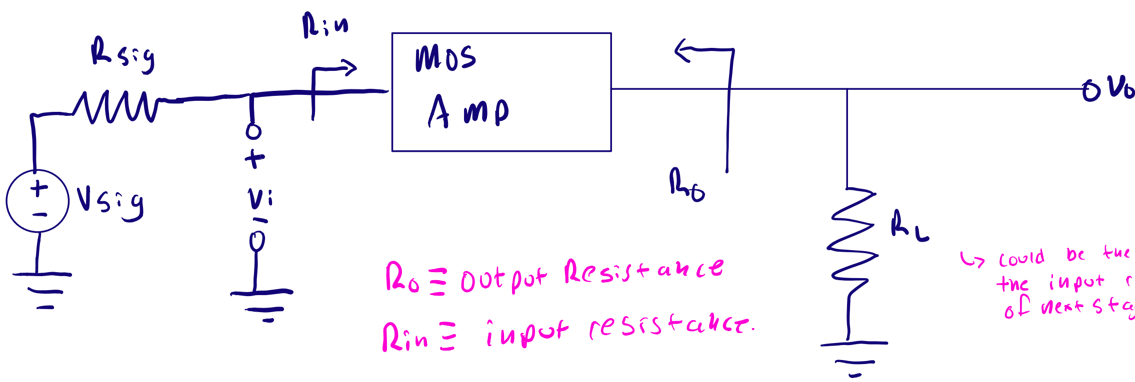
3 MOS Amp Configurations.

Common Source - most popular. Good gain

Common Gate - gate grounded v_i @ Source

Common drain - voltage follower V_i @ gate

Unilateral = R_L does not affect R_{in} → no internal feedback



↳ could be the load on the input resistance of next stage.

$R_o \equiv$ Output Resistance

$R_{in} \equiv$ input resistance.

$$R_{in} = \frac{V_i}{i_i} \qquad V_i = \frac{R_{in}}{R_{in} + R_{sig}} \cdot V_{sig}$$

$A_{vo} \equiv$ open circuit voltage gain $(R_L \to \infty)$

$$A_{vo} = \left.\frac{V_o}{V_i}\right|_{R_L \to \infty}$$

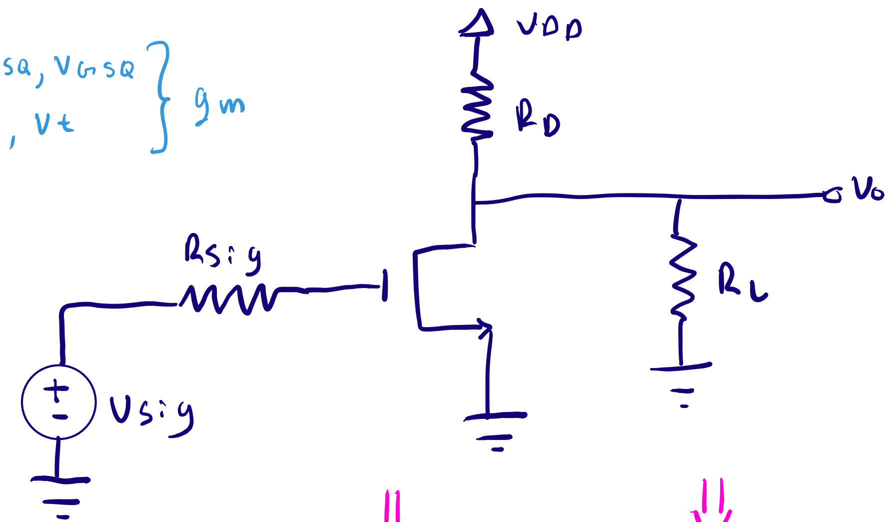
$R_o \equiv$ Look into the output of the transistor w/ $V_i = 0$

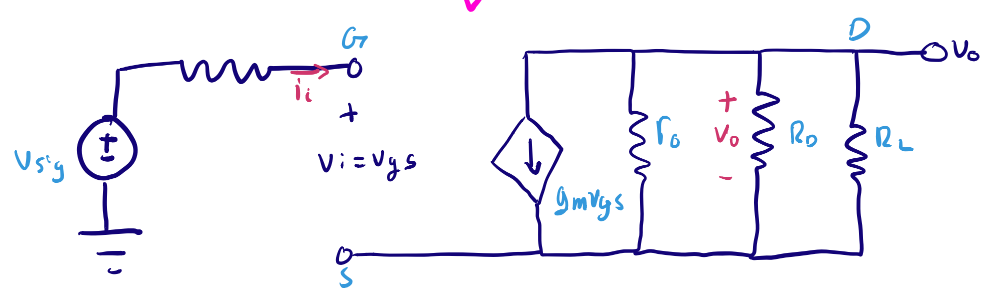
$A_v \equiv$ Voltage gain of the amplifier proper.

$A_v = \frac{V_o}{V_i}$ w/ R_L included.

$G_v \equiv$ Closed (overall voltage gain) $= \frac{V_o}{V_{sig}}$

$\left.\begin{array}{l} I_{DQ}, V_{DSQ}, V_{GSQ} \\ k'_n, \frac{W}{L}, V_t \end{array}\right\} g_m$





$R_{in} \Rightarrow \quad i_i = 0 \qquad R_{in} = \frac{V_i}{0} = \infty$

$R_o \Rightarrow \quad V_i = 0 \qquad R_o = R_D \| r_o$ usually $r_o \gg R_D \Rightarrow R_o \cong$

$A_{vo} = \left.\frac{V_o}{V_i}\right|_{R_L \to \infty} \Rightarrow \quad V_o = -g_m v_{gs} (r_o \| R_D)$

$V_o = -g_m (V_i) (r_o \| R_D)$

$g_m = k'_n \frac{W}{L} (V_{GSQ} - V_t) \qquad \frac{V_o}{V_i} = -g_m (r_o \| R_D)$

$A_v = \frac{V_o}{V_i} = -g_m (r_o \| R_D \| R_L)$

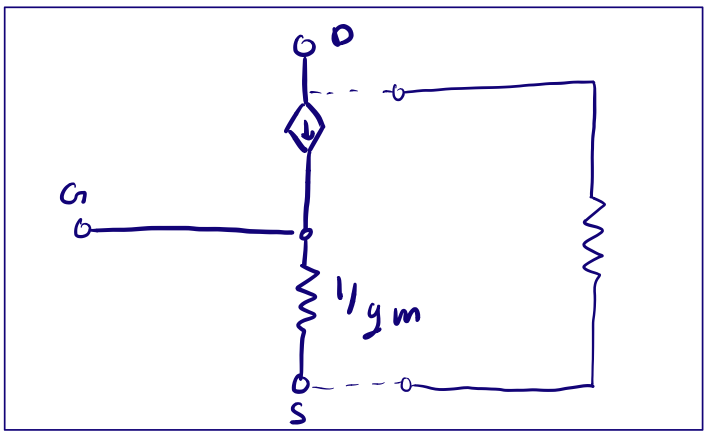
$$G_v = \frac{v_o}{v_{sig}} \Rightarrow v_i = v_{sig}$$

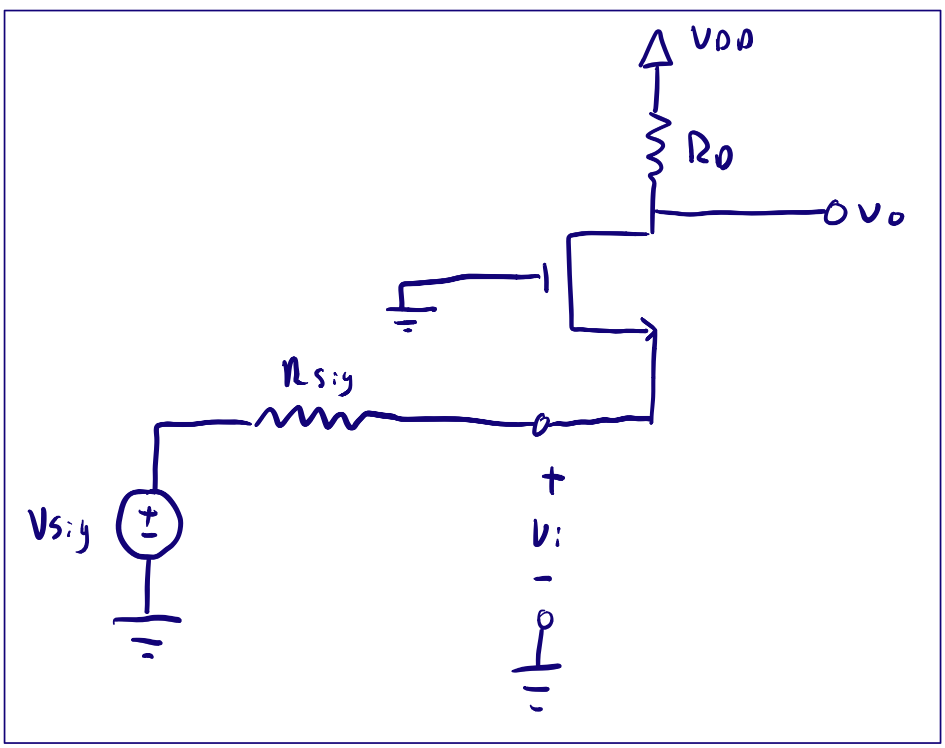
$$G_v = \frac{v_D}{v_{sig}} = -g_m (r_o \| R_D \| R_L)$$

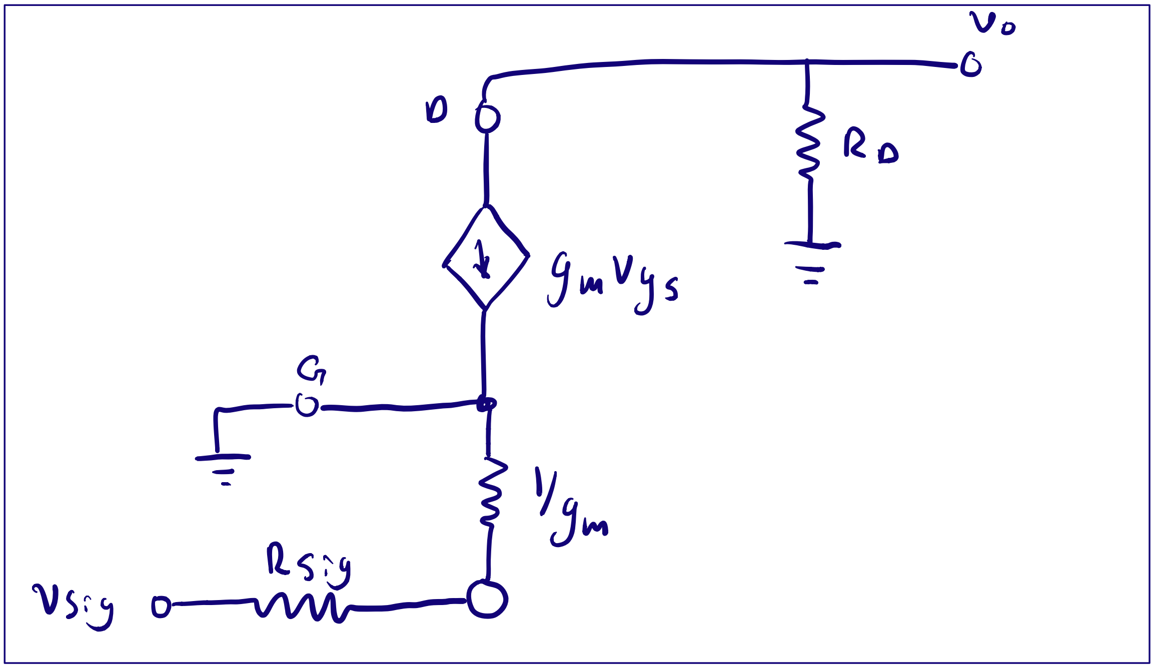
Common Gate Amplifier

→ not common unless at high frequencies.

↳ using the T model ⇒ small signal

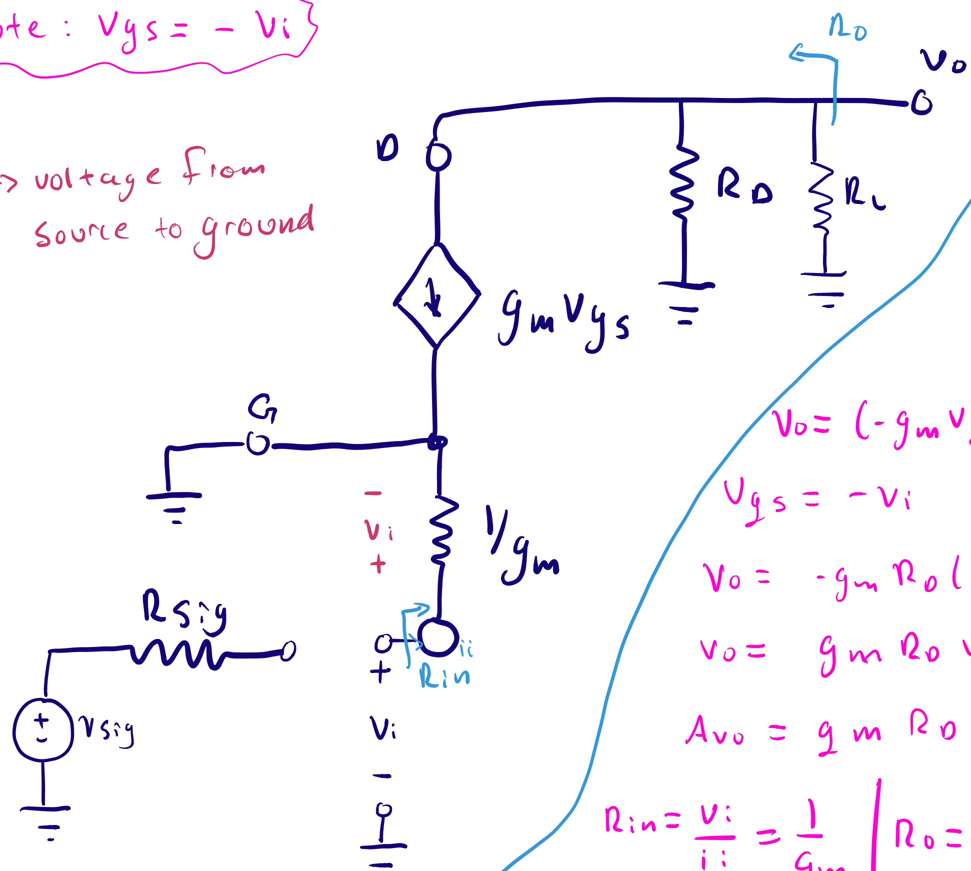






Note : $V_{gs} = -V_i$

$V_i \rightarrow$ voltage from source to ground



$V_o = (-g_m V_{gs}) R_D$

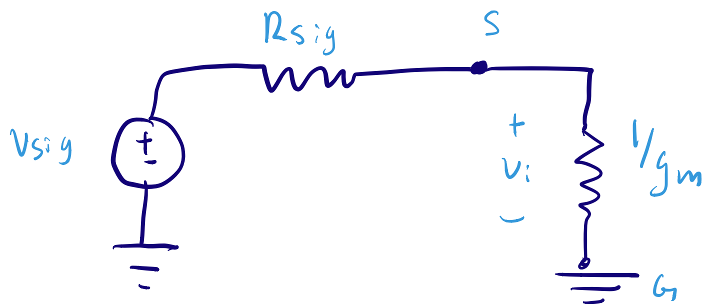
$V_{gs} = -V_i$

$V_o = -g_m R_D (-V_i)$

$V_o = g_m R_D V_i$

$A_{vo} = g_m R_D$

$R_{in} = \frac{V_i}{i_i} = \frac{1}{g_m}$ | $R_o = R_D$



$$v_i = v_{sig}\left(\frac{1/g_m}{R_{sig} + 1/g_m}\right)$$

$$A_v = \frac{v_o}{v_i} = g_m(R_D \| R_L)$$

$$G_v = \frac{v_o}{v_i} \cdot \frac{v_i}{v_{sig}} = g_m(R_D \| R_L) \cdot \left(\frac{1/g_m}{R_{sig} + 1/g_m}\right)$$

$$\boxed{G_v = \frac{R_D \| R_L}{R_{sig} + 1/g_m}} \Rightarrow g_m = k'_n \frac{W}{L}(V_{GSQ} - V_t)$$

will result in smaller gain if $\left\{ \begin{array}{l} g_m \Rightarrow \text{small} \\ R_D \Rightarrow \text{small..} \end{array} \right.$

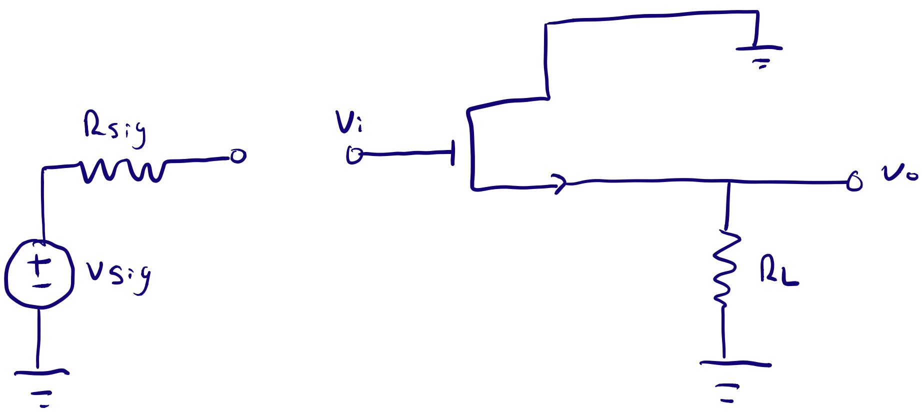
$R_{in} = 1/g_m \Rightarrow$ large

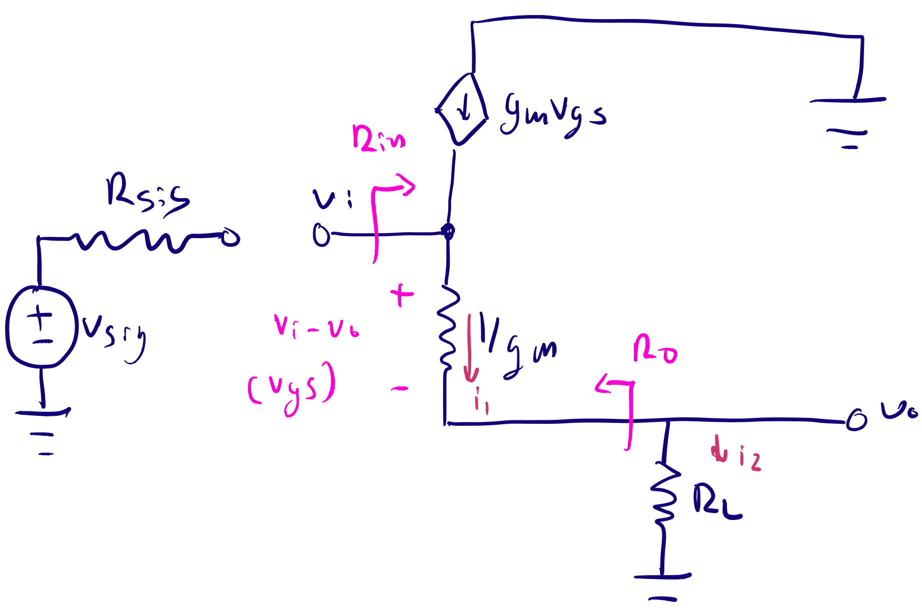
$R_o = R_D \Rightarrow$ small

Common Drain Amplifier

Source Follower.

Transistor eq. of voltage follower. Non inverting config to not lose any power.





$R_{in} = \infty$

$R_o = 1/g_m$

$A_v = \dfrac{v_o}{v_i}$

$i_1 = \dfrac{v_i - v_o}{1/g_m}$ $\quad i_2 = \dfrac{v_o}{R_L}$

$i_2 = i_1$

$\dfrac{v_i - v_o}{1/g_m} = \dfrac{v_o}{R_L}$ $\quad v_o\left(\dfrac{1}{R_L} + \dfrac{1}{1/g_m}\right) = \dfrac{v_i}{1/g_m}$

$\dfrac{v_o}{v_i} = \dfrac{R_L}{R_L + 1/g_m}$

For $R_L \to \infty$ $\quad A_{vo} = \dfrac{v_o}{v_i}\Big|_{R_L \to \infty} = 1$

$A_v = \dfrac{v_o}{v_i} = \dfrac{R_L}{R_L + 1/g_m}$

$G_v = \dfrac{v_o}{v_{sig}} = \dfrac{R_L}{R_L + 1/g_m}$

$R_{in} = \infty$

$R_o = 1/g_m$

high G_m for small R_o

$R_L >> 1/g_m \Rightarrow G_v \cong 1$