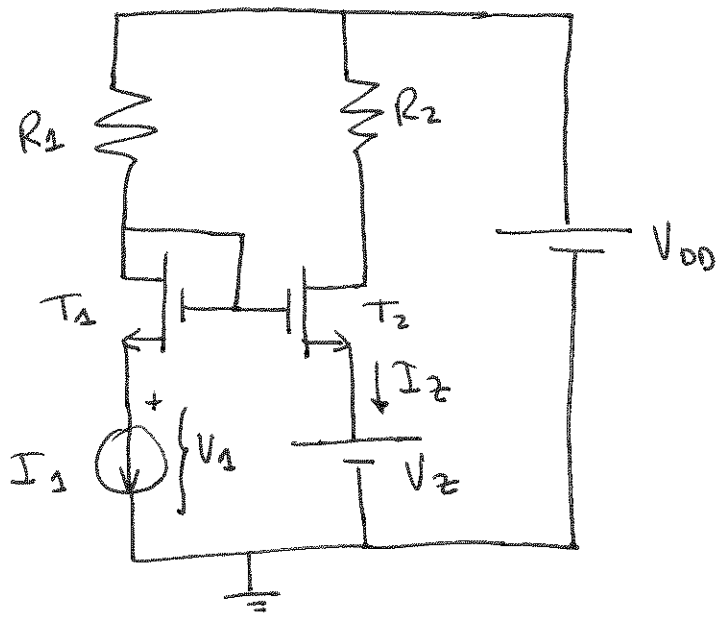
a) DC



Suponemos:

T_1 en saturación

T_2 en saturación

Zener en ruptura

$$I_{DS_1} = \frac{K}{2}\frac{W}{L}(V_{GS_1} - V_{TH})^2 = I_1 = 8mA \rightarrow V_{GS_1} = 5V$$

MALLA GS1 $\rightarrow V_{DD} = R_1 \cdot I_1 + V_{GS_1} + V_1 \rightarrow V_1 = 4V$

MALLA GS2 $\rightarrow V_{DD} = R_1 \cdot I_1 + V_{GS_2} + V_Z \rightarrow V_{GS_2} = 3'4V$

$$I_Z = I_{DS_2} = \frac{K}{2}\frac{W}{L}(V_{GS_2} - V_{TH})^2 = 2'88mA \rightarrow I_Z > 0 \quad \underline{OK}$$

MALLA DS1 $\rightarrow V_{DD} = R_1 I_1 + V_{DS_1} + V_1 \rightarrow V_{DS_1} = 5V > V_{GS_1} - V_{TH}$ OK

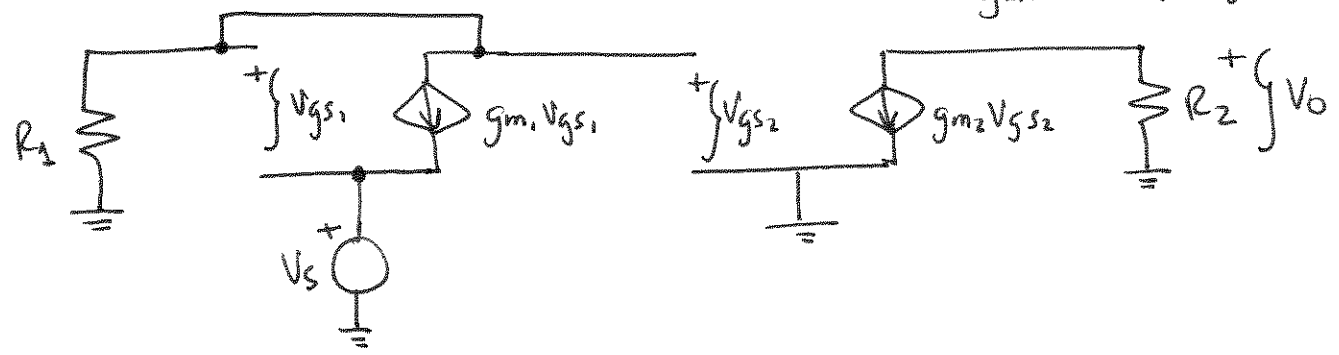
MALLA DS2 $\rightarrow V_{DD} = R_2 I_{DS_2} + V_{DS_2} + V_Z \rightarrow V_{DS_2} = 6'52V > V_{GS_2} - V_{TH}$ OK

b) $I_Z = 2'88mA$ $\begin{cases} > I_{Z,min} = 2'5mA \\ P_Z = 2'88mA \cdot 5'6V = 16'1mW < 50mW = P_{Z_{MAX}} \end{cases}$ OK

c) AC Ganancia máxima ⇒ $R_S = 0$, $R_L = \infty$

$$g_m = \sqrt{2K \frac{W}{L} I_{DQ}}$$

$g_{m_1} = 4\,mA/V^2$ $g_{m_2} = 2'4\,mA/V^2$



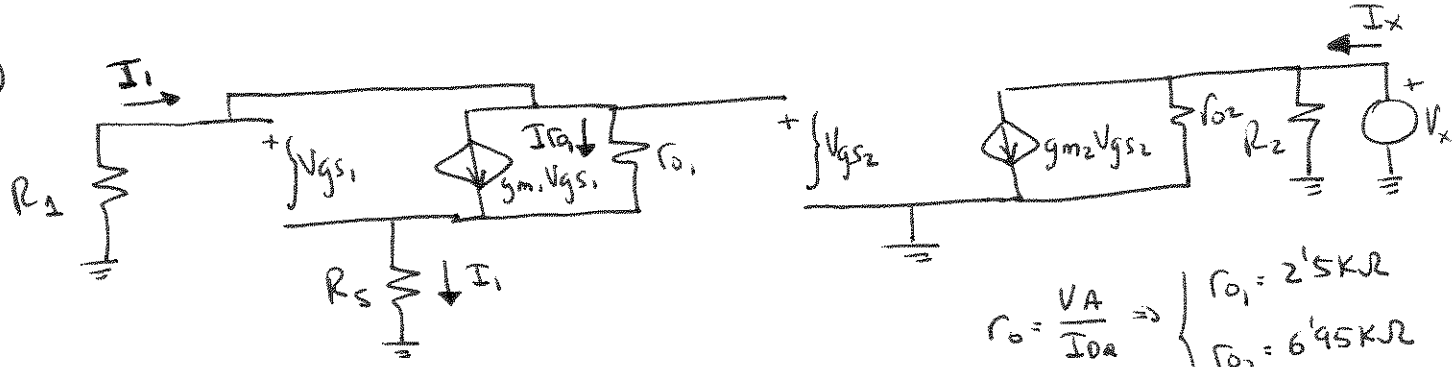
$$V_o = -g_{m_2} V_{gs_2} R_2 = +g_{m_2} R_2 \cdot g_{m_1} R_1 V_{gs_1}$$

$$g_{m_1} V_{gs_1} R_1 + V_{gs_2} = 0$$

$$g_{m_1} V_{gs_1} R_1 + V_{gs_1} + V_S = 0 \rightarrow V_S = -(g_{m_1} R_1 + 1) V_{gs_1}$$

$$\Rightarrow \frac{V_o}{V_S} = -\frac{g_{m_2} R_2 g_{m_1} R_1}{g_{m_1} R_1 + 1} = -1'8$$

d)



$$r_o = \frac{V_A}{I_{DQ}} \Rightarrow \begin{cases} r_{o_1} = 2'5\,K\Omega \\ r_{o_2} = 6'95\,K\Omega \end{cases}$$

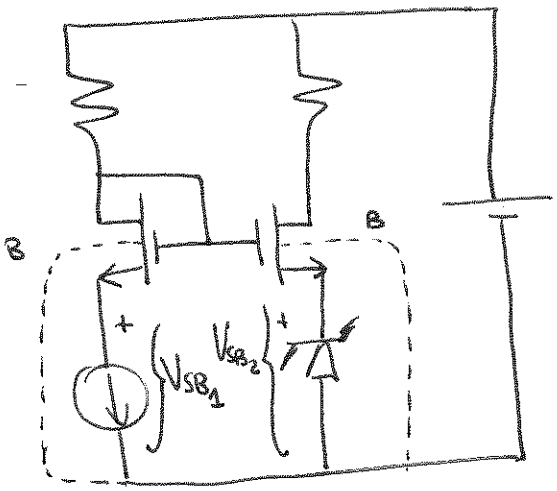
$$I_{r_{o_1}} = \frac{V_{gs_1}}{r_{o_1}} \Rightarrow I_1 = g_{m_1} V_{gs_1} + \frac{V_{gs_1}}{r_{o_1}} = \left(g_{m_1} + \frac{1}{r_{o_1}}\right) V_{gs_1}$$

$$\rightarrow R_1 \cdot I_1 + V_{gs_1} + R_S I_1 = 0 \rightarrow \left[(R_1 + R_S)\left(g_{m_1} + \frac{1}{r_{o_1}}\right) + 1\right] V_{gs_1} = 0 \rightarrow$$

$$\rightarrow V_{gs_1} = 0 \rightarrow V_{gs_2} = -I_1 R_1 = -R_1 \cdot \left(g_{m_1} + \frac{1}{r_{o_1}}\right) V_{gs_1} = 0 \rightarrow$$

$$\rightarrow I_x = \frac{V_x}{R_2} + \frac{V_x}{r_{o_2}} \rightarrow R_{OUT} = \frac{V_x}{I_x} = \left(\frac{1}{R_2} + \frac{1}{r_{o_2}}\right)^{-1} = 874'1\,\Omega$$

e) DC



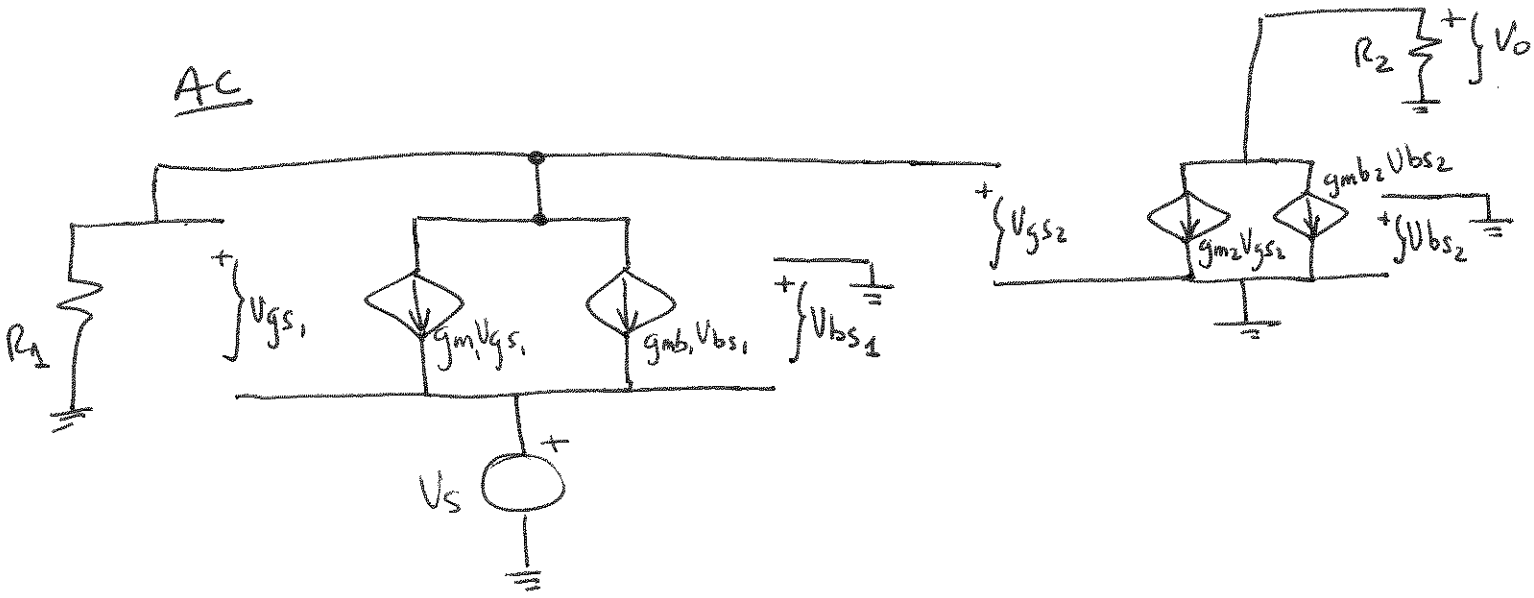
V_{TH} ↑ si V_{SB} ↑

$V_{SB_1} = V_1 = 4V$

$V_{SB_2} = V_2 = 5'6V$

$\Big\}$ $V_{TH_2} > V_{TH_1}$

AC



$V_{bs_2} = 0$ → No le afecta el efecto body a T_2

$V_{bs_1} = -V_s$ → Sí le afecta el efecto body a T_1