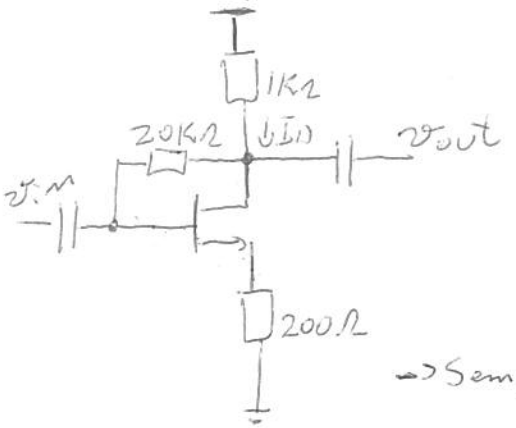
Aula 10 A

⑤



I_G

- $1000 I_D + 20.000 \cdot 0 + 200 I_D + V_{GS} = 1,8$

- $V_{GS} = 1,8 - 1200 I_D$

- $I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 = 1,3889 \cdot (V_{GS} - 0,5)^2$

  $\mu_n C_{ox} = 100.10^{-6}$; $\frac{W}{L} = \frac{5}{0,18}$; $V_{TH} = 0,5$

=> Sempre na saturação

~~$I_D = 1,3889 (V_{GS}^2 - 2 \cdot 0,1$~~

$I_D = 1,3889 \cdot (1,8 - 1200 I_D - 0,5)^2 \Rightarrow I_D = 1,3889 (1,3 - 1200 I_D)^2$

$I_D = 1,3889 \cdot (1,3^2 - 2,6 \cdot 1200 I_D + 1200^2 I_D^2)$

$20,6722 I_D^2 - 4,3347 I_D + 0,0023 = 0$

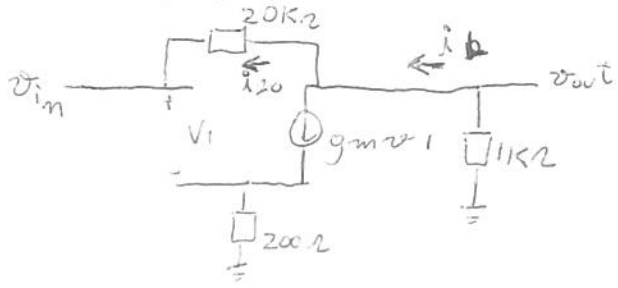
$I_D = \begin{cases} 0,2091 \Rightarrow V_{GS} = -249,17V \ X \\ 0,0005 \Rightarrow \boxed{V_{GS} = 1,1485V \\ I_D = 5,0290.10^{-4} A} \end{cases} \Rightarrow V_{TH} \Rightarrow OK$

- ~~$V_{GS} = V_{GS} + 200 I_D \Rightarrow V_{GS} = V_{TH} + 0,5 I_D$~~

- $g_m = \sqrt{2 I_D \mu_n C_{ox} \frac{W}{L}} \Rightarrow \boxed{g_m = 1,6738 mS}$

  $I_D = 5,4210^{-4}$; $\mu_n C_{ox} = 100.10^{-6}$; $\frac{W}{L} = \frac{5}{0,18}$

* Modelo de pequenos sinais



- $i_L = g_m v_1 + i_{20} \Rightarrow i_L = g_m v_1 + \frac{v_{out} - v_{in}}{20.10^3}$

- $i_L = \frac{v_{out}}{40^3}$

$\frac{v_{out}}{10^3} = g_m v_1 + \frac{v_{out}}{20.10^3} - \frac{v_{in}}{20.10^3}$

$v_{out} = g_m v_1 . 10^3 + \frac{v_{out}}{20} - \frac{v_{in}}{20} \Rightarrow v_{out} \cdot \frac{19}{20} = g_m v_1 . 10^3 - \frac{v_{in}}{20}$

$\Rightarrow \boxed{v_{out} = \frac{20}{19} g_m v_1 . 10^3 - 19 v_{in}}$

$\Rightarrow v_{in} = v_1 + 200 g_m v_1 \Rightarrow v_{in} = v_1 \cdot 1,3348$

$\Rightarrow v_{out} = \frac{20}{19} g_m v_1 . 10^3 - 19 . v_1 \Rightarrow v_{out} = -23,5485 v_1$

$g_m = 1,6738.10^{-3}$; $1,3348$; $-23,5485$

$\Rightarrow A_v = -17,68$

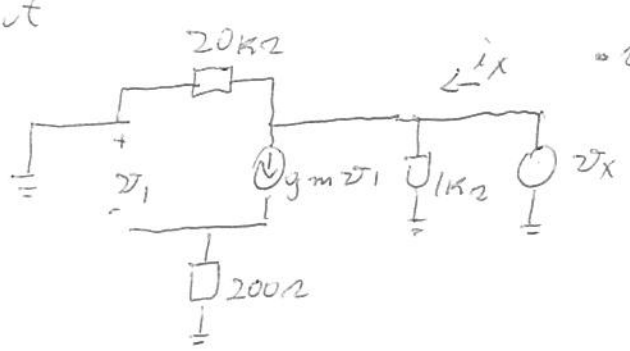
* z_{in}

$v_x = v_{in} = 1,3348 \cdot v_1$

$i_x = -i_{20} = \frac{v_{in} - v_{out}}{20.10^3} = \frac{1,3348 v_1 - (-23,5485 v_1)}{20.10^3} \Rightarrow \boxed{i_x = 9,5074.10^{-4} v_1}$

$z_{in} = \frac{v_x}{i_x} \Rightarrow \boxed{z_{in} = 1,4039.10^3 \Omega}$

* z_{out}



$\cdot v_1 = 0 \Rightarrow g_m v_1 = 0$

$\Rightarrow z_{out} = 20 // 1 \Rightarrow \boxed{z_{out} = 0,9524 k\Omega}$

* Saturação

$\cdot V_{DS} = V_{DD} - 1000 I_D - 200 I_D \Rightarrow \boxed{V_{DS} = 1,1944 V}$ ($I_D \rightarrow 5042.10^{-7}$, $1,8$)

$\cdot v_{ds} = v_{out} - 200 i_d = A_v v_{in} - 200 g_m v_1 \Rightarrow v_{ds} = -17,68 v_{in} - 0,3348 v_1$

$v_1 = \frac{v_{in}}{1,3348}$

$\boxed{v_{ds} = -17,93 v_{in}}$

$\cdot \boxed{V_{GS} = 1,1485 V}$

$\cdot v_{gs} = v_1 = \frac{v_{in}}{1,3348} \Rightarrow \boxed{v_{gs} = 0,7492 v_{in}}$

$\Rightarrow V_{ds} > V_{gs} - V_{TH} \Rightarrow V_{DS} + v_{ds} > V_{GS} + v_{gs} - V_{TH} \Rightarrow 1,1944 - 17,93 v_{in} > 1,1485 + 0,742 v_{in} - 0,5$

$\boxed{v_{in} < 0,0292 V}$

* Corte

1) $V_{gs} > V_{TH} \Rightarrow V_{GS} + v_{gs} > 0,5 \Rightarrow \boxed{v_{in} > -0,8656}$

($V_{GS} \rightarrow 1,1485$, $v_{gs} \rightarrow 0,7492 v_{in}$)

2-) $V_{ds} > V_{DD} \Rightarrow 1,1944 - 17,93 v_{in} > 0,8 \Rightarrow \boxed{v_{in} > -0,0342}$

($V_{DS} \rightarrow 1,1944$, $v_{ds} \rightarrow -17,93 v_{in}$)

$\therefore \boxed{-0,0342 < v_{in} < 0,0292 V}$