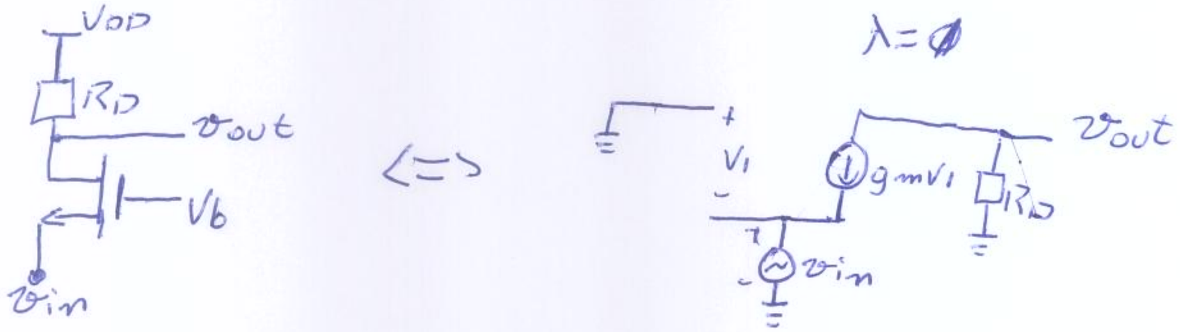
Aula 10B

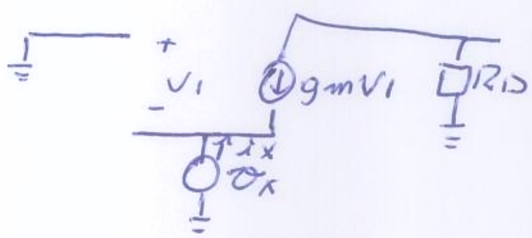
* Porta Comum



$v_{in} = -v_1$

$v_{out} = -g_m v_1 R_D$ $\Rightarrow A_v = \frac{v_{in}}{v_{out}} \Rightarrow \boxed{A_v = g_m R_D}$

• R_{in}

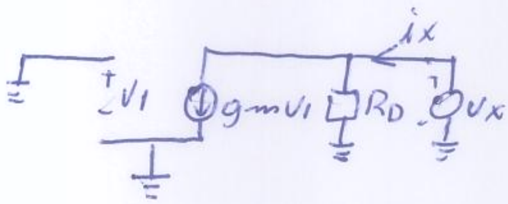


$v_x = -v_1$

$i_x = g_m v_1$

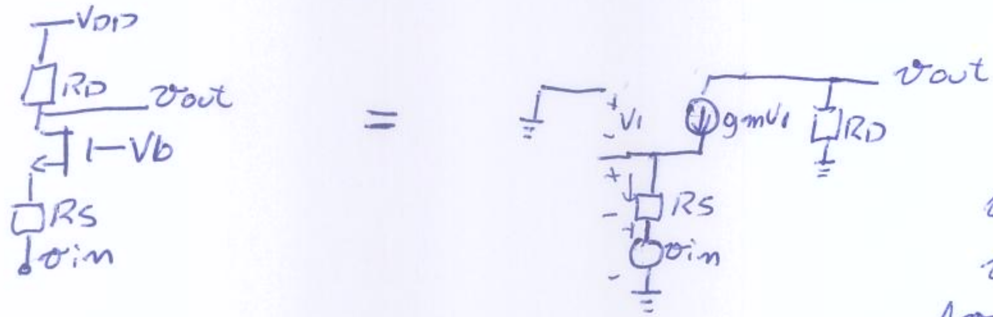
$R_{in} = \frac{v_x}{i_x} \Rightarrow \boxed{R_{in} = \frac{1}{g_m}}$

• R_{out}



$V_1 = \emptyset \Rightarrow g_m V_1 = \emptyset \Rightarrow \boxed{R_{out} = R_D}$

* Porta Comum com resistência de Fonte ($\lambda = \emptyset$)



$v_{out} = -g_m R_D v_1$

$v_{in} = v_{RS} - v_1$

$v_{in} = -g_m v_1 . R_S - v_1$

$v_{in} = -v_1(1 + g_m R_S)$

$A_v = \frac{g_m R_D}{1 + g_m R_S} \Rightarrow \boxed{A_v = \frac{R_D}{\frac{1}{g_m} + R_S}}$

• R_{in}

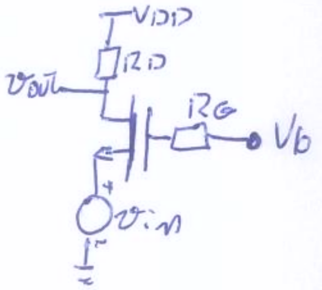
$v_x = -v_1(1 + g_m R_S)$

$i_x = -g_m v_1$ $\Rightarrow R_{in} = \frac{1 + g_m R_S}{g_m} \Rightarrow \boxed{R_{in} = \frac{1}{g_m} + R_S}$

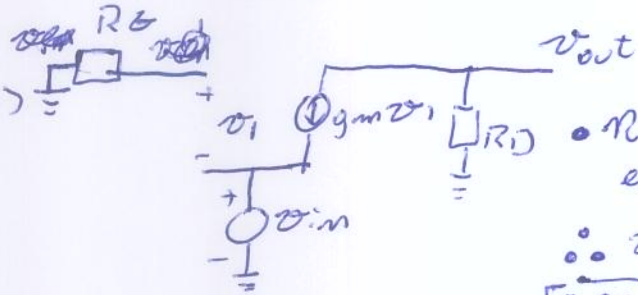
• R_{out}

$V_1 = \emptyset \Rightarrow g_m V_1 = 0 \Rightarrow \boxed{R_{out} = R_D}$

* Porta comum com resistência de gate (R_G)



$\Rightarrow$

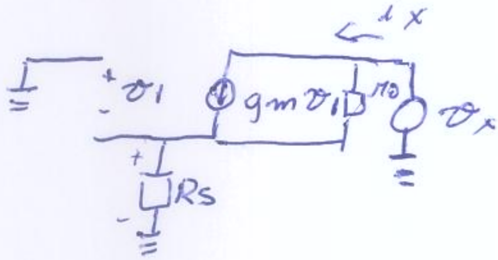


- Não passa corrente em RG

$\therefore$ o ganho e as impedâncias são os mesmos

* Impedância de saída ($\lambda \neq 0$)

$\Rightarrow$



$$v_{RS} = -v_1 \Rightarrow R_S i_x = -v_1 \Rightarrow \boxed{i_x = -\frac{v_1}{R_S}}$$

$$v_x = v_{RS} + v_{ro} \Rightarrow v_x = R_S i_x + r_o(i_x - g_m v_1)$$

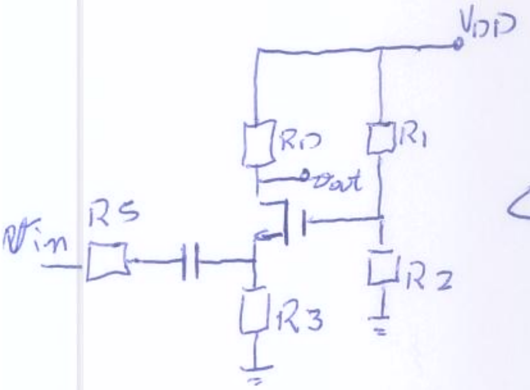
$$v_x = -R_S \frac{v_1}{R_S} + r_o\left(-\frac{v_1}{R_S}\right) - r_o g_m v_1$$

$$v_x = -v_1\left(1 + \frac{r_o}{R_S} + r_o g_m\right)$$

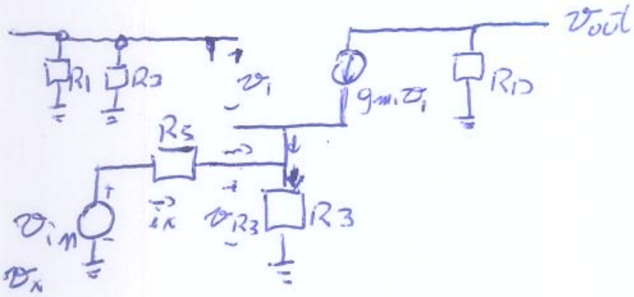
$$\frac{v_x}{i_x} = \frac{-v_1\left(1 + \frac{r_o}{R_S} + r_o g_m\right)}{-\frac{v_1}{R_S}} \Rightarrow R_{out} = R_S + r_o + R_S r_o g_m$$

$$\boxed{R_{out} = R_S(1 + r_o g_m) + r_o}$$

* Estágio Porta Comum com Polarização



$\Leftrightarrow$



- $v_{out} = -g_{m1} v_1 R_D$
- $v_{R3} = -v_1$
- $v_{in} = v_{RS} + v_{R3} = v_{RS} - v_1 = R_S i_S - v_1$

$v_{in} = R_S \cdot \left(\frac{v_{R3}}{R_3} - g_m v_1 \right) - v_1 = R_S \cdot \left(\frac{-v_1}{R_3} - g_m v_1 \right) - v_1$

$v_{in} = -\frac{R_S v_1}{R_3} - g_m R_S v_1 - v_1 \Rightarrow v_{in} = -v_1 \left(+\frac{R_S}{R_3} + g_m R_S + 1 \right)$

- $A_v = \frac{v_{out}}{v_{in}} = \frac{g_{m1} R_D}{R_S \cdot \left(\frac{1}{R_3} + g_m \right) + 1} = \frac{g_m R_D}{R_S \cdot \left(R_3 // \frac{1}{g_m} \right)^{-1} + 1} \cdot \frac{R_3 // 1/g_m}{R_3 // 1/g_m}$

$$\boxed{A_v = \frac{R_3 // 1/g_m}{R_S + R_3 // 1/g_m} \, g_m R_D}$$

- R_{in}

$v_x = -v_1 \left(\frac{R_S}{R_3} + g_m R_S + 1 \right)$

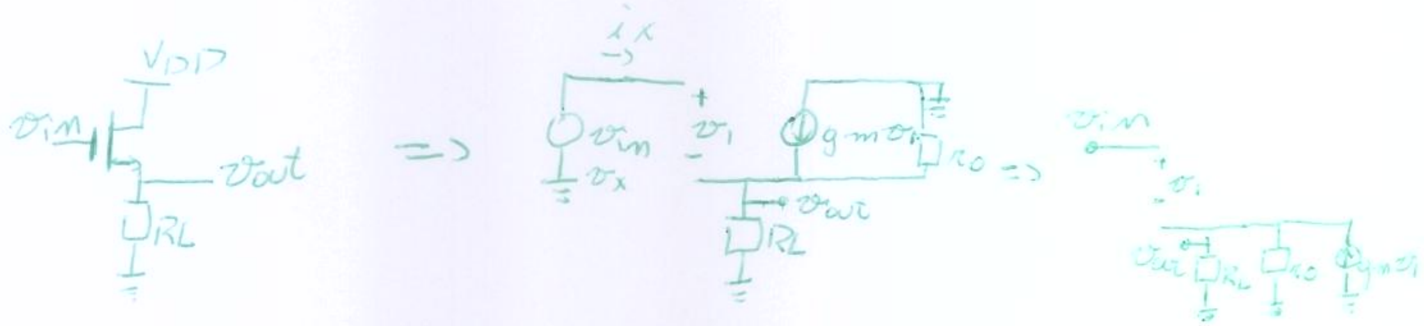
$i_x = \frac{v_{R3}}{R_3} - g_m v_1 = \frac{-v_1}{R_3} - g_m v_1 \Rightarrow i_x = -v_1 \left(\frac{1}{R_3} + g_m \right)$

- $R_{in} = \frac{v_x}{i_x} = \frac{\frac{R_S}{R_3} + g_m R_S + 1}{\frac{1}{R_3} + g_m} = \frac{R_S \cdot \left(\frac{1}{R_3} + g_m \right) + 1}{\left(\frac{1}{R_3} + g_m \right)} \cdot \frac{\left(\frac{1}{R_3} + g_m \right)^{-1}}{\left(\frac{1}{R_3} + g_m \right)^{-1}}$ (where $\left(\frac{1}{R_3} + g_m \right)^{-1} = R_3 // 1/g_m$)

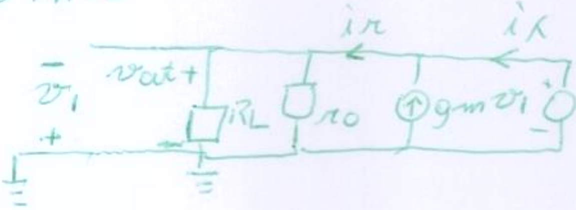
$$\boxed{R_{in} = R_S + R_3 // 1/g_m}$$

- $R_{out} \Rightarrow v_{in} = \emptyset \Rightarrow v_1 = \emptyset \Rightarrow g_m v_1 = \emptyset \Rightarrow \boxed{R_{out} = R_D}$

Seguidor de Fonte (Dreno Comum)



- $v_{out} = g_m v_1 \cdot r_o // R_L$
- $v_{in} = v_1 + v_{out} \Rightarrow v_{in} = v_1 + g_m v_1 \cdot r_o // R_L \Rightarrow \boxed{v_{in} = v_1 (1 + g_m r_o // R_L)}$
- $A_v = \dfrac{v_{out}}{v_{in}} = \dfrac{g_m \cdot r_o // R_L \;\div g_m}{1 + g_m r_o // R_L \;\div g_m} \Rightarrow \boxed{A_v = \dfrac{r_o // R_L}{\frac{1}{g_m} + r_o // R_L}} < 1$
- $R_{in} = \dfrac{v_x}{0} \Rightarrow \boxed{R_{in} = \infty}$
- $v_{in} = 0$



$v_1 = -v_x \Rightarrow v_x = -v_1$

$i_x = i_r - g_m v_1$

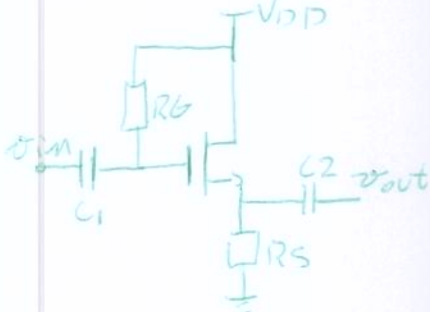
$i_x = i_r + g_m v_x$

$i_x = \dfrac{v_x}{R_L // r_o} + g_m v_x \Rightarrow i_x = v_x \left(\dfrac{1}{R_L // r_o} + g_m \right)$

$\dfrac{v_x}{i_x} = \left(\dfrac{1}{R_L // r_o} + g_m \right)^{-1} \Rightarrow \boxed{R_{out} = R_L // r_o // \frac{1}{g_m}}$

- obs: Se colocarmos RG, o ganho não muda, pois $i_g = 0$
  - $R_{in} = \infty$ e Rout baixo e $A_v \sim 1 \Rightarrow$ Buffer

* Seguidor de Fonte com Polarização

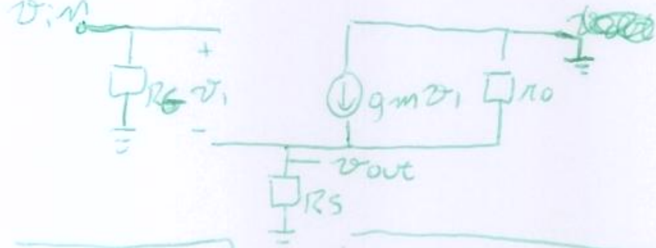


- $I_G = \phi \Rightarrow V_{GS} = V_{DS}$

$$\begin{cases} V_{GS} = V_{DD} - R_S I_D \\ I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 (1 + \lambda \underbrace{V_{DS}}_{V_{GS}}) \end{cases}$$

$$\boxed{I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} \cdot (V_{DD} - R_S I_D - V_{TH})^2 \cdot [1 + \lambda \cdot (V_{DD} - R_S I_D)]}$$

resolver



- $v_{out} = g_m v_1 \cdot r_o // R_L$
- $v_{in} = v_1 + v_{out} = v_1 (1 + g_m r_o // R_L)$
- $\boxed{A_v = \frac{r_o // R_L}{\frac{1}{g_m} + r_o // R_L}}$

↳ idêntico ao anterior

$\boxed{R_{in} = R_G}$

↳ diferente do anterior

$\boxed{R_{out} = R_S // r_o // \frac{1}{g_m}}$ → idêntico ao anterior

⇒ ~~[illegible]~~