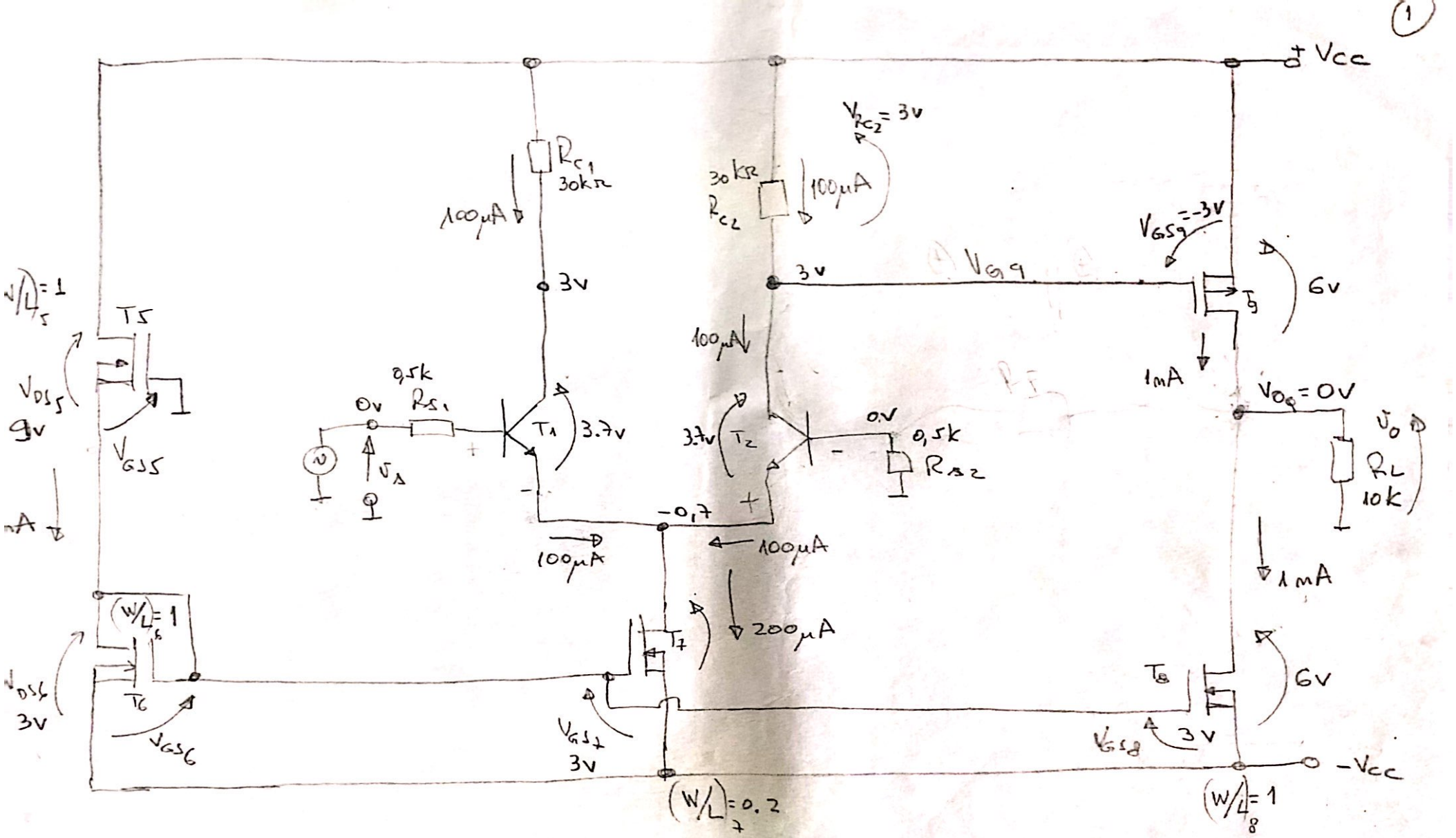


$\beta = 400$ $r_x \simeq 0$ $V_A = 100V$ $f_T = 300\,MHz$
$C_\mu = 2pf$

$C_{gs_1} = 5pf$ $C_{gd} = 2pf$ $V_{CC} = 6V$

N/T

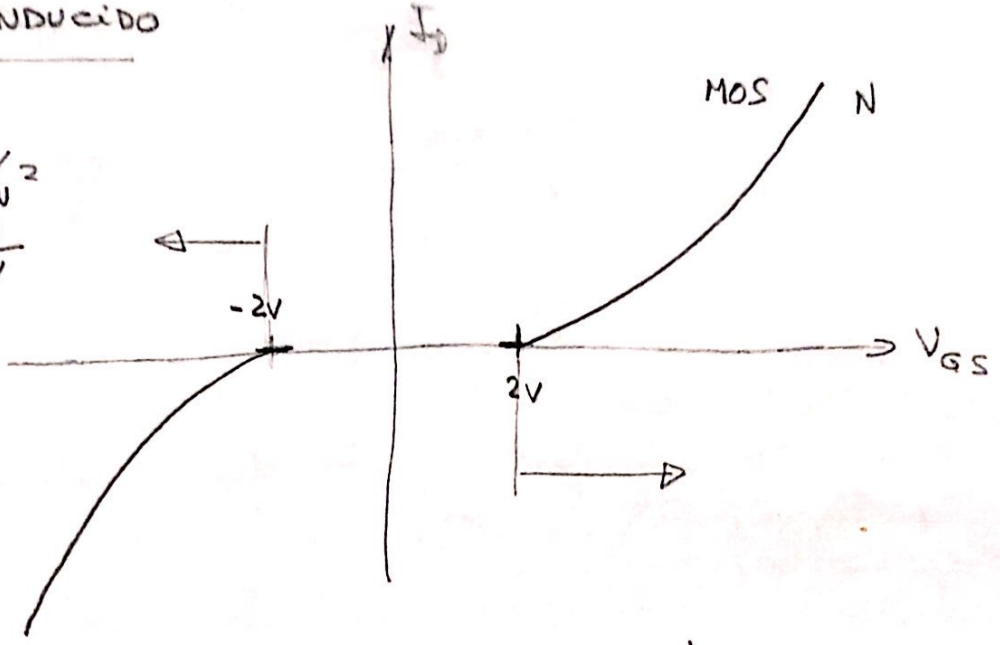
MOSFET INDUCIDO

$V_T = \pm 2V$

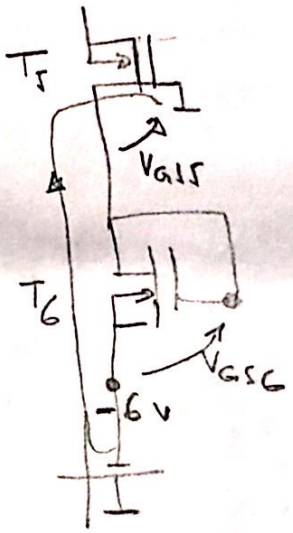
$k' = 1 mA/V^2$

$\lambda = 0{,}01 \frac{1}{V}$

$\frac{1}{\lambda} = 100 V$



a) $\left(W/L\right)_g$? para $V_{op} = 0V$



$I_{DS} = I_{DG}$

$k_5 = k_6$.

$V_{T5} = V_{T6}$

$V_{GS5} = V_{GS6} = 3V$

$V_{GS5} = V_{GS6} = 3V$

$$I_{D6,7} = k' \cdot \frac{W}{L} \left(V_{GS} - V_T\right)^2$$

$$I_{D6,7} = \frac{1 mA}{V^2} \cdot 1 \left(\underbrace{3V - 2V}_{1}\right)^2$$

$$= \frac{1 mA}{V^2} \cdot 1 \cdot 1V^2 = 1 mA.$$

$V_{GS5} = V_{GS6} = V_{GS7} = V_{GS8}$

$\left(W/L\right)_8 = 1 \Rightarrow \boxed{I_{D8} = I_{6,7} = 1mA.}$

$$I_{Dq}\Big|_{V_{op}=0V} = 1mA = k' \cdot \left(\frac{W}{L}\right)_q \left(V_{GS} - V_T\right)^2 \Rightarrow \boxed{\frac{1mA}{k'\left(V_{GS} - V_T\right)^2} = \left(\frac{W}{L}\right)_q} \quad (1)$$

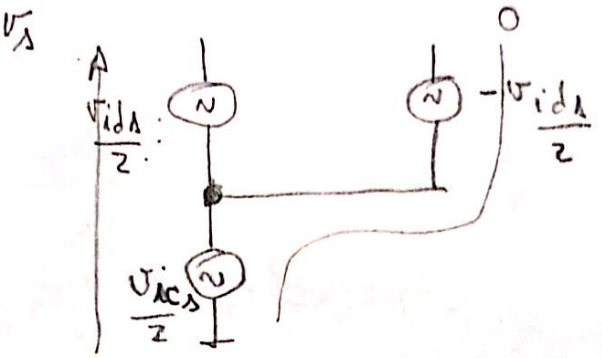
$$\boxed{I_{D7}} = k' \cdot \left(\frac{W}{L}\right)_7 \left(V_{GS7} - V_T\right)^2 = \frac{1mA}{V^2} \cdot 0{,}2 \cdot (1V)^2 = 0{,}2mA = \boxed{200\mu A}$$

$\boxed{I_{Dq} = 1mA \quad V_{GSq} = -3V} \Rightarrow$ De (1) $\frac{1mA}{\frac{1mA}{V^2}(-1V)^2} = \boxed{\left(\frac{W}{L}\right)_q = 1}$ PARA $V_{op} = 0V$

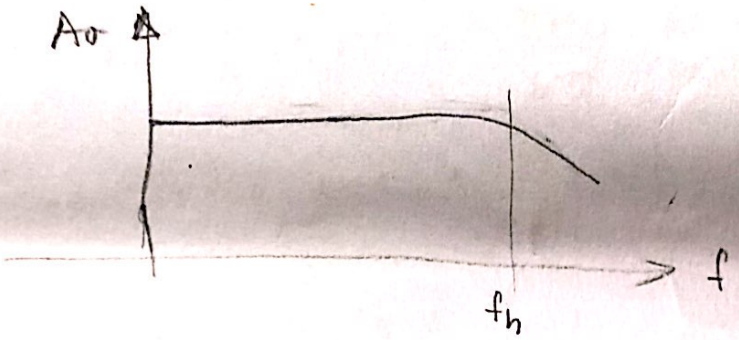
b)

$v_{id1} = v_s$

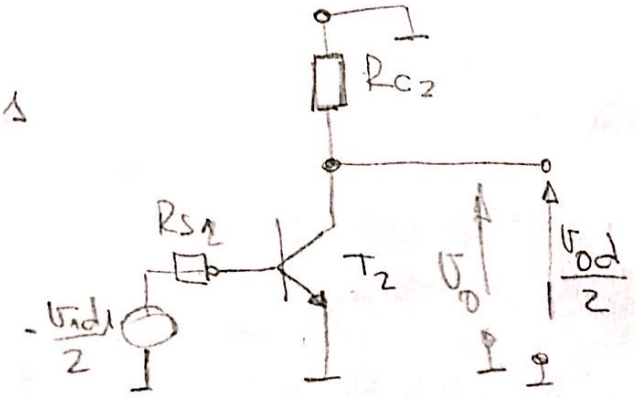
$v_{ic1} = \frac{v_s}{2}$



Amplificador desde c.c. No existen elementos reactivos externos a los transistores que actúen en bajas frecuencias, solo hay f_h



A_{vd1}



$\Rightarrow$ En nuestro caso es single ended.

$A_{vd} = \frac{v_o}{v_{id}} = \frac{120}{2} = 60$

$R_{ib2} >> R_{s1}$

$g_{m2} = \frac{I_{cq2}}{V_T} = 0{,}1\,mA \cdot 40\,\frac{1}{V} = 4\,\frac{mA}{V}$

$R_{ig} \to \infty$

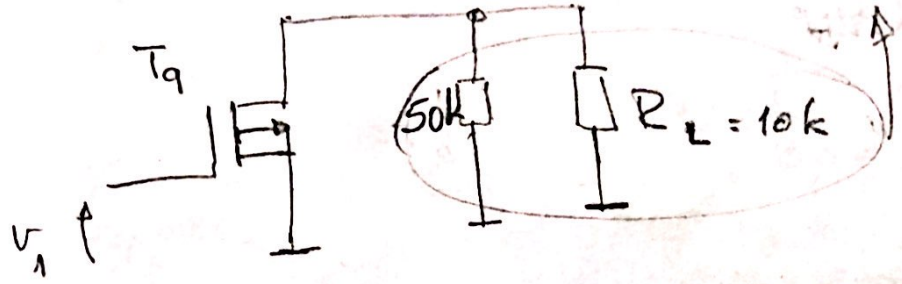
$R_{oc2} = \frac{V_A}{I_{cq2}} >> 30k$

$\frac{\frac{v_{od}}{2}}{-\frac{v_{id}}{2}} = A_{vdd} = -g_m R_{c2} = -4\,\frac{mA}{V} \cdot 30k = -120$

$A_{vdd} = \frac{v_{od}}{v_{id}} = +120$

$A_{vd} = \frac{v_o}{v_{id}} = 60$

T_9 **SC** (−)



$R_{od8} = \frac{1}{\lambda I_{DQ}} = r_{ds\,8} = \frac{100V}{1mA} = 100k. = R_{od9}$ $\quad R_{od8} \| R_{od9} = 50k = R_{od}$

$R_{od,9} \| R_L = 150k \| 10k = \frac{500}{69} k = 8{,}33k\Omega$

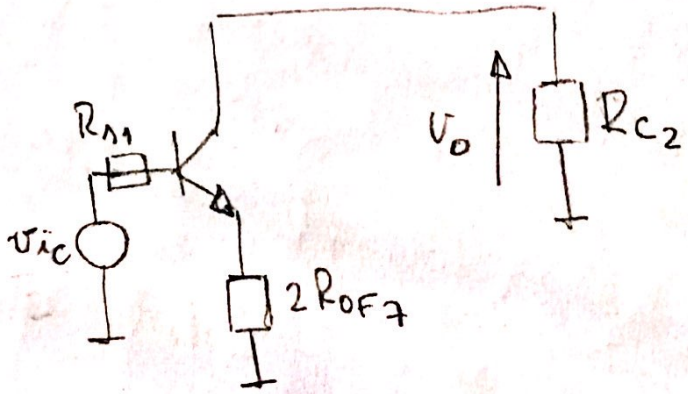
$g_{m9} = 2k(V_{GS} - V_T) = 2 \cdot 1 \cdot 1 = 2 \frac{mA}{V}$

$A_{v9} = -2\frac{mA}{V} \cdot 8{,}33k = -16{,}7.$

$A_{vd\,TOT} = T_i A_{vd} A_{v9} = 60 \cdot (-16{,}7) = -1000.$

$\sim 1 \quad R_i \gg 0{,}5k.$

A_{vcs}



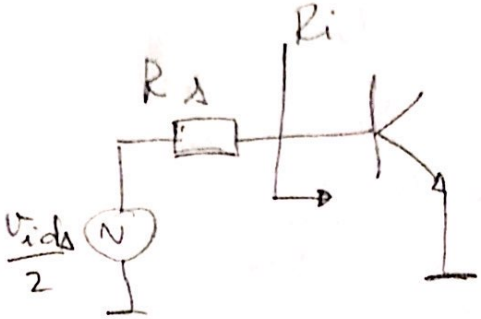
$R_i \gg R_{s1}$

$\frac{v_o}{v_{ic}} = -\frac{R_{c2}}{2R_{OF7}} = -\frac{30k}{2R_{of7}} = -\frac{30k}{2 \cdot 500k} = -\frac{3}{100}$

$= -0{,}03$

$R_{of7} = \frac{1}{\lambda T m_1} = \frac{100V}{200\mu A} = 0{,}5M = 500k$

Rid



$R_i >> R_A$

$$R_i = \frac{v_{id}/2}{i_p} = r_\pi \Rightarrow \frac{400}{\frac{4mA}{V}} = 100k$$

$$R_{id} = 2 \cdot 100k = 200k$$

$$A_{VC_{TOT}} = \underbrace{T_i}_{\sim 1} \cdot A_{VC} \cdot A_{Vg} = -0{,}03 \cdot (-16{,}7) \cong +0{,}5$$

$$=$$

Ro

$$R_o = r_{dA9} \,||\, r_{dA8} = 100k \,||\, 100k = 50k$$

RRMC

$$RRMC = 20 \log \frac{|A_{vd}|}{|A_{vc}|} = 20 \log 2000 =$$

$$= 66\,dB$$

$$A_{VA} = \frac{v_o}{v_A} \cong A_{vdA}$$

$$v_{idA} = v_A$$

$$v_{icA} = \frac{v_A}{2}$$

$$v_o = A_{VdA} \cdot v_{idA} + A_{VCA} \cdot v_{icA}$$

$$v_o = A_{VdA} \cdot v_A + A_{VCA} \frac{v_A}{2}$$

$$A_{VCA} \cdot \frac{v_A}{2} \ll A_{VdA} \cdot v_A$$

$\Rightarrow$

$$w_T \approx \frac{g_m}{C_\pi + C_\mu}$$

$$C_\pi + C_\mu = \frac{g_m}{w_T}$$

$$C_\pi = \frac{g_m}{w_T} - C_\mu.$$

$$C_\pi = \frac{0{,}004\,\frac{A}{V}}{2\pi\ 300\text{Mht}} - 2\text{pf}.$$

$$= \frac{0{,}004}{6{,}28 \cdot 300 \times 10^6} - 2\text{pf}$$

$$= \frac{0{,}004}{1884 \cdot 10^6} - 2\text{pf}$$

$$= \left(2{,}12 \cdot 10^{-6}\ 10^{-6}\right) - 2\text{pf}$$

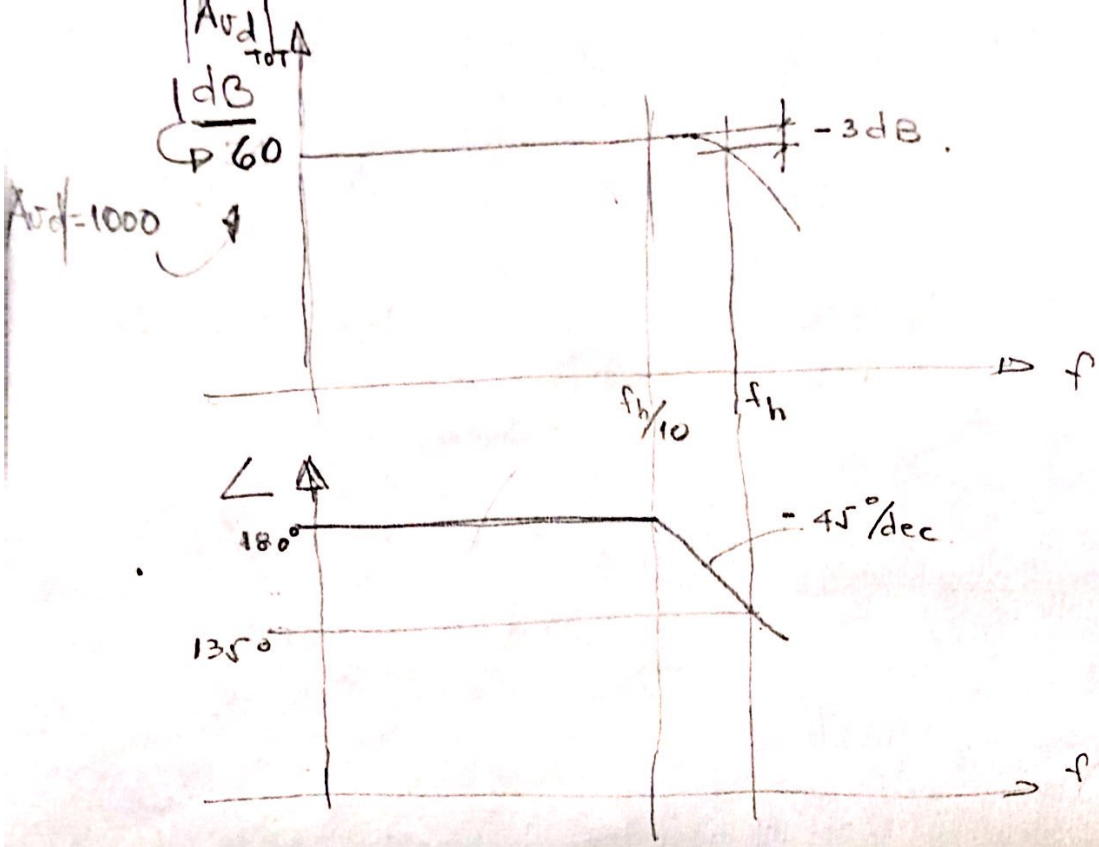
$$2.12\text{ pf} - 2\text{pf} = 0{,}12\text{pf}$$

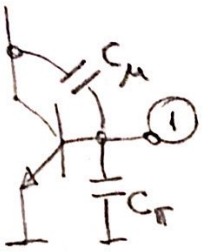
$$v_o = A_{vd_1} \cdot v_{id_1} + A_{vC_1} \cdot v_{ic_1}$$

$$v_o = A_{vd_1} \cdot v_1 + A_{v_{C_1}} \cdot \frac{v_1}{2}$$

$$A_{v_{C_1}} \frac{v_1}{2} \ll A_{vd}\, v_1.$$

$$A_{v_1} = \frac{v_o}{v_1} \approx A_{vd_1}.$$





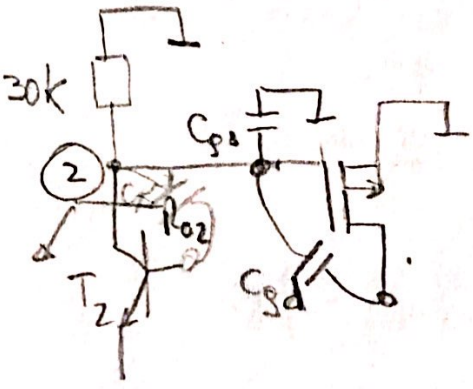
$\tau_1 = C_1 R_1$ $\quad C_M^* = C_M(1-A_v) = 2pf(1+120$

$= 240pf$

$C_\pi = 0{,}12pf$ $\quad C_1 \cong 240pf$.

$\tau_1 = 240pf \cdot 0{,}5k = 240 \frac{5}{10} \cdot 10^{-12} \cdot 10^3 =$

$= 120 \cdot 10^{-9} = 120ns$



$2pF + 5pF + 35pF$

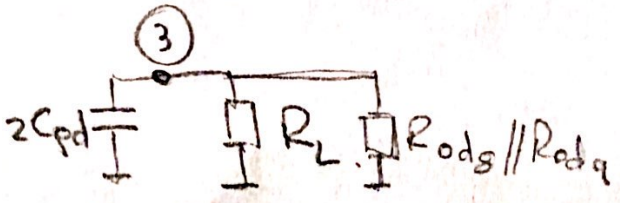
$\tau_2 = C_2 \cdot R_2 = 42pF \cdot 30k =$

$= 1260ns$

$C_2 = C_{gs} + C_{gd}^* \overset{N}{=} 20pf + C_{M2}$

$C_{gd}^* \overset{N}{\cong} 2pf(1+\pi) \overset{N}{\cong} 35pF$.

Nodo R_L



$\tau_3 \overset{N32ns}{<<} \tau_1$

$\tau_3 << \tau_2$

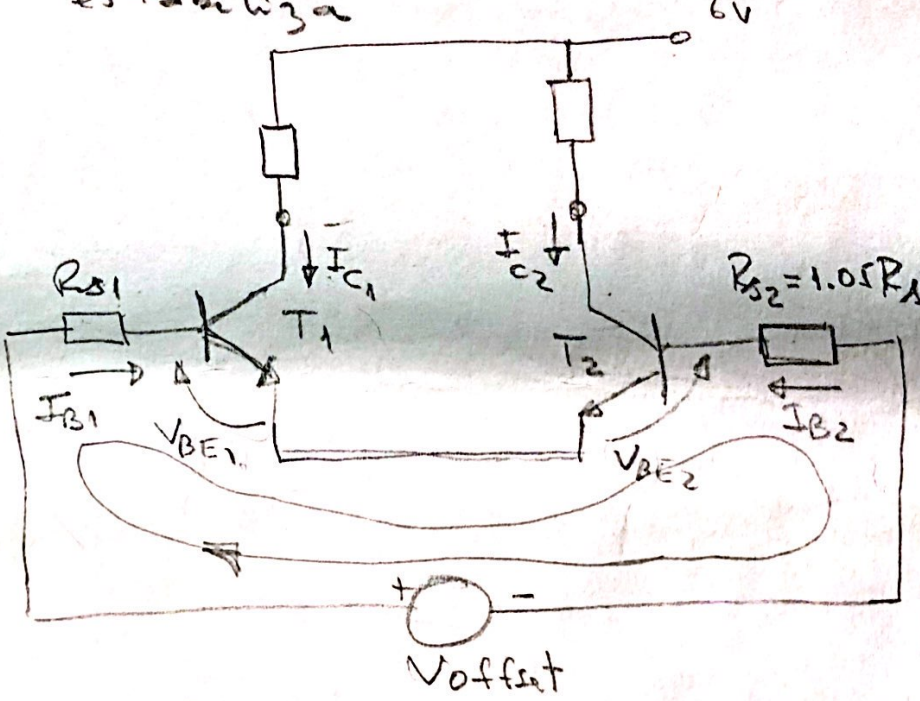
$\tau_1 + \tau_2 = 1380\,ns$

$\omega_h = 753\,rad/s$.

$f_h = 120\,KHz$.

d) RP (T) no estabiliza

e)



$I_{C1} = I_S e^{V_{BE1}/V_T}$

$V_{BE1} = V_T \cdot \ln \frac{I_{C1}}{I_S}$

$V_{BE2} = V_T \cdot \ln \frac{I_{C2}}{I_S}$

R_{DN}

$V_{offset} - I_{B1} R_{S1} - V_{BE1} + V_{BE2} + I_{B2} \cdot 1.05 R_{S1} = 0$

$V_{offset} = \frac{I_{C1}}{\beta} R_{S1} - V_{BE1} + V_{BE2} + \frac{I_{C2}}{\beta} \cdot 1.05 R_{S1} = 0$

$V_{offset} = \frac{I_C}{\beta} (R_{S1} - 1.05 R_{S1}) = -0,05 R_{S1} \frac{I_C}{\beta} =$

$= -0,05 \cdot 0,5k \frac{0,1\,mA}{400} = -\frac{25}{1000} k \cdot \frac{0,1\,mA}{400} = 6,25\,\mu$