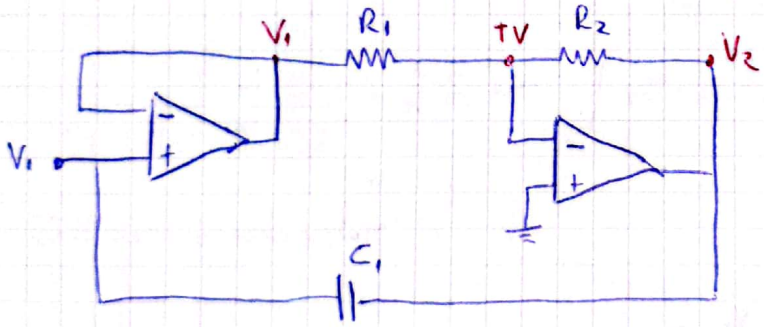
$$= V_1 \left[\frac{\not{4} C_1 R_1}{R_3 + \not{4} C_1 R_1 R_3} + \frac{\not{4}^2 C_1^2 R_1}{1 + \not{4} C_1 R_1} \right]$$

$$i_e = \left(\frac{\not{4} C_1 R_3 + 1 + \not{4} C_1 R_1}{R_3 + \not{4} C R_1 R_3} - \frac{1}{\not{4} C_1 R_1 R_3 + R_3} \right) V_1$$

$$i_e = \frac{\not{4} C_1 (R_1 + R_3)}{\not{4} C_1 R_1 R_3 + R_3} V_1$$

$$\rightarrow \frac{V_1}{i_e} = \boxed{\frac{\not{4} C_1 R_1 R_3 + R_3}{\not{4} C_1 (R_1 + R_3)} = Z_{in}}$$

c)



$$i_e = (V_1 - V_2) \not{4} C_1$$

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

$$i_e = V_1 \left(1 + \frac{R_2}{R_1}\right) \not{4} C_1 = \left(\frac{R_1 + R_2}{R_1}\right) \not{4} C_1 V_1$$

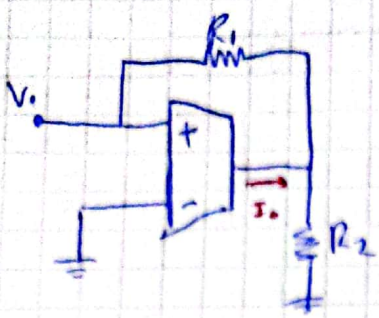
$$\rightarrow Z_{in} = \frac{R_1}{\not{4} C_1 (R_1 + R_2)} = \boxed{\frac{1}{\not{4} \left(\frac{R_1 + R_2}{R_1}\right)}} \rightarrow \text{naturaleza capacitiva}$$

NOTA

HOJA Nº

FECHA

d)



$I_0 = V_1 g_m$

$I_{R2} = I_0 + I_1$

$V_{R2} = (I_0 + I_1) R_2$

$V_{R2} = V_1 g_m R_2 + \frac{V_1 R_2}{R_1} - \frac{V_{R2} R_2}{R_1}$

$V_{R2}\left[1 + \frac{R_2}{R_1}\right] = V_1\left[g_m R_2 + \frac{R_2}{R_1}\right]$

$V_{R2}\left(\frac{R_1 + R_2}{R_1}\right) = V_1\left(\frac{g_m R_1 R_2 + R_2}{R_1}\right)$

$I_1 = \frac{V_1 - V_{R2}}{R_1}$

$V_{R2} = \left(\frac{g_m R_1 R_2 + R_2}{R_1 + R_2}\right) V_1$

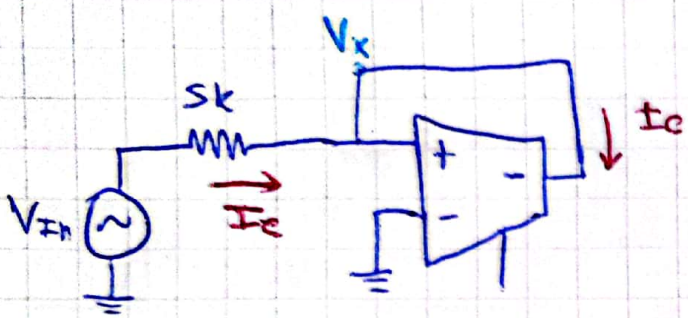
$I_e = \frac{V_1}{R_1} - V_1\left(\frac{g_m R_1 R_2 + R_2}{R_1^2 + R_1 R_2}\right)$

$= V_1\left(\frac{1}{R_1} - \frac{g_m R_1 R_2 + R_2}{R_1^2 + R_1 R_2}\right) = \frac{R_1^2 + R_1 R_2 - g_m R_1^2 R_2 - R_1 R_2}{R_1^2 + R_1^2 R_2} V_1$

$I_e = \frac{R_1 - g_m R_1 R_2 V_1}{R_1^2 + R_1 R_2} = \frac{1 - g_m R_2}{R_1 + R_2} V_1$

$Z_i = \frac{V_1}{I_e} = \boxed{\frac{R_1 + R_2}{1 - g_m R_2}}$

4)



$I_e = V_x \, g_m$

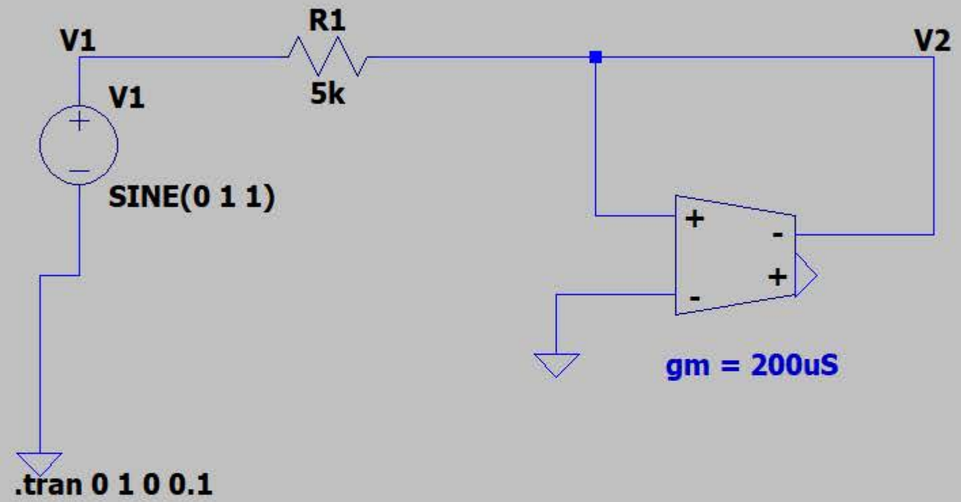
$Z_{in} = \frac{V_x}{I_e} = \frac{1}{g_m}$

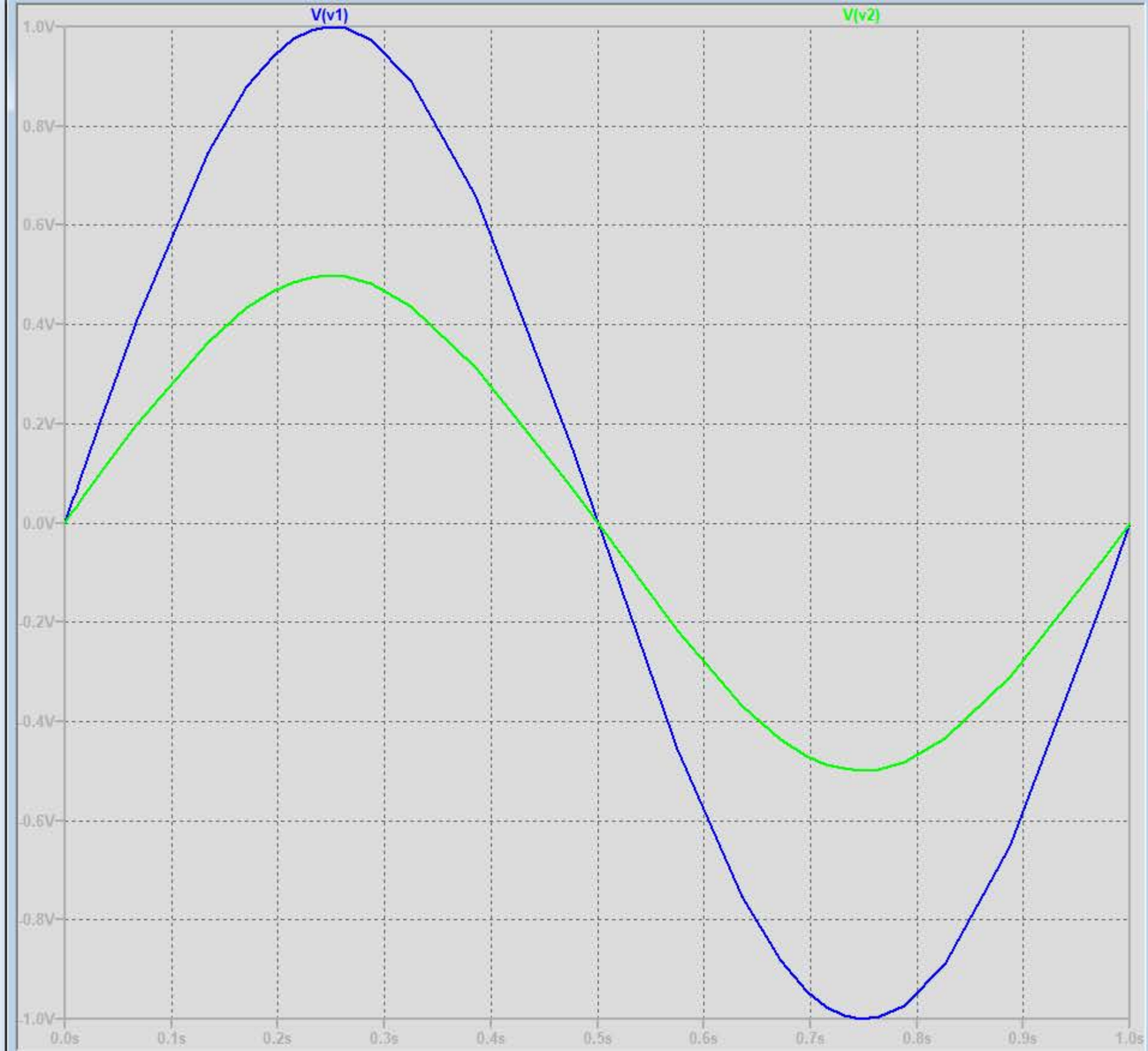
$\frac{1}{g_m} = 5k \rightarrow g_m = 200\,\mu S$

b) $I_{ABC} \cong 15\,\mu A$ (según gráfico)

$V_{in} = I_c \cdot 5k + V_o \cdot \frac{g_m}{g_m} = V_o \, g_m \cdot 5k + V_o \frac{g_m}{g_m} =$

$V_{in} = V_o (1 + 1) \rightarrow \frac{V_o}{V_{in}} = \frac{1}{2}$

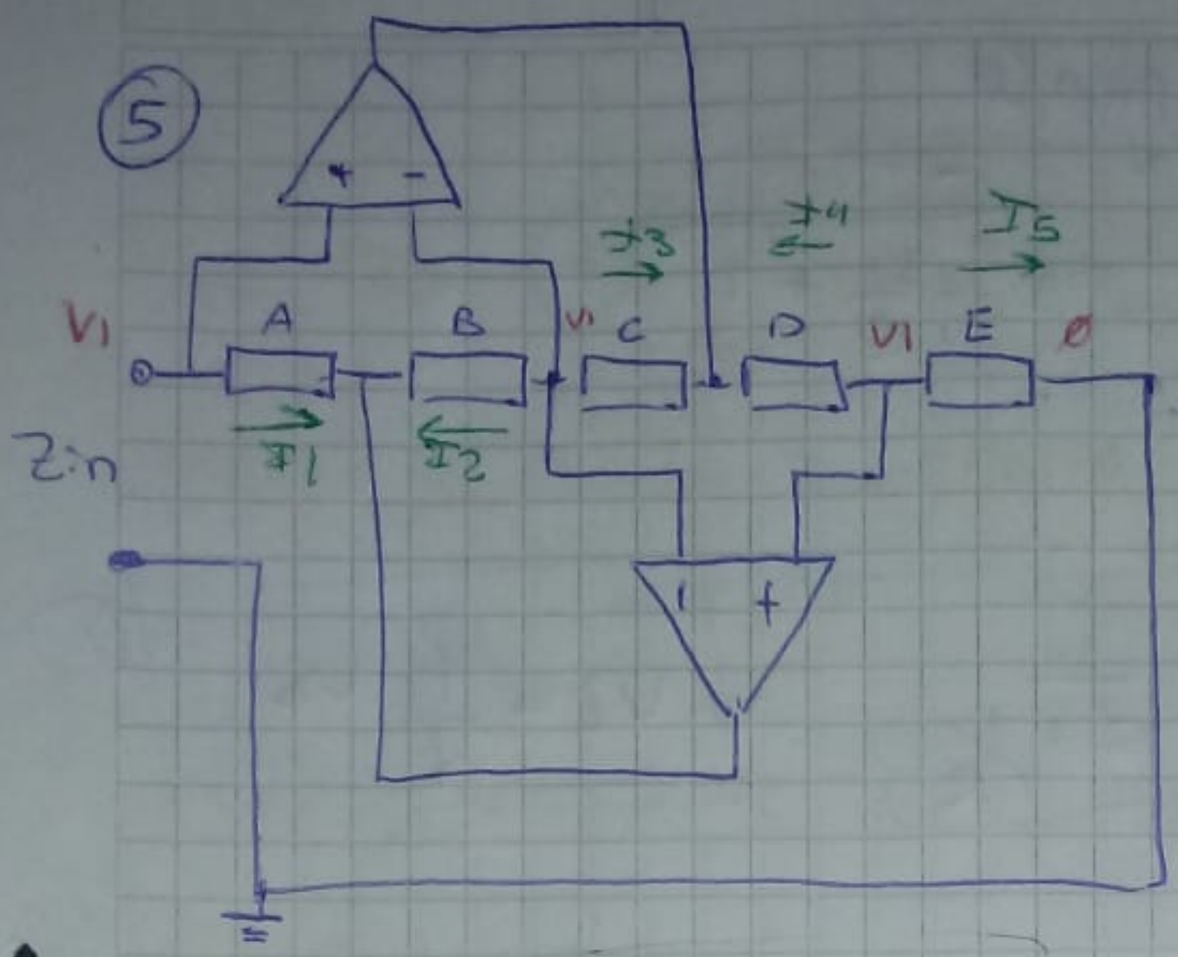

V1
R1
V2
V1
5k
SINE(0 1 1)
+
-
+
-
gm = 200uS
.tran 0 1 0 0.1


V(v1)
V(v2)
1.0V
0.8V
0.6V
0.4V
0.2V
0.0V
-0.2V
-0.4V
-0.6V
-0.8V
-1.0V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s

HOJA N°

FECHA

⑤



$$Z_A \cdot I_1 = Z_B \cdot I_2$$

$$I_1 = \frac{Z_B}{Z_A} \cdot I_2$$

$$I_2 = -I_3$$

$$I_1 = -\frac{Z_B}{Z_A} \cdot I_3$$

$$Z_5 I_3 = Z_D \cdot I_4$$

$$I_3 = \frac{Z_D}{Z_C} \cdot I_4$$

$$I_4 = -I_5 \rightarrow \boxed{I_1 = \frac{Z_B \cdot Z_D}{Z_A \cdot Z_C}} \rightarrow I_3 = \frac{V}{Z_5}$$

$$Z_1 = \frac{-Z_B}{Z_A} \cdot \frac{Z_D}{Z_C} I_4 = \frac{Z_B Z_D}{Z_A Z_C} I_5 = I$$

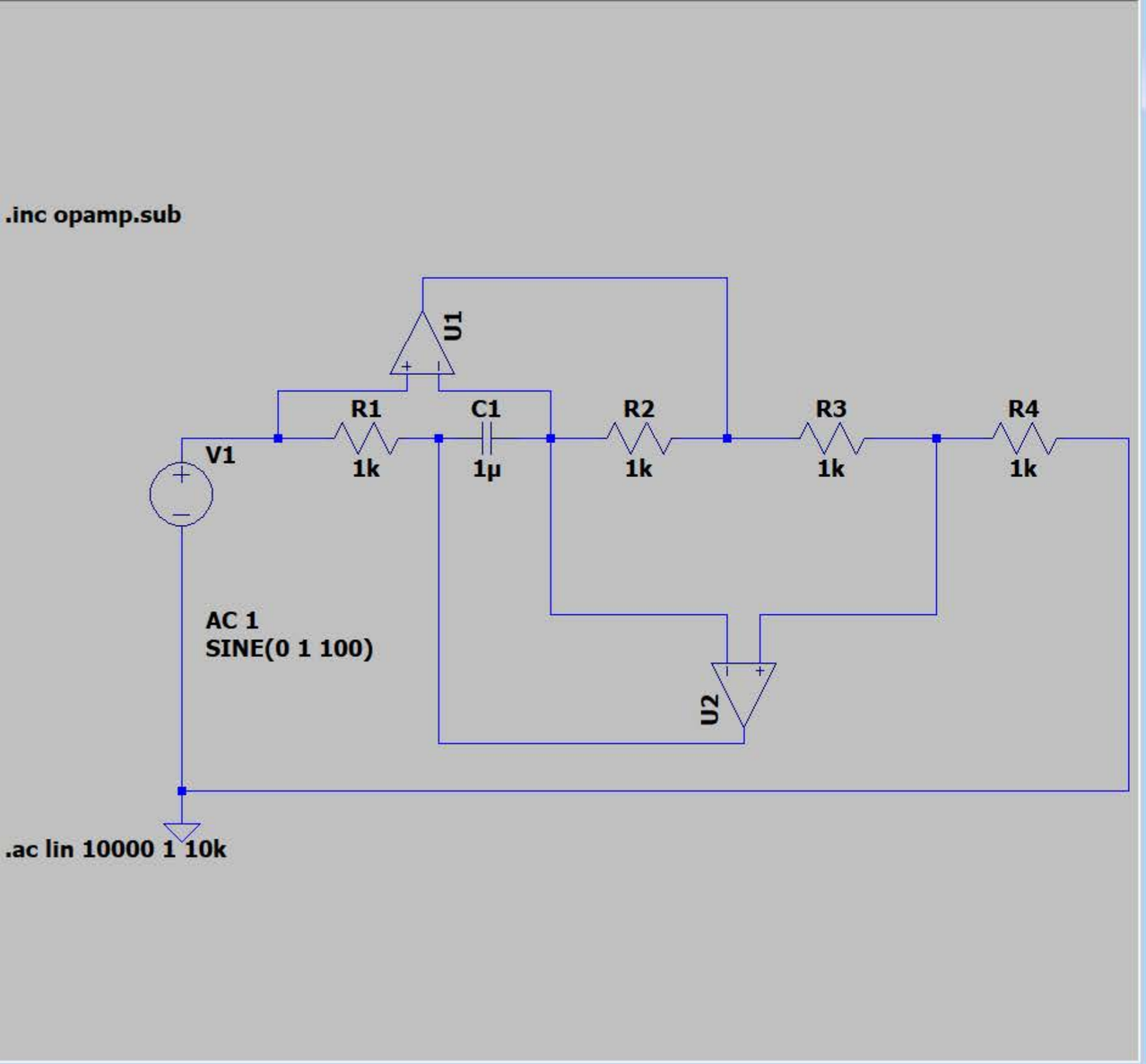
$$V \frac{Z_B Z_D}{Z_A Z_C Z_E} = I \rightarrow \boxed{Z_t = \frac{Z_A \cdot Z_C Z_E}{Z_B \cdot Z_D}}$$

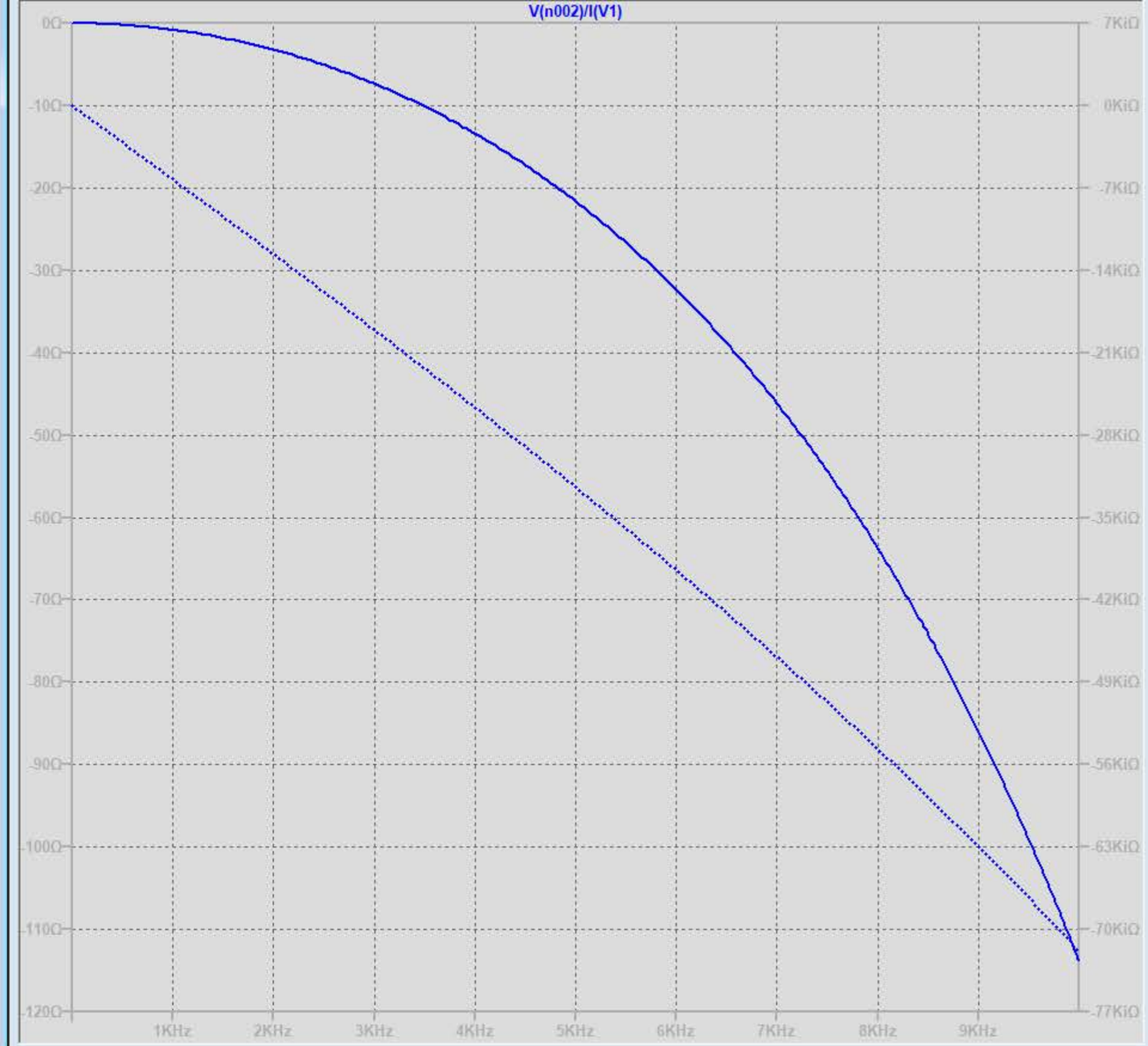
en ② $\rightarrow Z_t = \dfrac{R_1 R_2 R_4}{\frac{1}{\$C} R_3} \rightarrow \boxed{Z_t = \dfrac{\$C R_1 R_2 R_4}{R_3}}$ "Inductor"

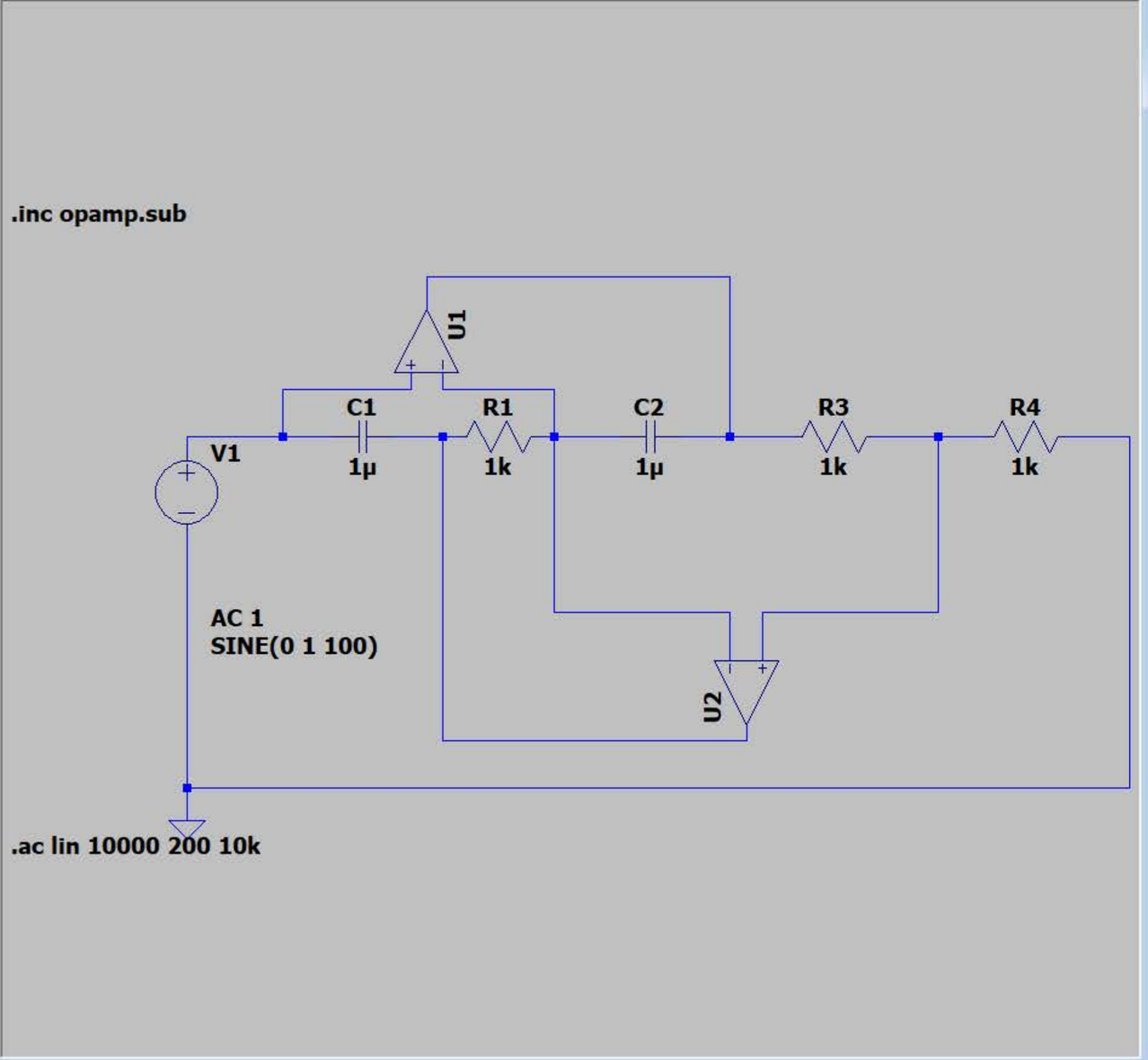
en ⑥ $\rightarrow Z_t = \dfrac{\frac{1}{\$C_1} \cdot \frac{1}{\$C_2} R_4}{R_1 R_3} \rightarrow$ [redacted] $= \boxed{\dfrac{R_4}{R_1 R_3 \$^2 C_1 C_2} = Z_t}$

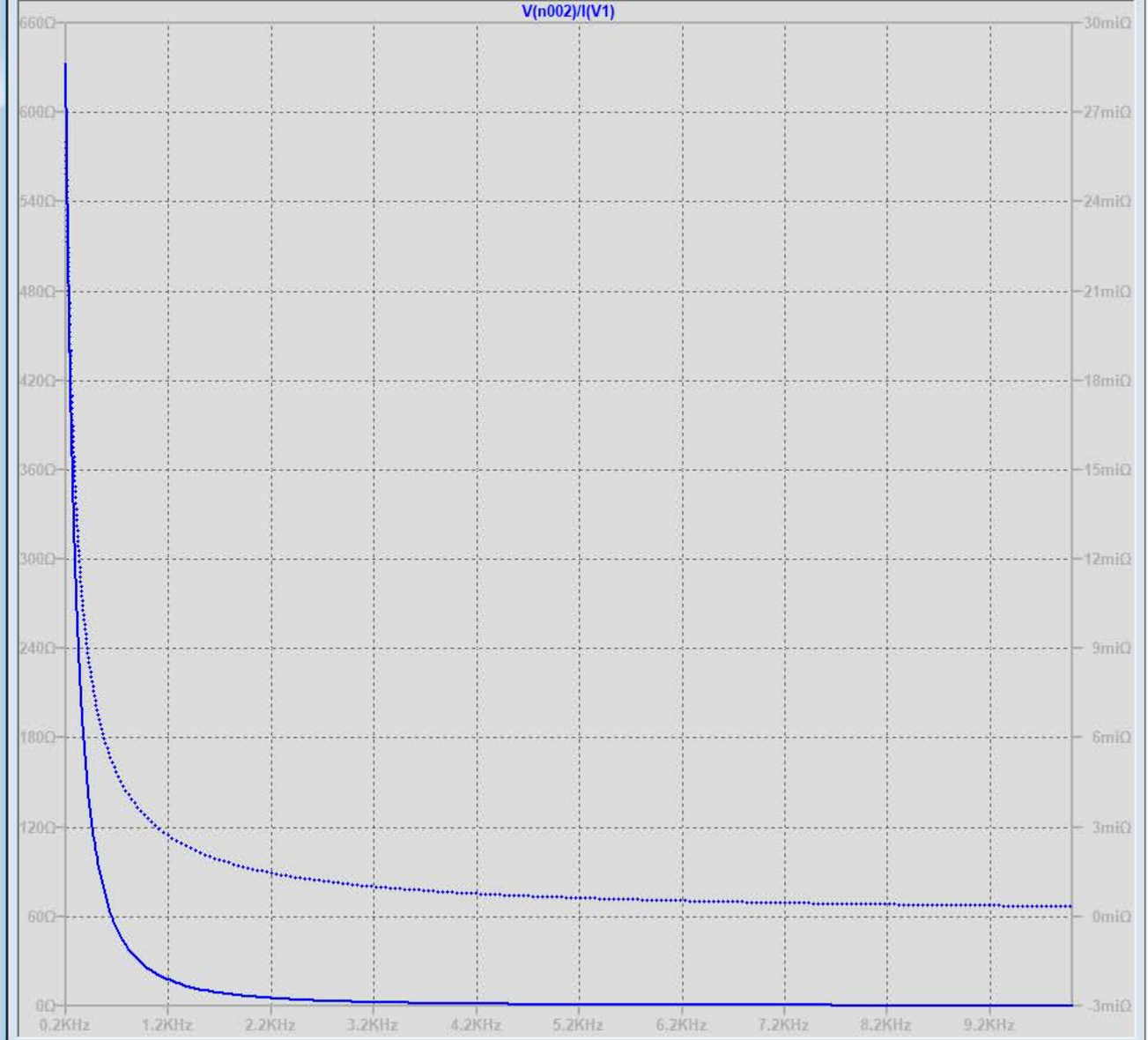
⑥

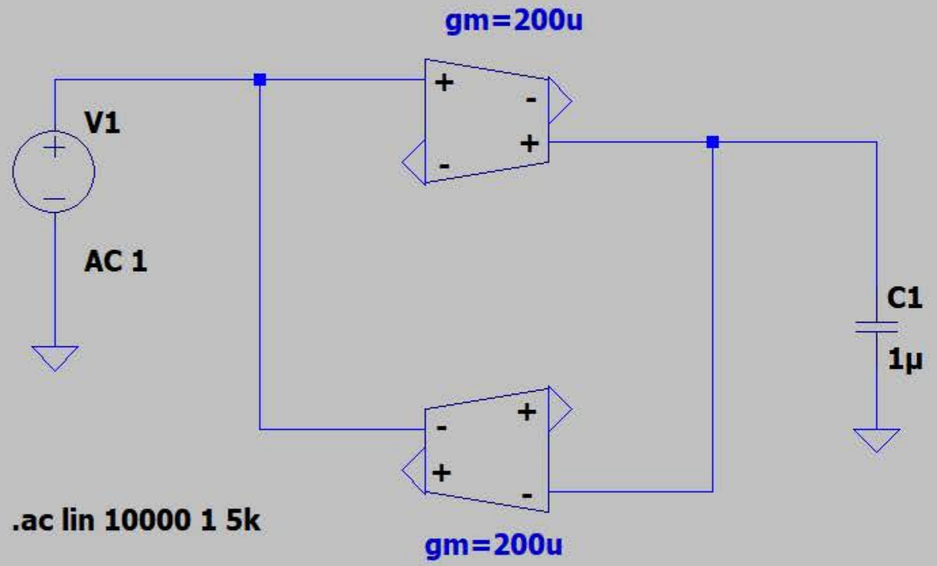
NOTA

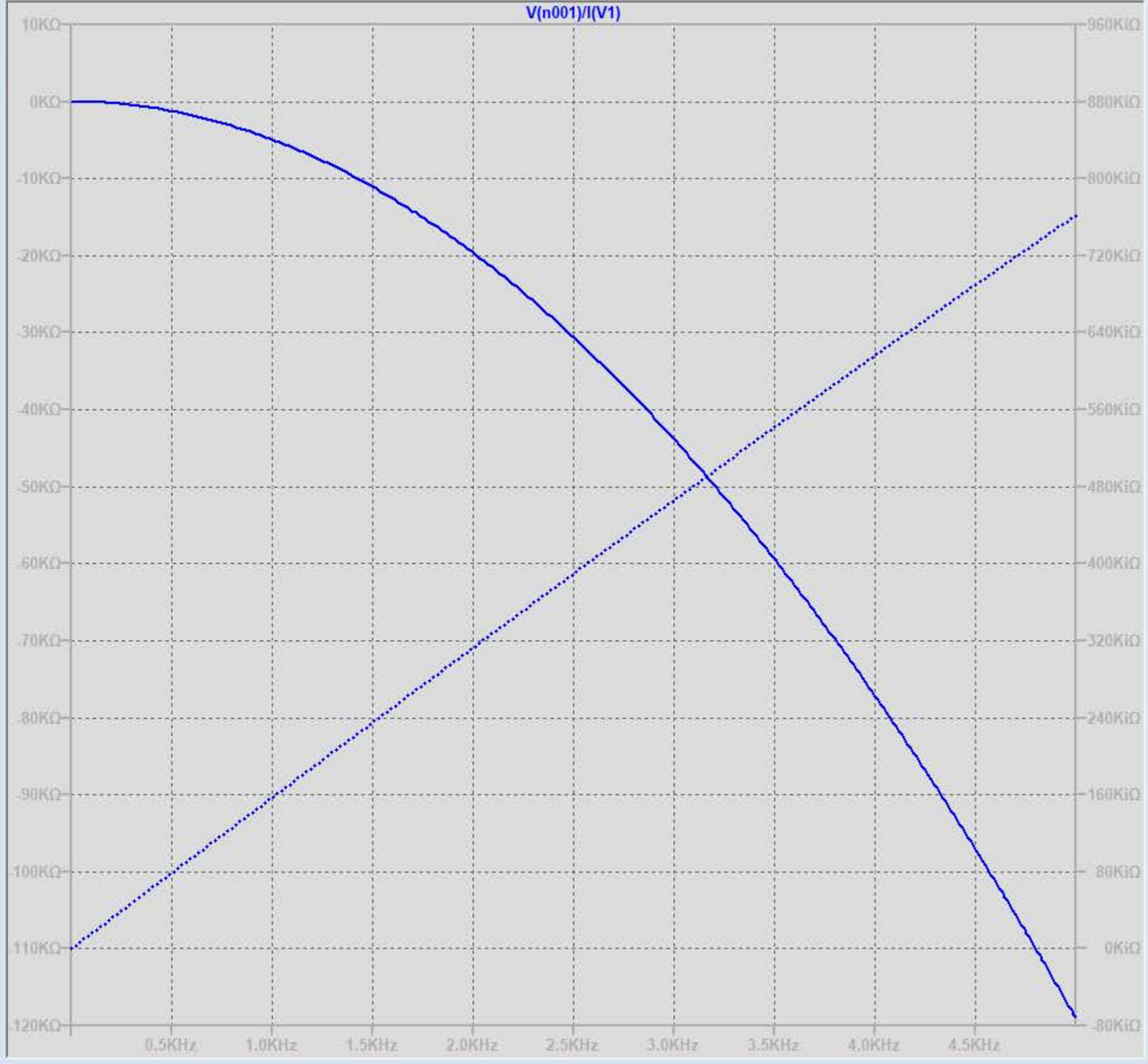

.inc opamp.sub
U1
R1
1k
C1
1µ
R2
1k
R3
1k
R4
1k
V1
AC 1
SINE(0 1 100)
U2
.ac lin 10000 1 10k


V(n002)/I(V1)
0Ω
-10Ω
-20Ω
-30Ω
-40Ω
-50Ω
-60Ω
-70Ω
-80Ω
-90Ω
-100Ω
-110Ω
-120Ω
7KiΩ
0KiΩ
-7KiΩ
-14KiΩ
-21KiΩ
-28KiΩ
-35KiΩ
-42KiΩ
-49KiΩ
-56KiΩ
-63KiΩ
-70KiΩ
-77KiΩ
1KHz
2KHz
3KHz
4KHz
5KHz
6KHz
7KHz
8KHz
9KHz

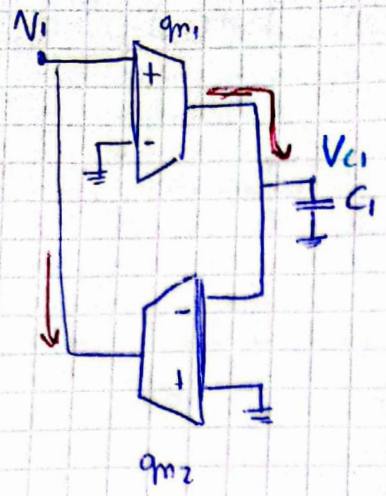

.inc opamp.sub
U1
C1
1µ
R1
1k
C2
1µ
R3
1k
R4
1k
V1
AC 1
SINE(0 1 100)
U2
.ac lin 10000 200 10k


V(n002)/I(V1)
660Ω
600Ω
540Ω
480Ω
420Ω
360Ω
300Ω
240Ω
180Ω
120Ω
60Ω
0Ω
30miΩ
27miΩ
24miΩ
21miΩ
18miΩ
15miΩ
12miΩ
9miΩ
6miΩ
3miΩ
0miΩ
-3miΩ
0.2KHz
1.2KHz
2.2KHz
3.2KHz
4.2KHz
5.2KHz
6.2KHz
7.2KHz
8.2KHz
9.2KHz


gm=200u
V1
AC 1
C1
1µ
.ac lin 10000 1 5k
gm=200u


V(n001)/I(V1)
10KΩ
0KΩ
-10KΩ
-20KΩ
-30KΩ
-40KΩ
-50KΩ
-60KΩ
-70KΩ
-80KΩ
-90KΩ
-100KΩ
-110KΩ
-120KΩ
960KΩ
880KΩ
800KΩ
720KΩ
640KΩ
560KΩ
480KΩ
400KΩ
320KΩ
240KΩ
160KΩ
80KΩ
0KΩ
-80KΩ
0.5KHz
1.0KHz
1.5KHz
2.0KHz
2.5KHz
3.0KHz
3.5KHz
4.0KHz
4.5KHz

5 b)



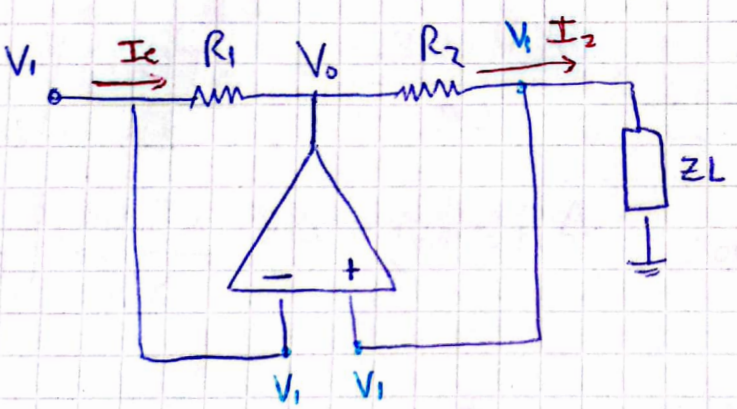
$$\frac{V_1}{I_e} = Z_i \rightarrow I_e = I_2 = g_{m2} \cdot V_{C1}$$

$$V_{C1} = \frac{I_{C1}}{\not{s}C} = \frac{I_1}{\not{s}C} = \frac{V_1 \cdot g_{m1}}{\not{s}C}$$

$$I_e = \frac{g_{m2} \cdot g_{m1} V_1}{\not{s}C_1}$$

$$\boxed{Z_{in} = \frac{\not{s}C_1}{g_{m1} g_{m2}}}$$

6)



$$I_e = \frac{V_1 - V_0}{R_1}$$

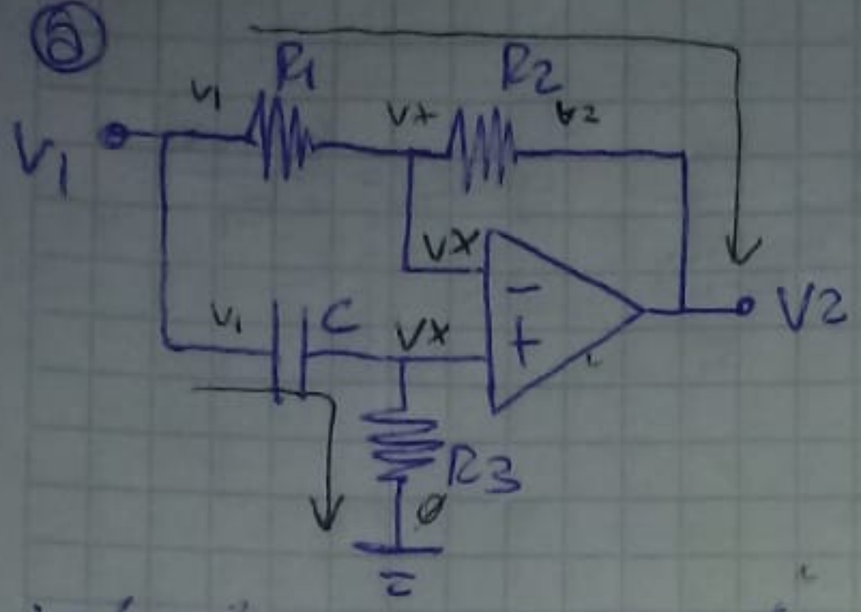
$$\frac{V_0 - V_1}{R_2} = \frac{V_1}{Z_L}$$

$$V_0 = V_1 \left(1 + \frac{R_2}{Z_L}\right)$$

$$I_e = \frac{V_1}{R_1} - V_1 \left(\frac{Z_L + R_2}{Z_L R_1}\right) = V_1 \left[\frac{1}{R_1} - \frac{Z_L + R_2}{R_1 Z_L}\right] = V_1 \left[\frac{Z_L - Z_L - R_2}{R_1 Z_L}\right]$$

$$\frac{I_e}{V_1} = \frac{-R_2}{R_1 Z_L} \rightarrow \boxed{Z_{in} = -\frac{R_1 Z_L}{R_2}}$$

⑦
⑥



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

$$V_X = \frac{V_1 \cdot R_3}{R_3 + \frac{1}{\$C}}$$

$$V_X = \frac{V_1 R_3 \$C}{\$C R_3 + 1}$$

$$\frac{V_X}{R_1} - \frac{V_1 R_3 \$C}{R_1} = \frac{V_1 R_3 \$C}{R_2} - \frac{V_2}{R_2} \rightarrow V_1\left(\frac{1}{R_1} - \frac{R_3 \$C}{R_1} - \frac{R_3 \$C}{R_2}\right) = \frac{-V_2}{R_2}$$

$$V_1\left(\frac{-R_2 + R_2 R_3 \$C + R_3 R_2 \$C}{R_1 R_2}\right) = V_2 \rightarrow V_1\left(\frac{-R_2^2 + R_2^2 R_3 \$C + R_3 R_2 R_1 \$C}{R_1 R_2}\right) = V_2$$

$$\frac{V_2}{V_1} = T(\$) = \frac{\$(R_3 R_2^2 C + R_3 R_2 R_1 C) - R_2^2}{R_1 R_2}$$

$$\frac{V_1}{R_1} - \frac{V_1 R_3 \$C}{R_1(\$CR_3+1)} = \frac{V_1 R_3 \$C}{R_2(\$CR_3+1)} - \frac{V_2}{R_2}$$

$$V_1\left(\frac{-R_2}{R_1} + \frac{R_3 \$C R_2}{R_1(\$CR_3+1)} + \frac{R_3 \$C R_2}{R_2(\$CR_3+1)}\right) = V_2$$

$$\frac{V_2}{V_1} = \frac{-R_2^2(\$CR_3+1) + R_3 \$C R_2^2 + R_3 \$C R_2 R_1}{R_1 R_2(\$CR_3+1)} = T(\$)$$

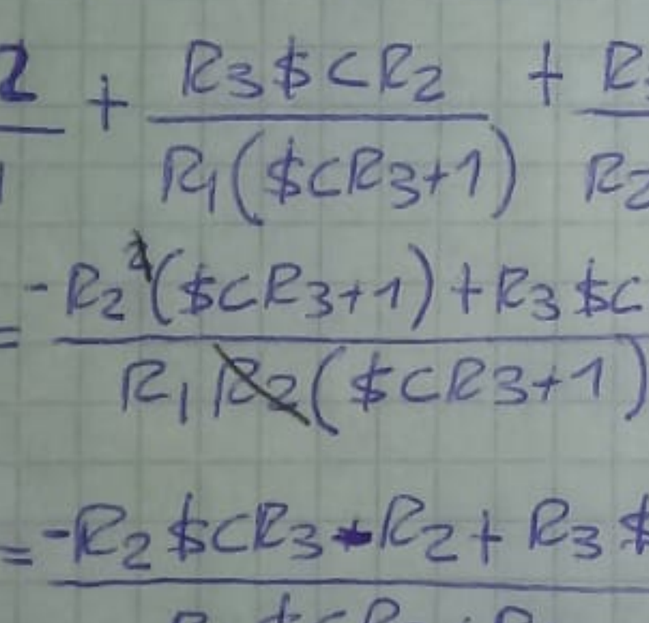
$$T(\$) = \frac{-R_2 \$CR_3 + R_2 + R_3 \$CR_2 + R_3 \$CR_1}{R_1 \$CR_3 + R_1} = \frac{\$(R_2 CR_3 + R_3 CR_2 + R_3 CR_1) + R_2}{\$(CR_3 R_1) + R_1}$$

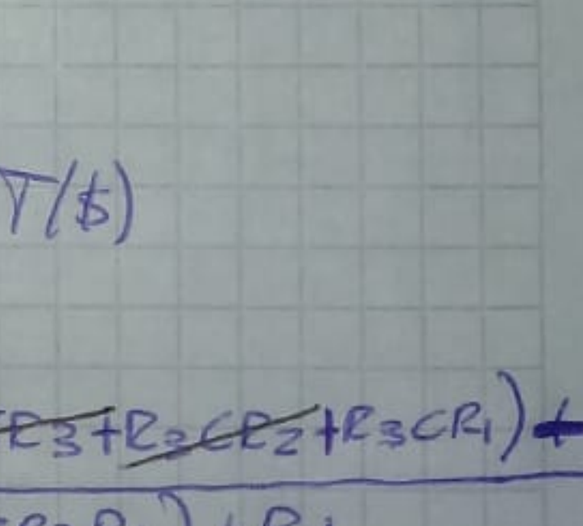
$$T(\$) = \frac{\$(\quad) + \frac{R_2}{CR_3 R_1}}{\$ + \frac{1}{CR_3}} = \boxed{\frac{\$ + \frac{R_2}{CR_3 R_1}}{\$ + \frac{1}{CR_3}}}$$

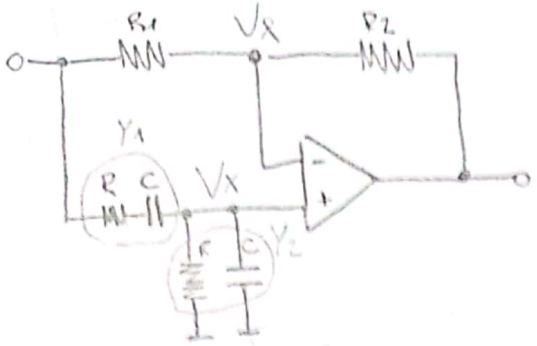
Asumiendo $R_2 = R_1$

$$\text{zero} = \omega_0^2 = \frac{1}{CR_2}$$

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







$$Z_1 = R + \frac{1}{SC} = \frac{SCR+1}{SC} = \frac{SC+G}{SCG}$$

$$Y_1 = \frac{SC}{SCR+1} = \boxed{\frac{SCG}{SC+G}}$$

$$\frac{1}{Z_2} = Y_2 = \frac{1}{R} + SC = \frac{SCR+1}{R} = \boxed{SC+G}$$

$$V_x(G_1+G_2) - V_1G_1 - V_2G_2 = 0 \quad (1) \qquad V_x = V_1 \cdot \frac{y_1}{y_1+y_2} \quad (2)$$

$$\frac{V_2}{V_1} = \frac{Y_1.(G_1+G_2) - G_1.(Y_1+Y_2)}{(Y_1+Y_2)G_2} = \frac{\frac{SCG}{SC+G}(G_1+G_2) - G_1\left(\frac{SCG}{SC+G}+(SC+G)\right)}{\left[\frac{SCG}{SC+G}+(SC+G)\right]G_2}$$

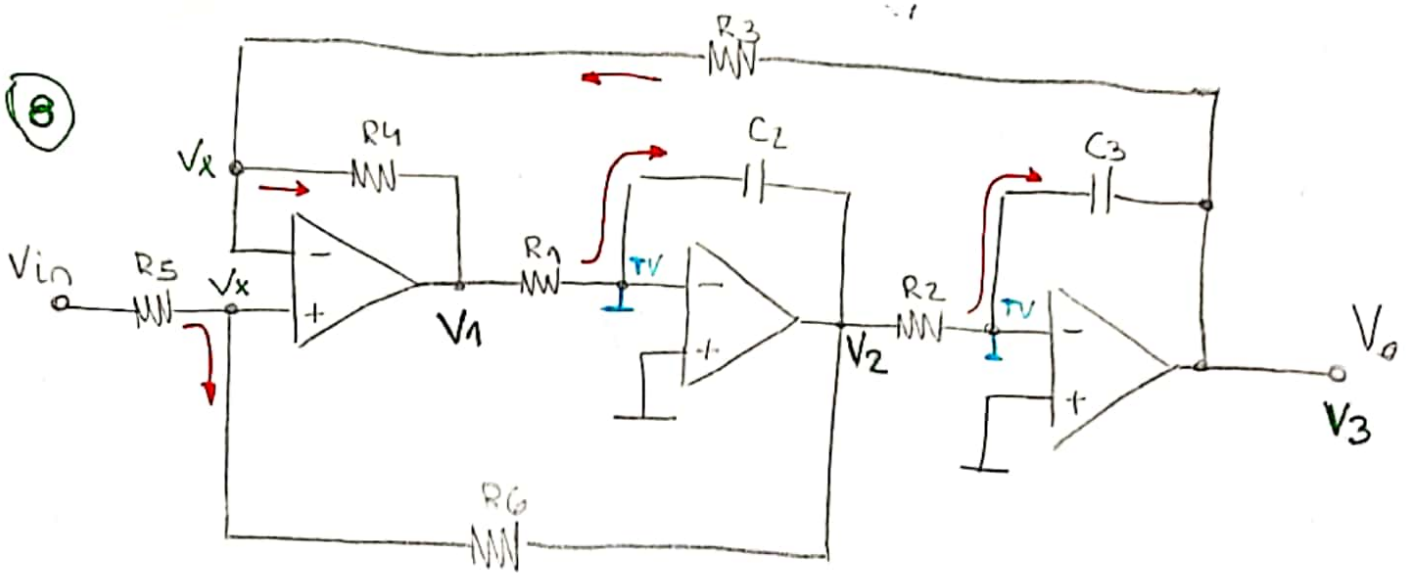
$$\frac{V_2}{V_1} = \frac{\frac{SCGG_1+SCGG_2}{SC+G} - \left(\frac{SCGG_1+S^2C^2G_1+SCGG_1+SCGG_1+G^2G_1}{SC+G}\right)}{\left(\frac{SCG+S^2C^2+SCG+SCG+G^2}{SC+G}\right)G_2}$$

$$\frac{V_2}{V_1} = \frac{-S^2C^2G_1 + S.CG.(G_2-2G_1) - G^2G_1}{(S^2C^2+S.3CG+G^2)G_2}$$

$$\frac{V_2}{V_1} = \frac{-S^2.G_1 + S\frac{G}{C}.(G_2-2G_1) - \frac{G^2G_1}{C^2}}{\left[S^2 + \frac{3G}{C}.S + \left(\frac{G}{C}\right)^2\right]G_2}$$

$$\boxed{\frac{V_2}{V_1} = -\frac{G_1}{G_2} \cdot \frac{S^2 + \frac{G}{CG_1}.(2G_1-G_2).S + \left(\frac{G}{C}\right)^2}{S^2 + \frac{3G}{C}.S + \left(\frac{G}{C}\right)^2}}$$

(8)



a) $(V_i - V_x)G_5 = (V_x - V_2)G_6$ ① $V_1 \cdot G_1 = -V_2 \cdot SC_2$ ② $V_2 G_2 = -V_3 \cdot SC_3$ ③

$(V_3 - V_x)G_3 = (V_x - V_1)G_4$ ④

$V_2 = -V_1 \cdot \frac{G_1}{SC_2}$ $V_3 = -V_2 \cdot \frac{G_2}{SC_3}$

$V_3 \cdot G_3 + V_1 G_4 = V_x \cdot (G_3 + G_4) \longrightarrow -V_2 \cdot \frac{G_2 G_3}{SC_3} + V_1 \cdot G_4 = V_x \cdot (G_3 + G_4)$

$\longrightarrow V_1 \left(\frac{G_1 G_2 G_3}{S^2 C_2 C_3} + G_4\right) = V_x \cdot (G_3 + G_4)$ Ⓐ

b) $-V_x(G_5 + G_6) = -V_i G_5 - V_2 \cdot G_6 \longrightarrow V_x \cdot (G_5 + G_6) = V_i G_5 - V_1 \frac{G_1 G_6}{SC_2}$

$V_X = V_i \frac{G_5}{(G_5 + G_6)} - V_1 \frac{G_1 G_6}{SC_2 (G_5 + G_6)}$ Ⓑ

③+Ⓐ $V_1 \left(\frac{S^2 C_2 C_3 G_4 + G_1 G_2 G_3}{S^2 C_2 C_3}\right) = V_i \cdot \frac{G_5 (G_3 + G_4)}{(G_5 + G_6)} - V_1 \cdot \frac{G_1 G_6 (G_3 + G_4)}{SC_2 (G_5 + G_6)}$ $\frac{G_6}{G_3}$

$V_1 \left(\frac{S^2 C_2 C_3 G_4 + G_1 G_2 G_3}{S^2 C_2 C_3} + \frac{G_1 G_6 (G_3 + G_4)}{SC_2 (G_5 + G_6)}\right) = V_i \cdot \frac{G_5 (G_3 + G_4)}{(G_5 + G_6)}$

$V_1 \left(\frac{S^3 C_2 C_3 G_4 (G_5 + G_6) + G_1 G_2 G_3 (G_5 + G_6) + S C_3 G_1 G_6 (G_3 + G_4)}{S^2 C_2 C_3 (G_5 + G_6)}\right) = V_i \frac{G_5 (G_3 + G_4)}{(G_5 + G_6)}$

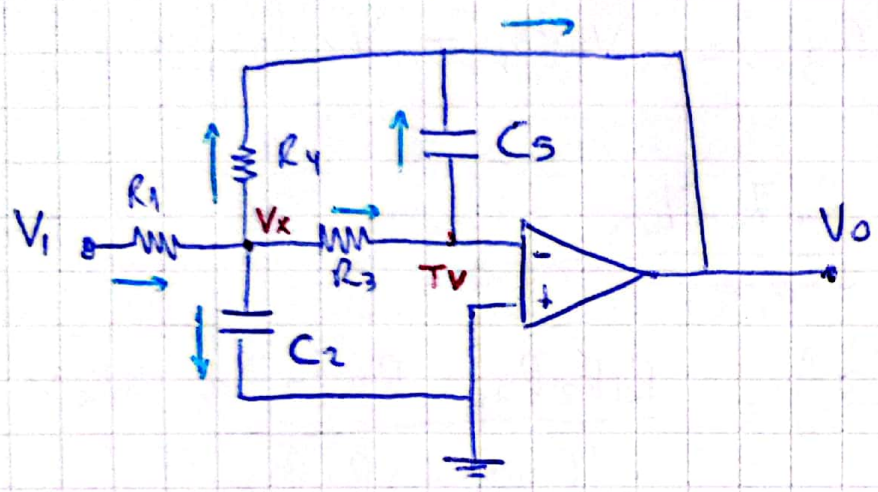
$$\frac{V_1}{V_i} = \frac{S^2 C_2 C_3 G_5 (G_3 + G_4)}{S^2 C_2 C_3 G_4 (G_5 + G_6) + S C_3 G_1 G_6 (G_3 + G_4) + G_1 G_2 G_3 (G_5 + G_6)}$$

a) $\frac{V_1}{V_i} = \frac{G_5 (G_3 + G_4)}{G_4 (G_5 + G_6)} \cdot \frac{S^2}{S^2 + \frac{G_1 G_6 (G_3 + G_4)}{C_2 G_4 (G_5 + G_6)} S + \frac{G_1 G_2 G_3}{C_2 C_3 G_4}} = \frac{R_6}{R_3} \cdot \frac{(R_3 + R_4)}{(R_5 + R_6)} \cdot \frac{S^2}{S^2 + \frac{R_5 (R_3 + R_4)}{R_1 R_3 C_2 (R_5 + R_6)} S + \frac{R_4}{R_1 R_2 R_3 C_2 C_3}}$

b) $\frac{V_2}{V_i} = -\frac{G_1 G_5 (G_3 + G_4)}{C_2 G_4 (G_5 + G_6)} \cdot \frac{S}{S^2 + \frac{G_1 G_6 (G_3 + G_4)}{C_2 G_4 (G_5 + G_6)} S + \frac{G_1 G_2 G_3}{C_2 C_3 G_4}} = \frac{-R_6 (R_3 + R_4)}{R_1 R_3 C_2 (R_5 + R_6)} \cdot \frac{S}{S^2 + \frac{R_5 (R_3 + R_4)}{R_1 R_3 C_2 (R_5 + R_6)} S + \frac{R_4}{R_1 R_2 R_3 C_2 C_3}}$

c) $\frac{V_3}{V_i} = \frac{G_1 G_2 G_5 (G_3 + G_4)}{C_2 C_3 G_4 (G_5 + G_6)} \cdot \frac{1}{S^2 + \frac{G_1 G_6 (G_3 + G_4)}{C_2 G_4 (G_5 + G_6)} \cdot S + \frac{G_1 G_2 G_3}{C_2 C_3 G_4}} = \frac{R_6 (R_3 + R_4)}{R_1 R_2 R_3 C_2 C_3 (R_5 + R_6)} \cdot \frac{1}{S^2 + \frac{R_5 (R_3 + R_4)}{R_1 R_3 C_2 (R_5 + R_6)} \cdot S + \frac{R_4}{R_1 R_2 R_3 C_2 C_3}}$

9)



$$\frac{V_1 - V_x}{R_1} = \frac{V_x - V_o}{R_4} + \frac{V_x}{R_3} + \frac{V_x}{Z_2}$$

$$① \quad \frac{V_1 - V_x}{R_1} = -\frac{V_o}{R_4} + V_x\left(\frac{1}{R_4} + \frac{1}{R_3} + \frac{1}{Z_2}\right)$$

$$\frac{V_x}{R_3} = \frac{-V_o}{Z_5} \rightarrow V_x = -V_o \frac{R_3}{Z_5} \quad ②$$

$$\frac{V_o}{V_1} = -\frac{1}{C_2 C_5 R_1 R_3 \$^2 + \$(R_1 R_3 + R_1 R_4)}$$

$$\frac{V_o}{V_1} = -\frac{1}{C_2 C_5 R_1 R_3} \; \frac{1}{\$^2 + \$\dfrac{(R_1 R_3 + R_1 R_4 + R_3 R_4)}{C_2 R_1 R_3 R_4} + \dfrac{1}{C_2 C_5 R_3 R_4}}$$

NOTA

Para $R_1 = R_3 = R_4 = 1\Omega$ y $C_2 = 1F$ y $C_5 = 0{,}01F$.

$$H(s) = \frac{-100}{s^2 + 3s + 100} \qquad W_0 = 10 \rightarrow Q = \frac{10}{3} = 3{,}3\hat{3}$$

b) Para que $W_0 = 1000 r/s \rightarrow W_0^2 = 10^6 = \frac{1}{C_2 C_5 R_3 R_4}$ ①

$C_2 = 4700pF$ y $C_5 = 47pF$

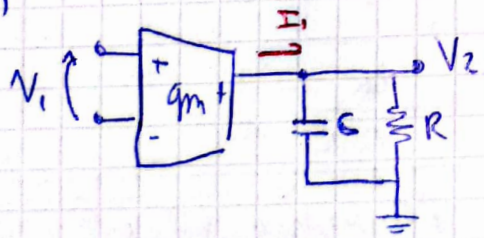
Si queremos mantener Q

$$\frac{W_0}{Q} = 300 = \frac{(R_1 R_3 + R_1 R_4 + R_3 R_4)}{C_2 R_1 R_3 R_4}$$ ②

de ① $\rightarrow$ $2{,}209 \cdot 10^{-3} = \frac{1}{R_3 R_4} \rightarrow R_3 R_4 = 4{,}526 \cdot 10^{12}$

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

10)



$$\frac{V_2}{V_1} = Rg_m \frac{s + \frac{1}{CR}}{s}$$

$I_1 = V_1 \cdot g_m$

$$V_2 = V_1 \left(\frac{1}{sC} + R\right) g_m = V_1 \left(\frac{sCR + 1}{sC}\right) g_m$$

$$\frac{V_2}{V_1} = \left(\frac{sCR + 1}{sC}\right) g_m$$