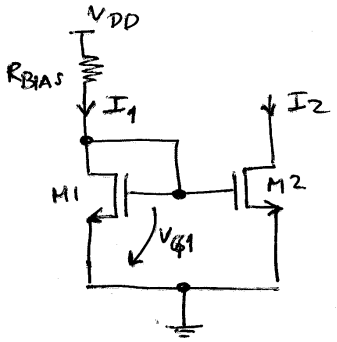
ELECTRÓNICA 1 – AULA 7

TRANSISTORES MOS – BLOCOS BÁSICOS PARA DESENHO DE CIRCUITOS INTEGRADOS

O ESPELHO DE CORRENTE



em saturação

$$I_1 = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_1 (V_{GS1} - V_T)(1 + \lambda V_{DS1})$$

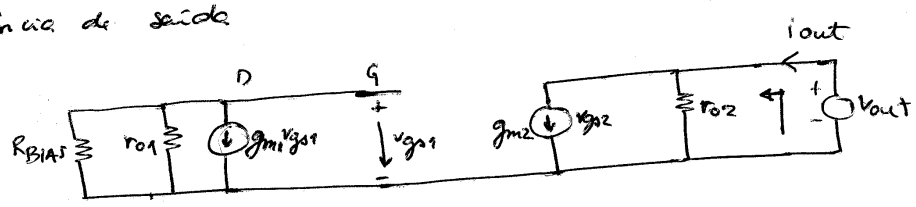
$$I_2 = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_2 (V_{GS2} - V_T)(1 + \lambda V_{DS2})$$

mas $V_{GS1} = V_{GS2}$

logo

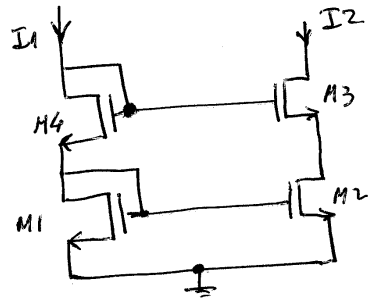
$$\frac{I_2}{I_1} = \frac{(W/L)_2}{(W/L)_1}\,\frac{1 + \lambda V_{DS2}}{1 + \lambda V_{DS1}} \;//$$

resistência de saída



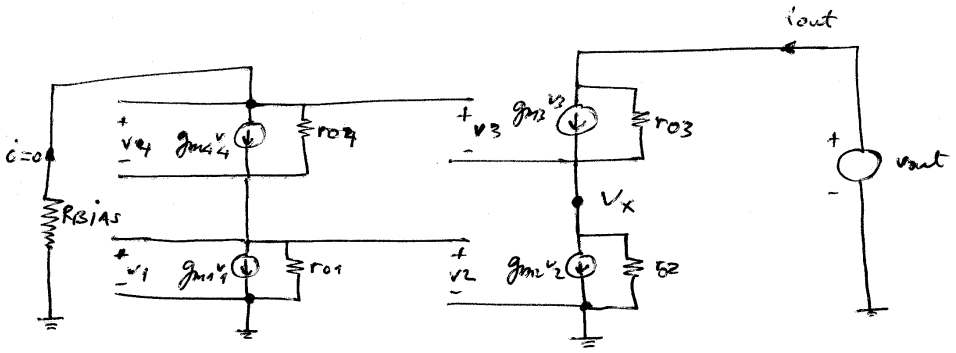
$$r_{out} = \frac{v_{out}}{i_{out}} = r_{o2} \;// \quad \text{com} \quad r_{o2} = \frac{1}{\lambda I_2}$$

O espelho de corrente em cascata



$$\frac{I_2}{I_1} = \frac{(W/L)_2}{(W/L)_1}\,\frac{1 + \lambda V_{DS}}{1 + \lambda V_{DS1}}$$

resistência de saída



$$r_{out} = \frac{v_{out}}{i_{out}}$$

mas $v_2 = 0$ e $v_3 = -v_x$

logo $$v_{out} = r_{o3}(i_{out} + g_{m3} v_x) + r_{o2} i_{out}$$

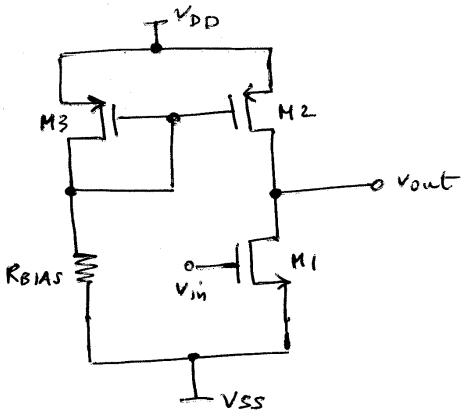
mas $$v_x = r_{o2} i_{out}$$

logo $$v_{out} = r_{o3}(i_{out} + g_{m3} r_{o2} i_{out}) + r_{o2} i_{out}$$

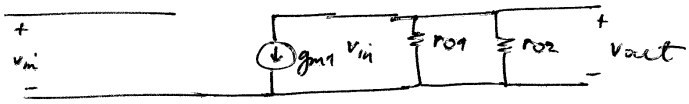
logo $$r_{out} = r_{o2} + r_{o3} + g_{m3} r_{o3} r_{o2}$$

$$\simeq g_{m3} r_{o3} r_{o2} \;//$$

Configuração de fonte comum em circuito integrado



modelo de pequeno sinal

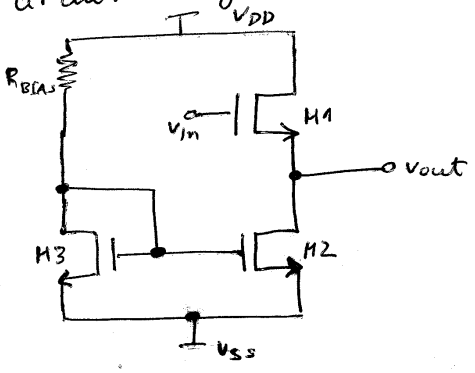


logo

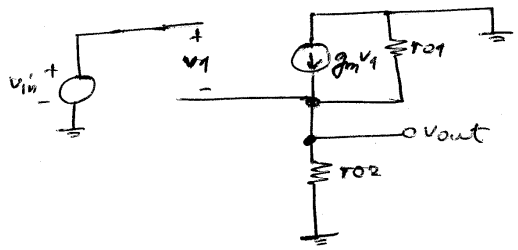
$$A_v = \frac{v_{out}}{v_{in}} = g_{m1}\,(r_{o1} \,//\, r_{o2})$$

com $r_{o1} = \dfrac{1}{\lambda_1 I_1}$ e $r_{o2} = \dfrac{1}{\lambda_2 I_2}$

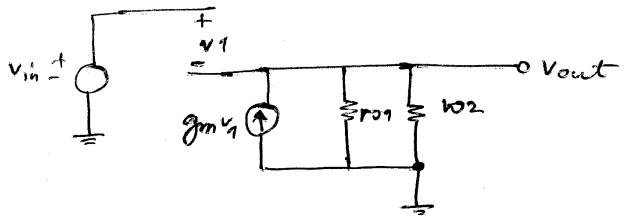
Configuração de dreno comum (source follower) em circuito integrado



Modelo de pequeno sinal



circuito equivalente



$v_1 = (v_{in} - v_{out})$

logo

$$v_{out} = g_m (v_{in} - v_{out}) (r_{o1} \parallel r_{o2})$$

$$[1 + g_m (r_{o1} \parallel r_{o2})] \, v_{out} = g_m (r_{o1} \parallel r_{o2}) \, v_{in}$$

logo $$A_V = \frac{g_m (r_{o1} \parallel r_{o2})}{1 + g_m (r_{o1} \parallel r_{o2})} \simeq 1$$