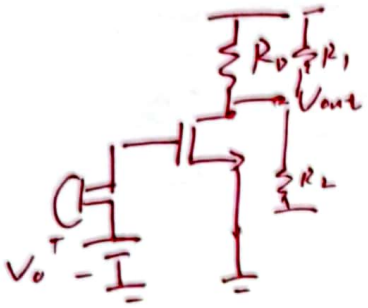
Simplifications



$\lambda = 0$.

$A_v = -g_m$ (total resistance tied from drain to ac ground)

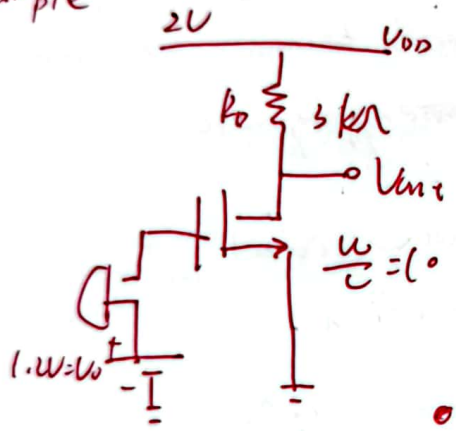
这里的电阻在小信号情况下看，V_{DD}和GND都为GND.

∴ for example $A_v = -g_m (R_D \parallel R_1 \parallel R_L)$

common source ⇒ $V_{in}: V_{GS}$

$V_{out}: V_{DS}$

Example



First assume that it's in sat zone

⇒ caculate out and check the zone.

if we want to double the gain.

- Try doubly R_D? [R_D↑ V_{DS}↓ not in sat

(Cue always want an amplifier working in sat).

(sat means larger to 0, larger A_v (in ac)

but in dc, larger to ~~means it may~~ MOS may out of sat.]

- Try increase] $g_m = \sqrt{2\mu_n C_{ox} \frac{W}{L} I_D}$ ↗I_D? 跟上面结果一样] to

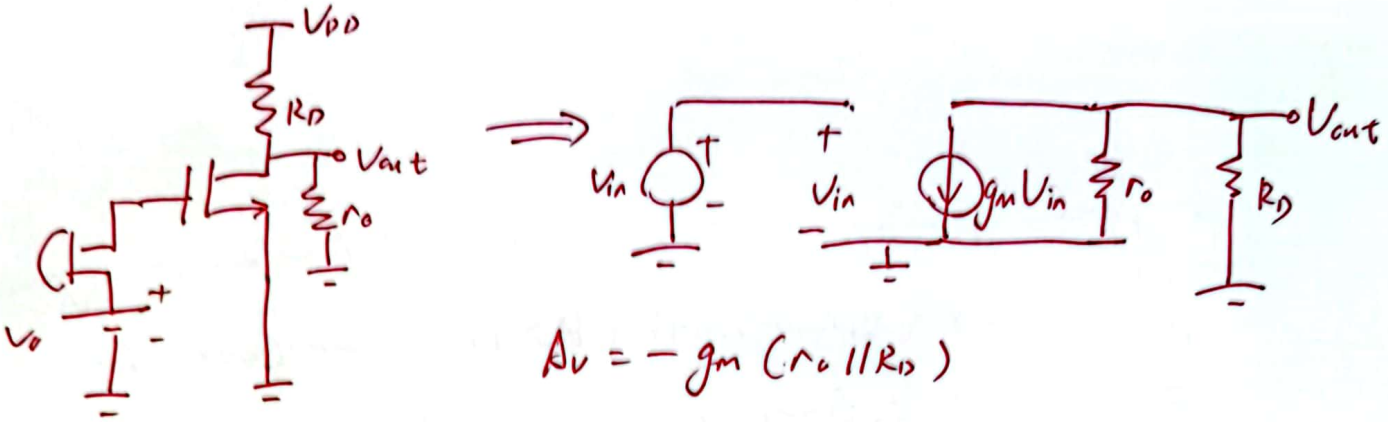
we want the lower biasoff but higher swing of

↘ $\frac{W}{L}$↑?

if $\frac{W}{L}$ becomes sufficiently large,

$g_m \doteq \frac{I_D}{1.5 V_T}$ → $V_T = 26mV = \frac{kT}{q}$

Inclusion of Channel-Length Mod.

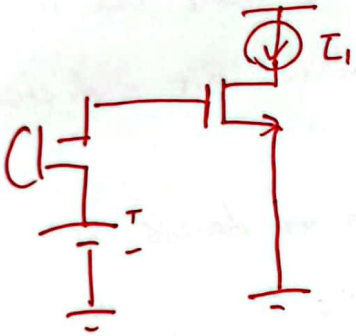


$$A_V = -g_m (r_o \| R_D)$$

We want the largest A_V. means the largest R_D.

but the circuit cannot be open, because we need bias.

So. a current source is ~~appropriate~~ appropriate.



I_1 is const & ideal.

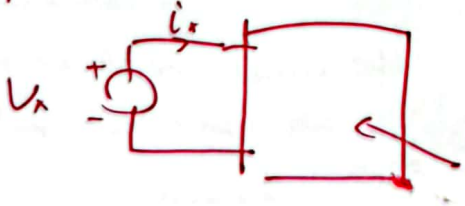
Saturation

Now $A_V = -g_m r_o$. intrinsic gain of Mo

usually = 5~10.

Concept of Port Impedance

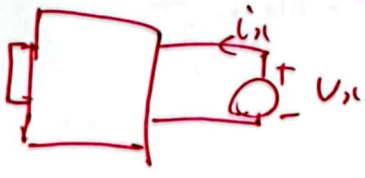
Input Independance



set all ~~or~~ indepent sources to zero.

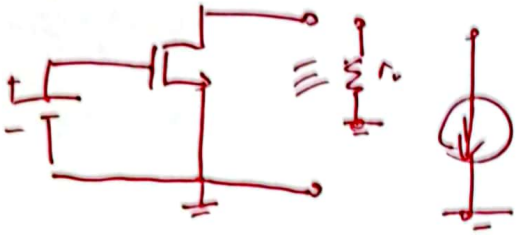
$$R_{in} = \frac{V_x}{i_x}$$

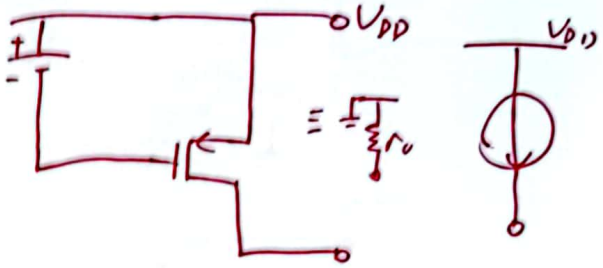
out put ~~impedance~~ impedance



输入和输出.

Let's build a current source:

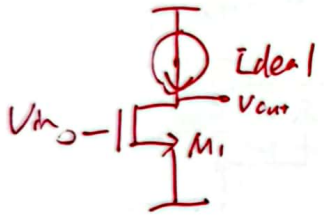




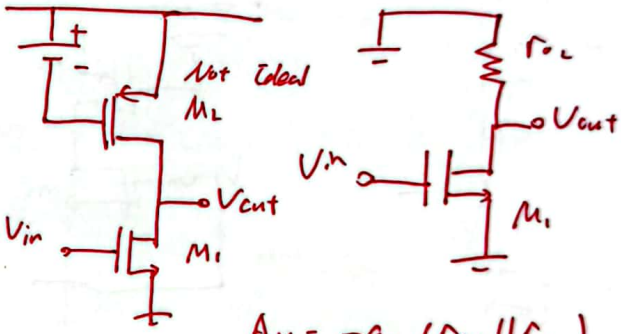
if a Mos is working as a current source, we can refer it as a r_o. ($\lambda > 0$)

$\lambda = 0 \Rightarrow$ open.

Common-Source Stage with Current-Source Load

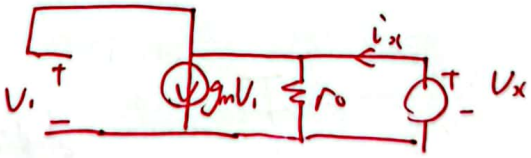


$\Rightarrow A_v = -g_m r_o$



$A_v = -g_{m1}(r_{o1} \| r_{o2})$

Diode-Connected Device

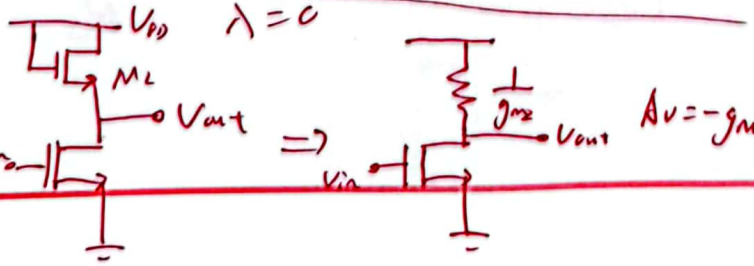


$G \leftrightarrow D$

$$\begin{cases} V_1 = V_x \\ i_x = \frac{V_x}{r_o} + g_m V_1 \end{cases} \Rightarrow \frac{V_x}{i_x} = r_o \| \frac{1}{g_m}$$

通常 $\frac{1}{g_m} \ll r_o$

$$\Rightarrow \approx \frac{1}{g_m}$$



$\lambda = 0$

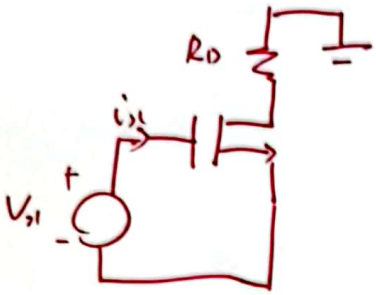
$\Rightarrow$

$A_v = -g_{m1} \frac{1}{g_{m2}}$

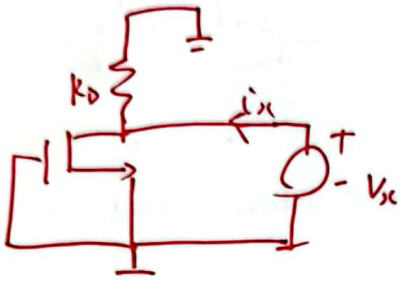
Common-Source Stage with Diode-Connected Load

Input and Output Impedances.

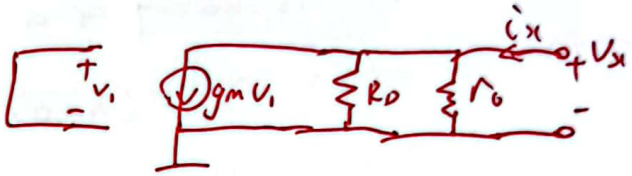
电阻公式



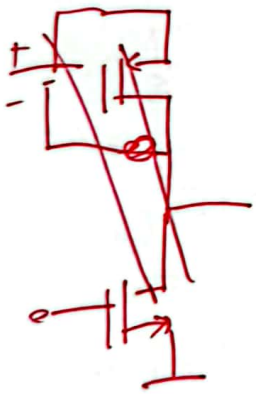
input imp. $= \frac{V_x}{i_x} = \infty$ (at low frequencies)

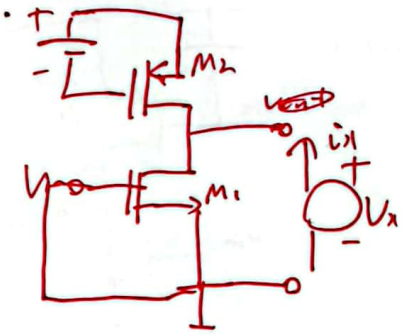


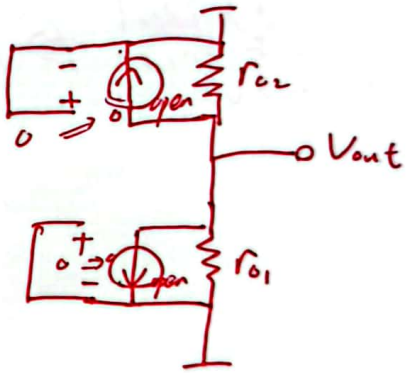
output imp. $= \frac{V_x}{i_x} = R_D \parallel r_o$



电流源公式

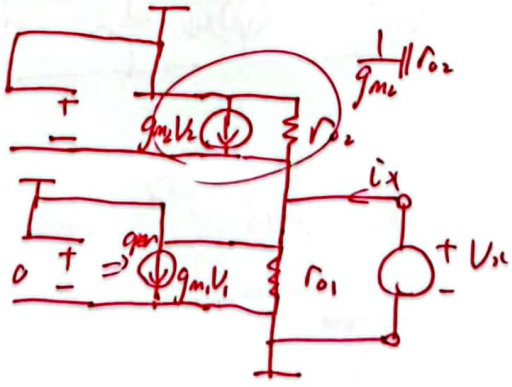






$\frac{V_x}{i_x} = r_{o2} \parallel r_{o1}$

二极管公式



$\frac{V_x}{i_x} = \left(\frac{1}{g_{m2}} \parallel r_{o2} \parallel r_{o1}\right)$

之与.