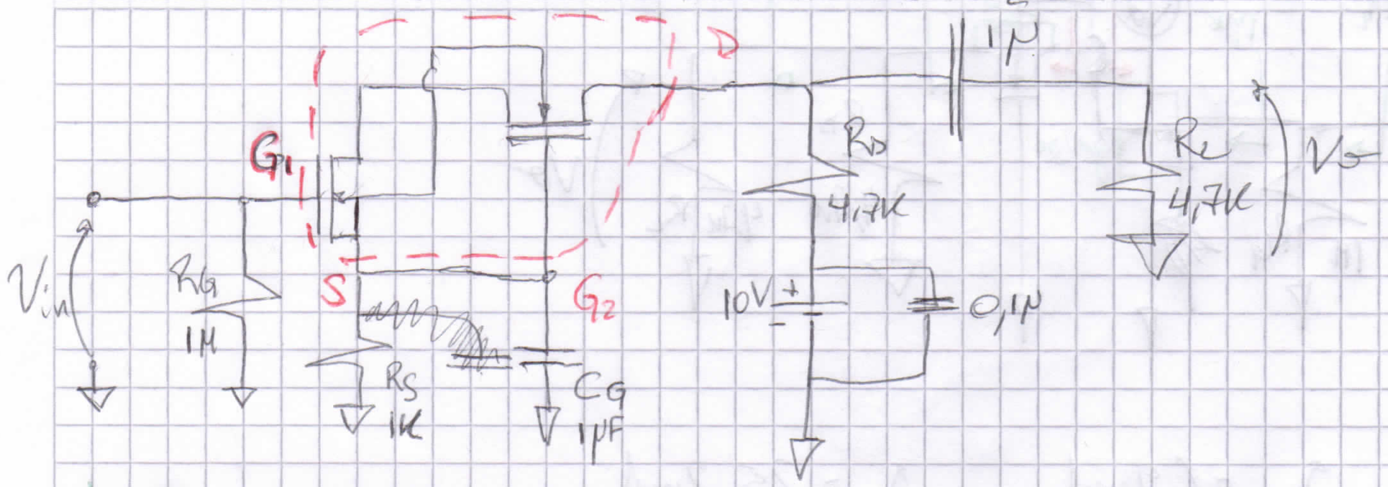
TL3



1) Q

2) A_V

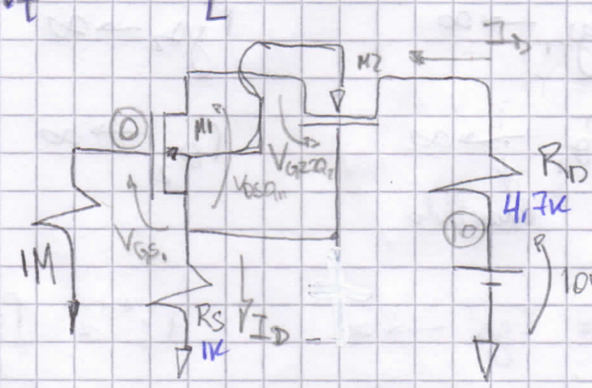
3) R_i R_o

4) $\hat{V}_{o\,Max}$

5) A_{VL}, R_{t_L} en frecuencia

$K_1 = 15 \frac{mA}{V^2}$ $V_T = -1V$ $\frac{W}{L} = 1$

$K_2 = 200 \frac{mA}{V^2}$



$\cdot)$ $0 - V_{GSQ_1} - I_D R_S = 0 \Rightarrow -V_{GSQ_1} - R_S K_1 (V_{GSQ_1} - V_{T_1})^2 = 0$ (✱)

$\cdot)$ $V_{DSQ_1} = -V_{GSQ_2}$

$\cdot)$ $10V - I_D R_D - V_{DSQ_2} - V_{DSQ_1} - I_D R_S = 0$

$10V - I_D (R_D + R_S) - V_{DSQ_T} = 0$

(✱): $-V_{GSQ_1} - R_S K_1 V_{GSQ_1}^2 + 2 R_S K_1 V_{GSQ} V_{T_1} - R_S K_1 V_{T_1}^2 = 0$

$-R_S K_1 V_{GSQ_1}^2 + (2 R_S K_1 V_{T_1} - 1) V_{GSQ_1} - R_S K_1 V_T^2 = 0$

$-15 V_{GSQ_1}^2 - 31 V_{GSQ_1} - 15 = 0 \Rightarrow V_{GSQ_1} \cong -0,77V$

$\Rightarrow I_{DQ_T} = 793,5 \mu A$

$\cdot)$ $V_{GSQ_2} = -0,94V \Rightarrow V_{DSQ_1} = 0,94V$

$\Rightarrow V_{DQ_1} = 1,734 = V_{SQ_2}$

$\Rightarrow V_{DSQ_2} = 4,54V$

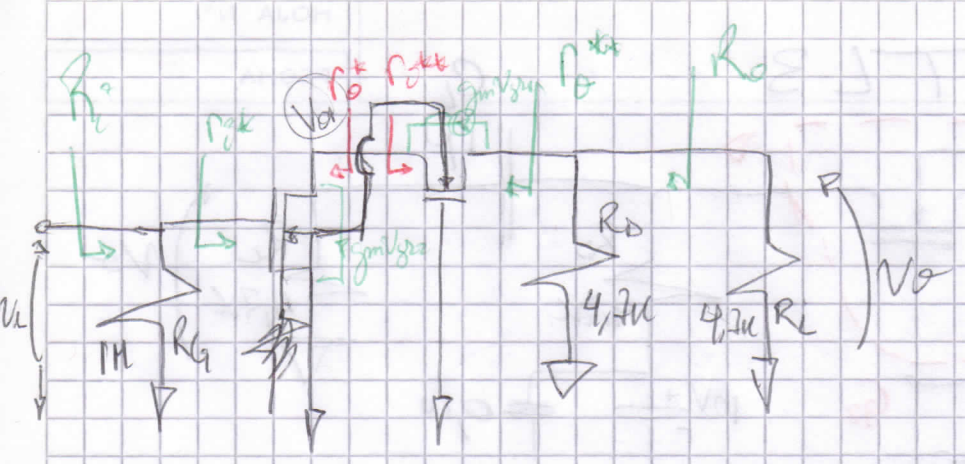
$V_{SQ_1} = 0,794V$

$V_{DQ_2} = 6,27V$

$\} V_{DSQ_T} = 5,48V$

NOTA $Q_1 = (0,94V; 793,5\mu A)$ $Q_2 = (4,54; 793,5\mu A)$

$V_{GSQ_1} = -0,77V$ $V_{GSQ_2} = -0,94V$



$g_{m_1} = 6,9 \frac{mA}{V}$ $\quad$ $g_{m_2} = 25,2 \frac{mA}{V}$

$r_{gs_1} \to \infty$ $\quad$ $r_{gs_2} \to \infty$

$r_{o_1} \to \infty$ $\quad$ $r_{o_2} \to \infty$

↓ enunciado

$r_i^{o*} = r_{gs} \to \infty$ $\quad$ $r_i^{**} = \frac{r_{gs1} + 0}{r_{gs} g_{m2}} = \frac{1}{g_{m2}} = 39,7\Omega$

$r_o^* = r_{o_1} \to \infty$ $\quad$ $r_o^{**} = r_{o_2} \to \infty$

$R_i^o = 1M\Omega // r_i^* \cong 1M\Omega$ (?)

$R_o = 4,7K\Omega // r_o^{**} \cong 4,7K\Omega$

$A_V = \frac{V_o}{V_i} = \frac{V_o}{V_s} = A_{V2} = \frac{-i_d \cdot 2,35K\Omega}{\frac{i_d}{g_{m1}} \cdot r_{gs}} = -g_{m_1} 2,35K\Omega = -16,215$

$g_m^{**} = \frac{i_{d2}}{V_{gs1}} = \frac{g_{m2} V_{gs2}}{i_d \, r_{gs1}} = \frac{g_{m2} V_{gs}}{\frac{g_{m2} V_{gs}}{g_{m1}} r_{gs}} = g_{m_1}$

NOTA

4) $\hat{V}_{oMS_1} = V_{DSQ_1} = 940mV$

$\hat{V}_{oMC_1} = I_{DQ_1} \cdot r_o^{**} = 793,5\mu A \cdot 39,7\Omega = 31,5mV$

$\hat{V}_{oMS_2} = 4,54V$

$\hat{V}_{oMC_2} = 793,5\mu A \cdot 2,35k\Omega = 1,86V$

$\Rightarrow \hat{V}_{oMC_1}$ impone el límite de distorsión

$$A_{V_1} = \frac{V_{o1}}{V_i} = \frac{-i_d \cdot r_o^{**}}{\frac{i_d}{g_{m_1} r_{g2}}} = -g_{m_1} \cdot r_o^{**} = -273,93 \times 10^{-3}$$

$\hat{V}_{iM} \simeq 115mV$

$$A_{V_2} = \frac{V_o}{V_{o1}} = \frac{-i_d \, 2,35k\Omega}{-i_d \, r_o^{**}} = \frac{2,35k\Omega}{39,7\Omega} \simeq 59,2$$

$\hat{V}_{oM_{total}} = A_{V_2} \cdot \hat{V}_{oM_{(oMC_1)}} = 59,2 \cdot 31,5mV \simeq 1,86V$

•) 1) $\Delta V_{DS} = (V_{DSQ_1} - v_{d1}) = -(I_{DQ} - i_{D_1}) \cdot \underbrace{r_i^*}_{39,7\Omega} = (i_{D_1} - I_D)\, r_i^*$

$$\Rightarrow i_{D_1} = I_D + \frac{V_{DSQ_1}}{r_i^*} - \frac{v_{d1}}{r_i^*}$$

$$= 793,5\mu A + 23,68mA - \frac{v_{d1}}{39,7\Omega}$$

$$i_{D_1} = 24,5\,mA - \frac{v_{d1}}{39,7\Omega} \quad RCD\,1$$

OA0: 24,5 mA ; raiz = 0,97265

$V_{O_{MAX_1}} = 0,97V - 0,94V = 30mV$

2) $i_{D_2} = I_D + \frac{V_{DSQ_2}}{\frac{4,7K\Omega}{2}} - \frac{v_{d1}}{\frac{4,7K\Omega}{2}} = I_{DQ_1} + \frac{V_{DSQ_2}}{2,35K\Omega} - \frac{v_{d1}}{2,35K\Omega}$

$$i_{D_2} = 2,73\,mA - \frac{v_{d1}}{2,35K\Omega} \quad RCD\,2$$

OA0: 2,73mA ; raiz: 6,42V

•) $V_{O_{MAX_2}} = 6,42V - 4,54V = 1,88V \simeq 1,9V$

•) $A_{V_1} = \frac{V_{O1}}{V_i} \Rightarrow V_i = \frac{V_{O1_{M_1}}}{|A_{V_1}|} = 110mV\ (109,5uV)$

$V_{O_{MAX}} = 110mV \cdot |A_V| = 1,78V \simeq 1,8V$

∴ T1 limita

$I_{CQ_1} = 793{,}5\,\mu A$ $\quad I_{CQ_2} = 793{,}5\,\mu A$

$V_{DSQ_1} = 0{,}94V$ $\quad V_{DSQ_2} = 4{,}54V$

$g_{m_1} = 6{,}9\frac{mA}{V}$ $\quad g_{m_2} = 25{,}2\frac{mA}{V}$

$r_{gs_1}, r_{o_1} \to \infty$ $\quad r_{gs_2}, r_{o_2} \to \infty$

$C_{gs_1} \to 0$?

$C_{gd_1} \to 0$?

$R_D = 4{,}7k\Omega$

Datasheet:

$C_{in_{gate\,1}} = 2{,}2pF$

$C_{in_{gate\,2}} = 1{,}1pF$

$C_{output} = 0{,}8$

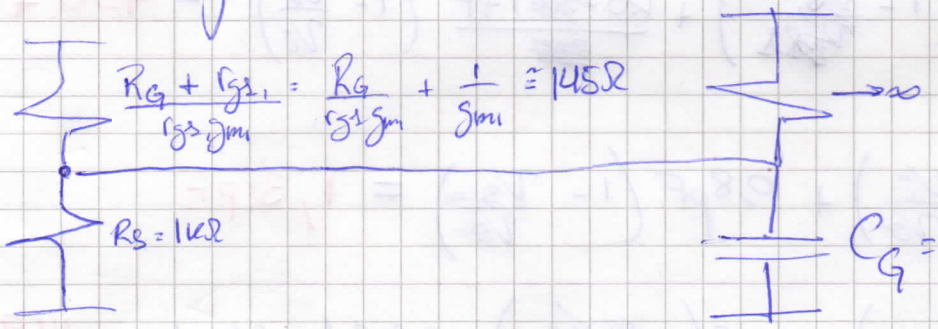
En el modelo simple:

C_{gs} { $C_{g_1s} = 2{,}2pF$; $C_{g_2s} = 1{,}1pF$

{ $C_{dr} = C_{d_2s} = 0{,}8pF$; $C_{gd} = C_{g_1d} = 25fF$

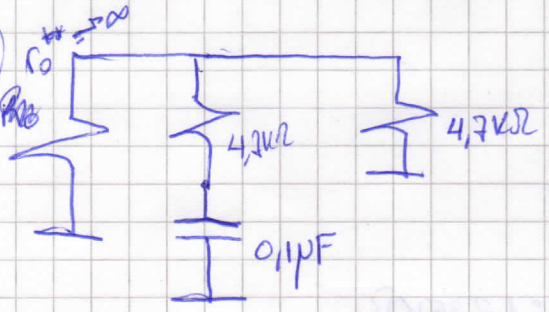
Rta de bajas frecuencias:

(1)

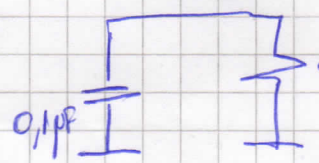


$\Rightarrow \tau_1 = (145 // 1k) \cdot 1\mu F = 0{,}127ms \Rightarrow$ $f_{1_f} = 7{,}87kHz$ ~~1,25kHz~~ !

(2)



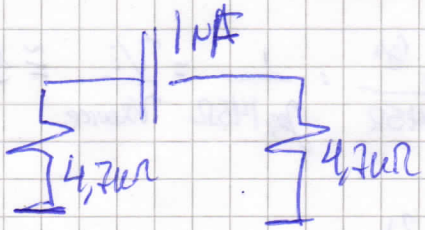
$\equiv$



$\Rightarrow \tau_2 = 0{,}94ms$

$f_{2_f} = 1{,}06kHz$

(3)

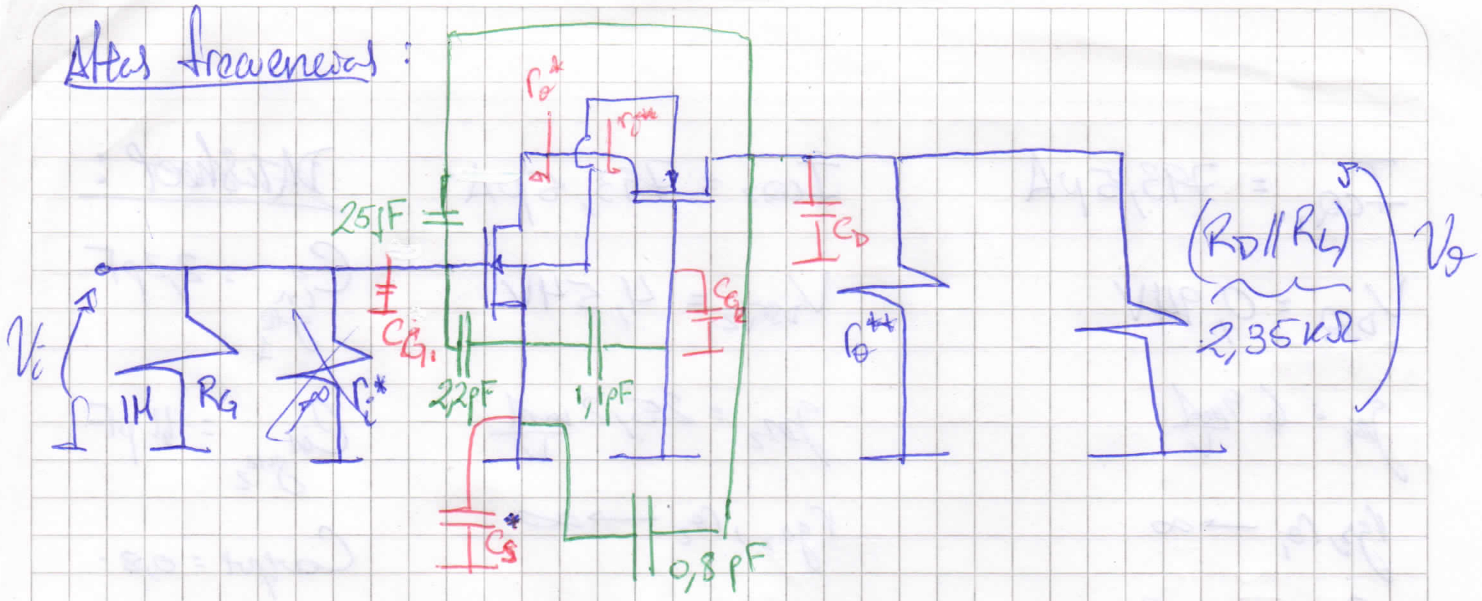


$\tau_3 = 9{,}4ms \Rightarrow$ $f_{3_f} = 106{,}4Hz$

$\sum f_f = 9{,}04kHz \approx 7{,}87kHz$ - Error del 13% ?

$f_f = 7{,}87kHz$?

Altas frecuencias:



$$C_{G_1} = 22pF \cdot \left(1 - \frac{V_{source}}{V_i}\right) + 25fF\left(1 - \frac{V_o}{V_i}\right) = 430fF$$

$$C_D = 25fF\left(1 - \frac{V_i}{V_o}\right) + 0{,}8pF\left(1 - \frac{V_{source}}{V_o}\right) = 1{,}3pF$$

$$C_{Source} = 0{,}8pF\left(1 - \frac{V_o}{V_{source}}\right) + 1{,}1pF\left(1 - \frac{V_{gate2}}{V_{source}}\right) + 2{,}2pF\left(1 - \frac{V_i}{V_{source}}\right) = 14{,}9pF$$

$$C_{G_2} = 1{,}1pF \cdot \left(1 - \frac{V_{source}}{V_{gate2}}\right) = 1{,}1pF$$

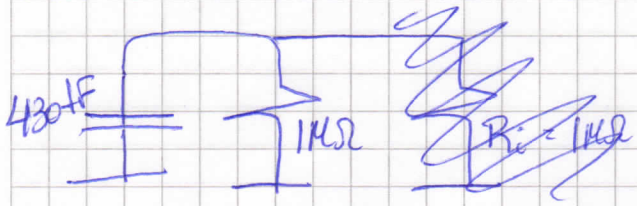
•) $\frac{V_o}{V_i} = -16{,}215$

•) $\frac{V_{g2}}{V_{source}} = \frac{1M}{1M + r_{g2}} \cong 0$

•) $\frac{\frac{id}{g_m r_{gs}} r_{gs}}{id\,145\Omega} = \frac{1}{g_m 145\Omega} = \frac{V_i}{V_{source}} \cong 1$

•) $\frac{V_o}{V_{source}} = \frac{-id\ 2{,}35K\Omega}{+id \cdot \frac{r_{g2}+1M}{g_m r_{gs}}} = -\frac{2{,}35K\Omega}{145\Omega} = -16{,}21$

G1)

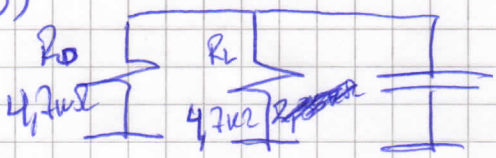


430nΩ

$\Rightarrow \tau_{G_1} = 430fF \cdot 1M\Omega = 215nΩ$

$\Rightarrow f_{G_1} = 370,1 kHz$

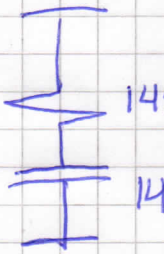
D)



$\Rightarrow \tau_{G_1} = 2,35 kΩ \cdot 1,3pF = 3,1nΩ$

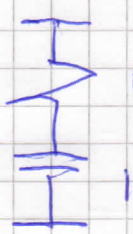
$\Rightarrow f_D = 51,3 MHz$

S)



$\tau_S = 2,16nΩ \Rightarrow f_S = 73,7 MHz$

$G_2 =$



No Vc (?)

*) $\sum f_{ficticio} = 794,81 MHz$

*) Menor: 370,1kHz $f_L = 4,65 MHz$

f_h aprox