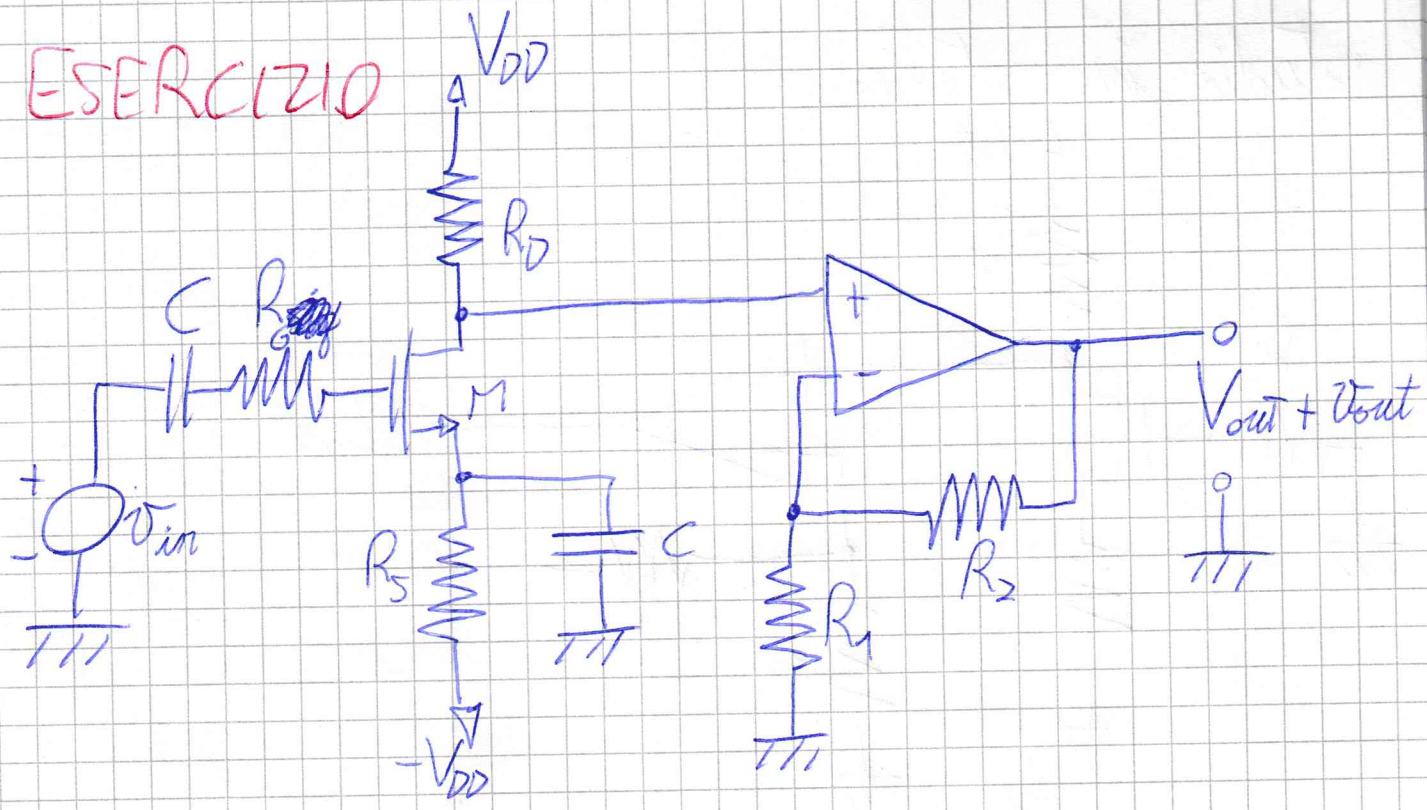
ESERCIZIO



$L^+ = |L^-| = 12V$

$M = \{K = 0,5 \frac{mA}{V^2} \; ; \; V_t = 2V \; ; \; \lambda = 0\}$

$V_{DD} = 5V \quad C = \infty \quad R_G = 5K\Omega \quad R_S = 0,5K\Omega$

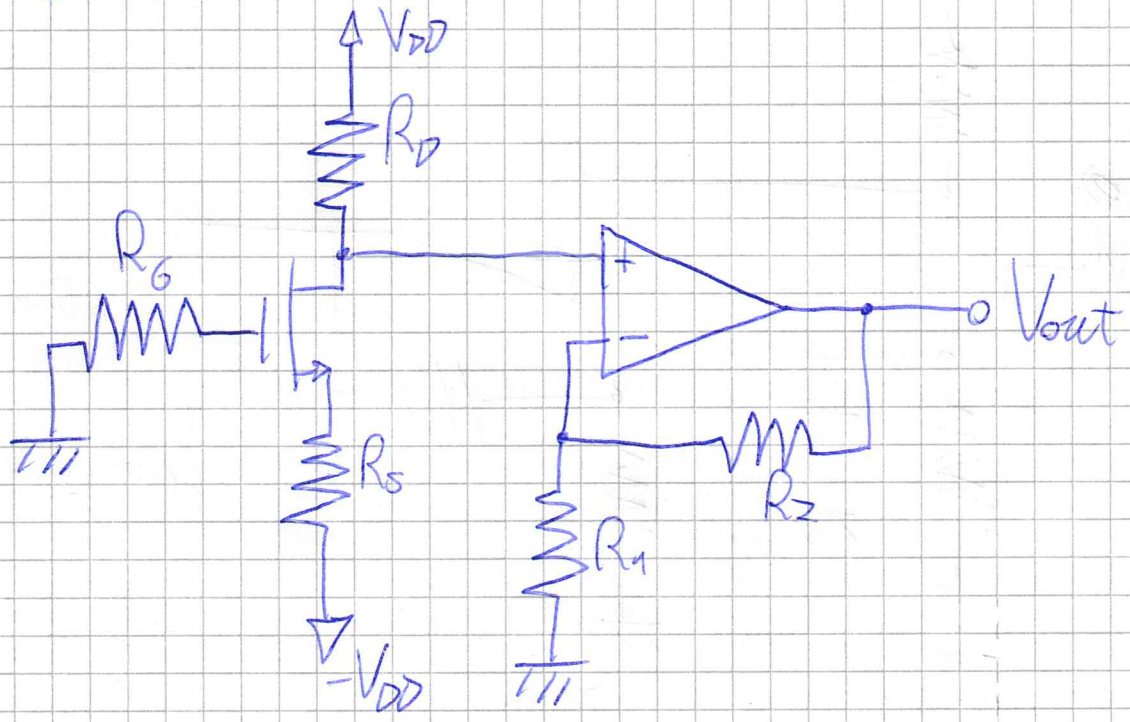
$R_1 = 1K\Omega \quad R_2 = 5K\Omega$

$R_D = ?$

$V_{out} = 0V$

$A_V = \frac{v_{out}}{v_{in}} = ?$

Studio in statica



$$\begin{cases} V_{GS} = V_G - V_S = 0 - i_D R_S + V_{DD} \\ i_D = K(V_{GS} - V_t)^2 \end{cases}$$

$$V_{GS} = V_{DD} - R_S K (V_{GS} - V_t)^2 =$$

$$V_{GS} = 5 - \frac{1}{4}(V_{GS} - 2)^2$$

$$V_{GS} = 5 - \frac{1}{4}(V_{GS}^2 - 4V_{GS} + 4)$$

$$V_{GS} - 5 = -\frac{1}{4}(V_{GS}^2 - 4V_{GS} + 4)$$

$$20 - 4V_{GS} = V_{GS}^2 - 4V_{GS} + 4$$

$V_{GS}^2 - 16 = 0$

$V_{GS} = \pm 4\,V$

$V_{GS} = 4\,V > V_t = 2\,V$

$i_D = \frac{1}{2}(4-2)^2 = 2\,mA$

$V_{DS} = V_{DD} - i_D R_D - i_D R_S + V_{DD} =$

$V_{DS} = 5 - 2R_D - 1 + 5 = 9 - 2R_D \geq V_{GS} - V_t = 4 - 2 = 2$

$V_{DS} = 9 - 2R_D > V_{GS} - V_t = 4 - 2 = 2$

$9 - 2R_D > 2 \qquad -2R_D > -7 \qquad R_D < \frac{7}{2}\,K\Omega$

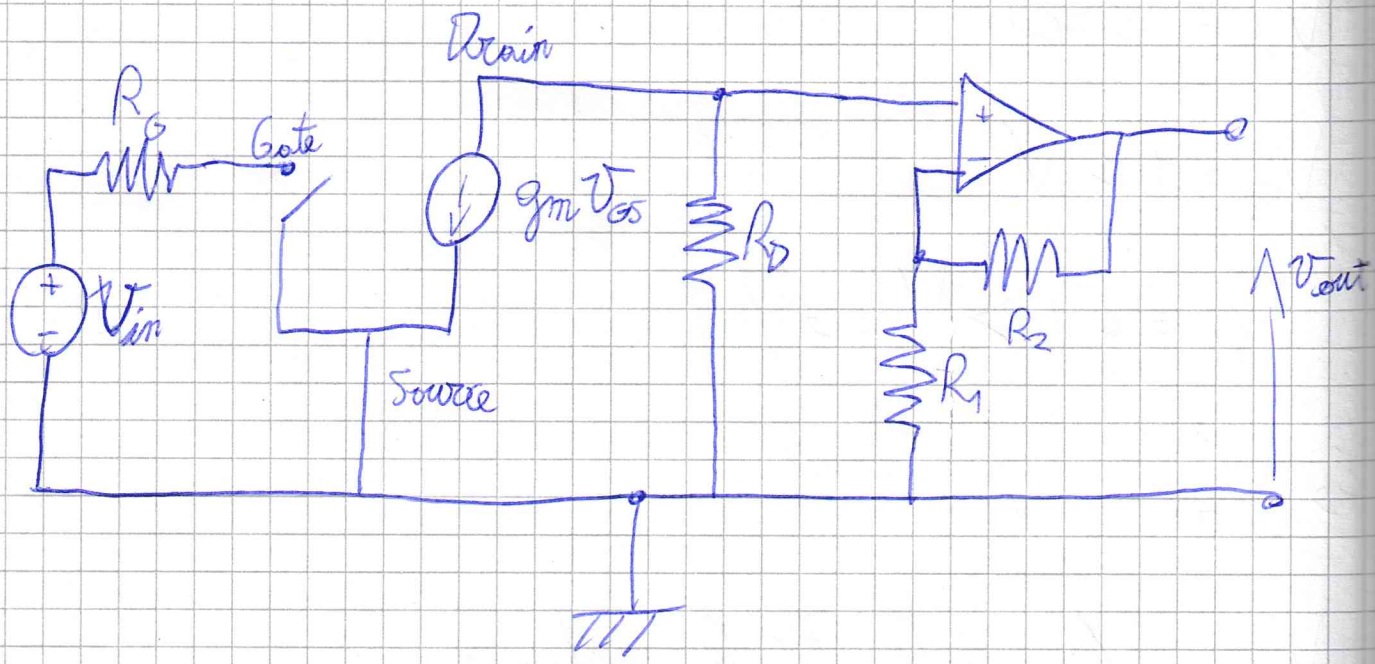
$V^+ = V_D = V_{DD} - i_D R_D = 5 - 2R_D$

$V_{out} = V^+ \left(1 + \frac{R_2}{R_1}\right) = 0$

$(5 - 2R_D)\,6 = 0 \qquad 5 - 2R_D = 0$

$-2R_D = -5 \qquad R_D = \frac{5}{2} = 2{,}5\,K\Omega$

Studio piccoli segnali



$$g_m = 2K(V_{GS} - V_t) = 2$$

$$v_{GS} = v_{in}$$

$$V_D = g_m R_D v_{in} = 2 \cdot 2{,}5\, v_{in} = 5\, v_{in} = V^+$$

$$v_{out} = V^+\left(1 + \frac{R_2}{R_1}\right) = 6V^+ = 30\, v_{in}$$

$$A = \frac{v_{out}}{v_{in}} = 30$$