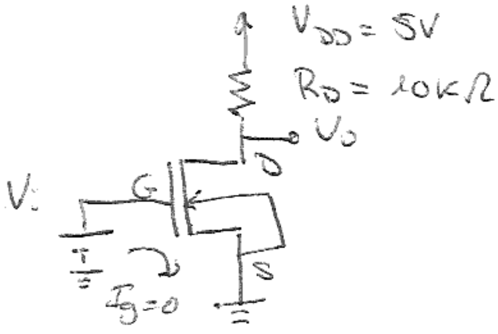
Ejercicios MOSFET.



$V_i = 5V$

$V_T = 1V$

$\frac{W}{L} = 2$

$K = 20 \cdot 10^{-6} \frac{A}{V^2}$

V_{GS}

V_{DS}

I_{DS}

Al tener el NMOS un condensador en la puerta la corriente $I_G = 0$ (C.C.)

* Malla Puerta - Fuente

$$V_i = V_{GS} = 5V > 1V = V_T \Rightarrow \text{No está en corte.}$$

* Malla Drenador - Fuente

$$V_{DD} = I_{DS} \cdot R_D + V_{DS}$$

* Suponemos saturación $(V_{DS} \geq V_{GS} - V_T)$

$$I_{DS} = \frac{K}{2} \frac{W}{L} (V_{GS} - V_T)^2 = \frac{20 \cdot 10^{-6}}{2} \frac{A}{V^2} \cdot 2 \cdot (5-1)^2 = 0.32 mA$$

$$V_{DS} = V_{DD} - I_{DS} \cdot R_D = 1.8V$$

$$V_{DS} = 5V - 0.32mA \cdot 10K\Omega$$

$$V_{GS} - V_T > V_{DS}$$

$$5 - 1 > 1.8 \rightarrow \text{TRIODO}$$

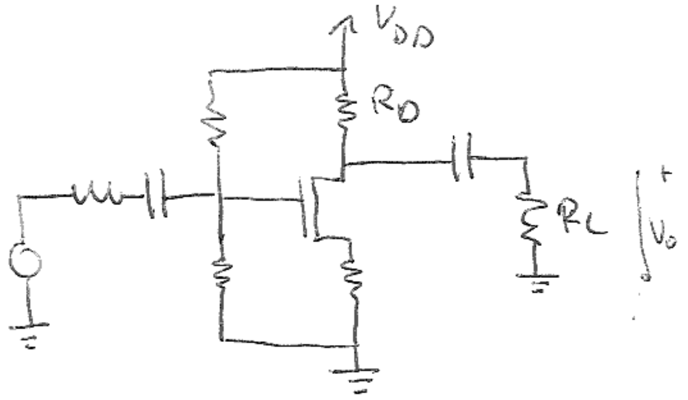
* Suponemos Triodo.

$$I_{DS} = \frac{K}{2}\frac{W}{L}\left[(V_{GS}-V_T)V_{DS} - \frac{V_{DS}^2}{2}\right] = 40\cdot10^{-6}\left[4V_{DS} - \frac{V_{DS}^2}{2}\right]$$

$$V_{DS}^2 - 13V_{DS} + 25 = 0$$

$$V_{DS} = 2.35\,V \quad \checkmark$$

$$10.65\,V \quad \times$$



$V_{DD} = 20V$

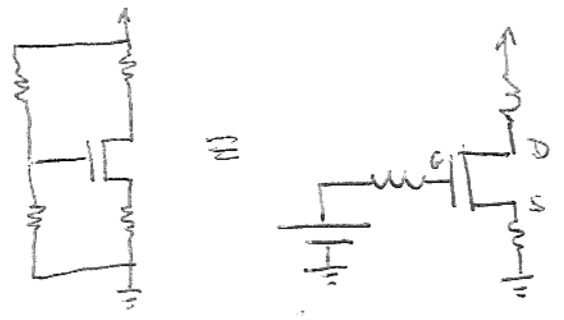
$R_D = 10k\Omega$

$R_S = 5k\Omega$

$Rb_1 = 15k\Omega$

$Rb_2 = 12{,}3k\Omega$

① Pto polarización



$V_{TH} = \frac{V_{DD}}{Rb_1+Rb_2} \cdot Rb_2$

$R_{eq} = \frac{Rb_1 \cdot Rb_2}{Rb_1+Rb_2}$

$$\overset{0 \quad I_g = 0}{}$$

* $V_{TH} = \cancel{I_G \cdot R_{Eq}} + V_{GS} + I_D \cdot R_S$

* Suponemos saturación

$I_D = \frac{k}{2}\frac{W}{L}(V_{GS} - V_T)^2$

$\Rightarrow V_{GS}^2 - 17 = 0$ → $4.12V$ ✓ ; → $-4.12V$ ✗

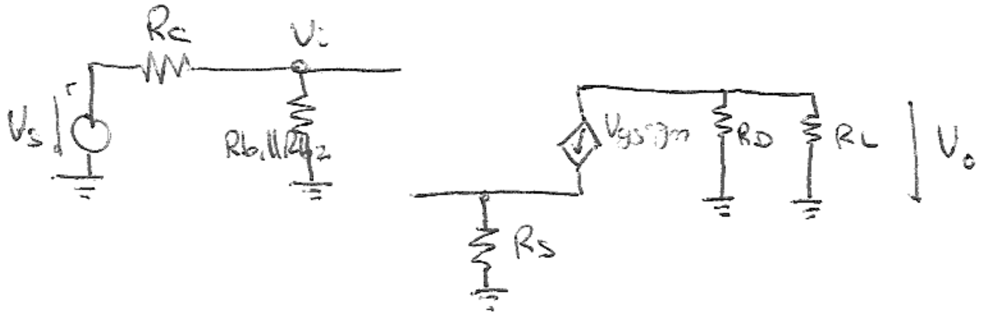
$I_D = 0.97 mA$

Hay canal porque $V_{GS} = 4.12 > V_T = 1V$ no está en corte

* $V_{DD} = I_D R_D + V_{DS} + I_D R_S \Rightarrow V_{DS} = 5{,}4V$

$V_{DS} \geq V_{GS} - V_T$? $\Rightarrow 5.4 \geq 4{,}12 - 1 \Rightarrow$ Saturacion

$I_D = 0.97\,mA$ (gm de pequeña señal)



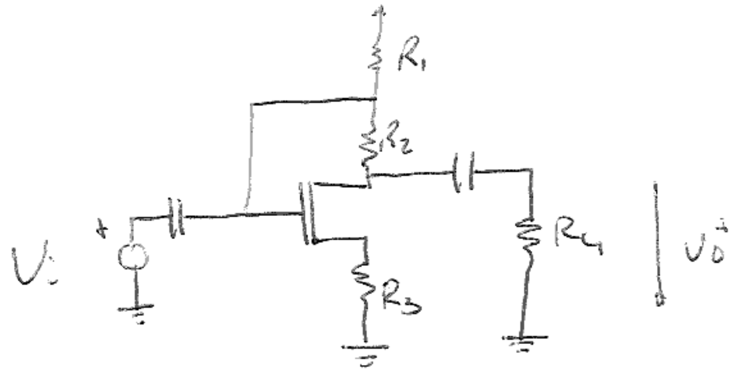
$$V_i = V_{GS} + I_{Rs} \cdot R_S$$

$$I_{Rs} = V_{gs} \cdot g_m$$

$$V_i = V_{gs}(1 + g_m R_S)$$

$$V_o = (R_D \| R_L) \cdot g_m V_{gs}$$

$$\frac{V_o}{V_i} = \frac{(R_D \| R_L) g_m \cancel{V_{gs}}}{\cancel{V_{gs}}(1 + g_m R_S)}$$



1) Polarización

* $V_{DD} = I_D(R_1 + R_3) + V_{GS}$ (1)

* $V_{DD} = I_D(R_1 + R_2 + R_3) + V_{DS}$ (2)

* Saturación $V_{DS} \geq V_{GS} - V_T$

$I_D = \frac{1}{2} \frac{k\, w}{L} (V_{GS} - V_T)^2$ (3)

(1)(3) $V_{GS} \rightarrow 3V$ ✓ $> V_T = 1V \Rightarrow$ No está en corte.
$\rightarrow -1.3V$ ✗

Para que haya canal, $V_{GS} > V_T$

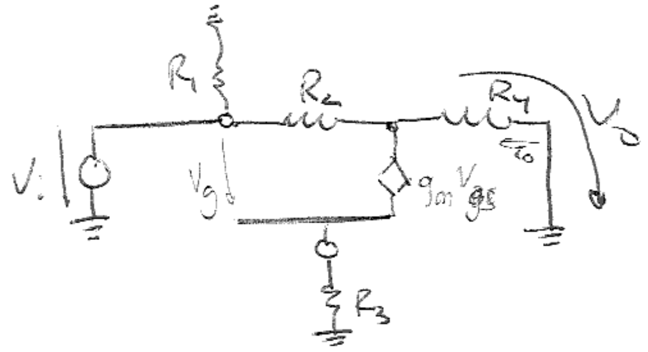
$$I_D = \frac{V_{DD} - V_{GS}}{R_1 + R_3} = 1.2 \cdot 10^{-3} A$$

(2) $V_{DS} = V_{DD} - I_D(R_1 + R_2 + R_3) = 2.4V$

$V_{DS} = 2.4V > 3V - 1V \Rightarrow$ Saturado

② Pequeña Señal.

$I_D = 1.2\,mA$



$V_i = V_g$

$V_o = -\,i_o \cdot R_4 = -\left(g_m V_{GS} + \dfrac{V_i - V_o}{R_2}\right) R_4$

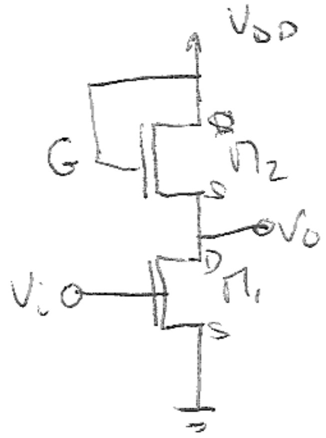
$I R_2 = \dfrac{V_i - V_o}{R_2}$

$V_{gs} = V_g - V_s = V_i - R_3 g_m V_{gs}$

$V_{gs} = \dfrac{V_i}{1 + R_3 g_m}$

$I_o = g_m V_{gs} + I R_2$

$$\frac{V_o}{V_i} = \frac{\left(\frac{1}{R_2} - \frac{g_m}{1+g_m R_3}\right)}{\left(\frac{1}{R_2} + \frac{1}{R_4}\right)}$$



$V_{DD} = 5V$

$V_T = 1V$

$k = 20\cdot10^{-6}$

$\frac{W}{L} = 2$

$V_G = V_D \Rightarrow V_{GS} = V_{DS} \Rightarrow$

$V_{DS} \geq V_{GS} - V_T \Rightarrow$

Siempre en saturación o corte

Inversor en Saturación

$\boxed{V_i = 0V}$ $V_{GS} = V_i = 0V < V_T \Rightarrow$ Corte

$I_{D_1} = 0 \Rightarrow I_{D_2} = 0$

$V_{DS} = V_T \Rightarrow I_D = \phi = \frac{1}{2} k\frac{W}{L}(V_{DS}-V_T)^2$

$V_{DD} = V_{DS_2} + \underset{V_{DS1}}{\underset{\parallel}{V_o}} \Rightarrow V_o = V_{DD} - \underset{V_T}{\underset{\parallel}{V_{DS2}}}$

$\boxed{V_i = 5V}$

$V_{GS_1} = 5V = V_i > V_T \Rightarrow M_2$ saturado

$I_{D_1} = I_{D_2} \Rightarrow$ Hay canal

* Suponemos Triodo.

$V_{GS1} = 5V$ $\quad V_{GS2} = V_{DS2}$

$V_{DS_1} = V_o$

$I_D = \underbrace{\frac{k}{2}\frac{W}{L}(V_{DD}-V_o-V_T)^2}_{I_{D_1}} = \underbrace{k\frac{W}{L}\left[(V_i-V_T)\cdot V_o - \frac{V_o^2}{2}\right]}_{I_{D_2}}$

$V_o = \begin{cases} 1.17V & \checkmark \\ 6.82V & \times \end{cases}$