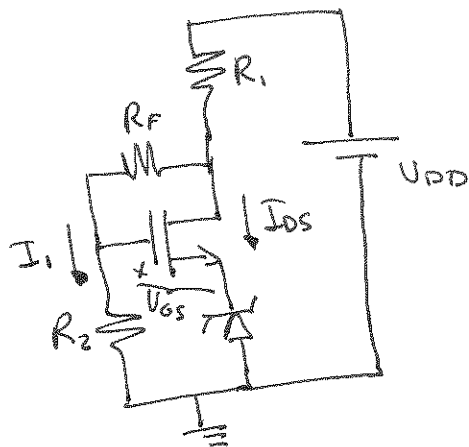


Solución Examen Refuerzo MOS

a) Circuito en DC



Supongo Zener en ruptura:

$$\text{Zener Symbol} \equiv \frac{1}{T} |V_Z|$$

Supongo NMOS en saturación

$$I_{DS} = \frac{K}{2} \frac{W}{L} (V_{GS} - V_T)^2 \quad \begin{matrix} V_{DS} > V_{GS} - V_T \\ V_{GS} > V_T \end{matrix}$$

MALLA G-S

$$V_{DD} = (I_1 + I_{DS}) R_1 + I_1 R_F + V_{GS} + V_Z$$

$$I_1 R_2 = V_{GS} + V_Z \quad \rightarrow \quad V_{DD} = \left(\frac{V_{GS} + V_Z}{R_2} + I_{DS} \right) R_1 + \frac{V_{GS} + V_Z}{R_2} R_F + V_{GS} + V_Z$$

$$V_{DD} - \frac{R_1}{R_2} V_Z - \frac{R_F}{R_2} V_Z - V_Z = \frac{R_1}{R_2} V_{GS} + \frac{R_F}{R_2} V_{GS} + V_{GS} + I_{DS} R_1$$

$$18 = \frac{5}{3} V_{GS} + I_{DS} R_1 \quad \left\{ \begin{array}{l} 18 = \frac{5}{3} V_{GS} + 0.4 (V_{GS} - 1)^2 \\ \Rightarrow 0.4 V_{GS}^2 + \frac{13}{15} V_{GS} - 17.6 = 0 \end{array} \right.$$

$$I_{DS} = 0.4 (V_{GS} - 1)^2$$

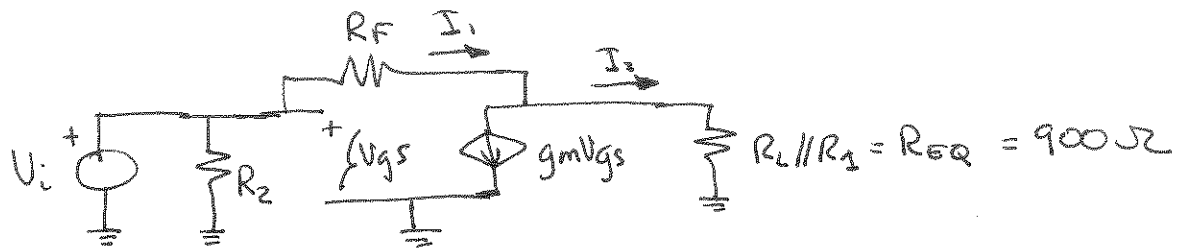
$$V_{GS} \Rightarrow \begin{cases} 5.64 \text{ V} \\ -7.8 \text{ V X} \end{cases} \quad \rightarrow \quad I_{DS} = 8.6 \text{ mA}$$

MALLA D-S

$$V_{DD} = I_{DS} R_1 + V_{DS} + V_Z \quad \rightarrow \quad V_{DS} = 11.8 \text{ V} > V_{GS} - V_T \quad \text{OK SATURACIÓN}$$

$$b) \quad I_Z = I_{DS} = 8.6 \text{ mA} \quad \left\{ \begin{array}{l} > I_{Z, \min} = 4 \text{ mA} \\ < I_{Z, \max} = \frac{P_{\max}}{V_Z} = 27.8 \text{ mA} \end{array} \right. \quad \text{OK}$$

c)



$$d) \quad V_{gs} = V_i \quad \rightarrow \quad I_1 = g_m V_{gs} + I_2 \Rightarrow \frac{V_i - V_o}{R_F} = g_m V_i + \frac{V_o}{R_{EQ}} \Rightarrow$$

$$\Rightarrow V_i \left(\frac{1}{R_F} - g_m \right) = V_o \left(\frac{1}{R_F} + \frac{1}{R_{EQ}} \right) \Rightarrow$$

$$\Rightarrow \frac{V_o}{V_i} = \frac{\frac{1}{R_F} - g_m}{\frac{1}{R_F} + \frac{1}{R_{EQ}}} = \frac{1 - g_m R_F}{1 + \frac{R_F}{R_{EQ}}} = -1'28$$

$$g_m = \sqrt{2k \frac{W}{L} I_{DS}} = 3'71 \text{ mA/V}$$