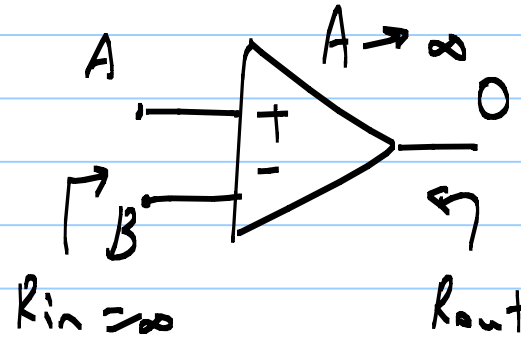
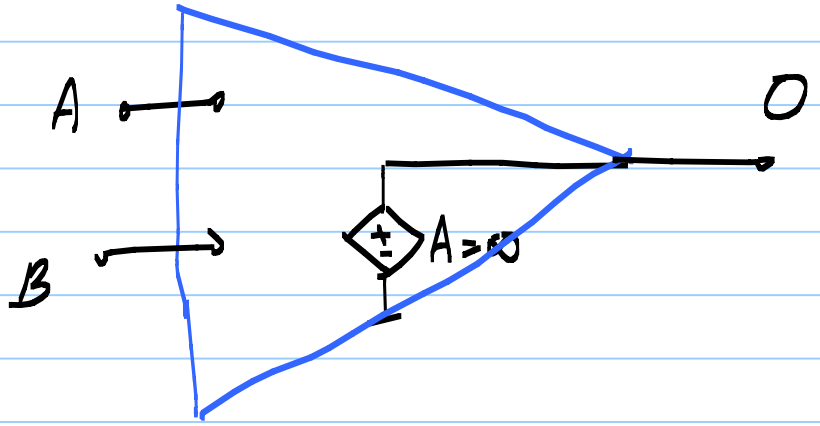
8/9/20

Lecture 20

Negative f.b. to create small signal controlled sources

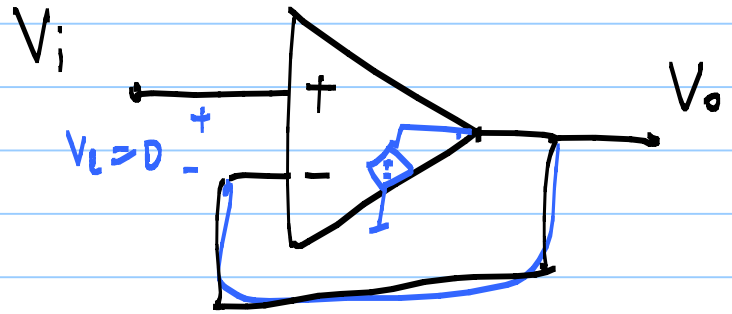
VCVS using opamp





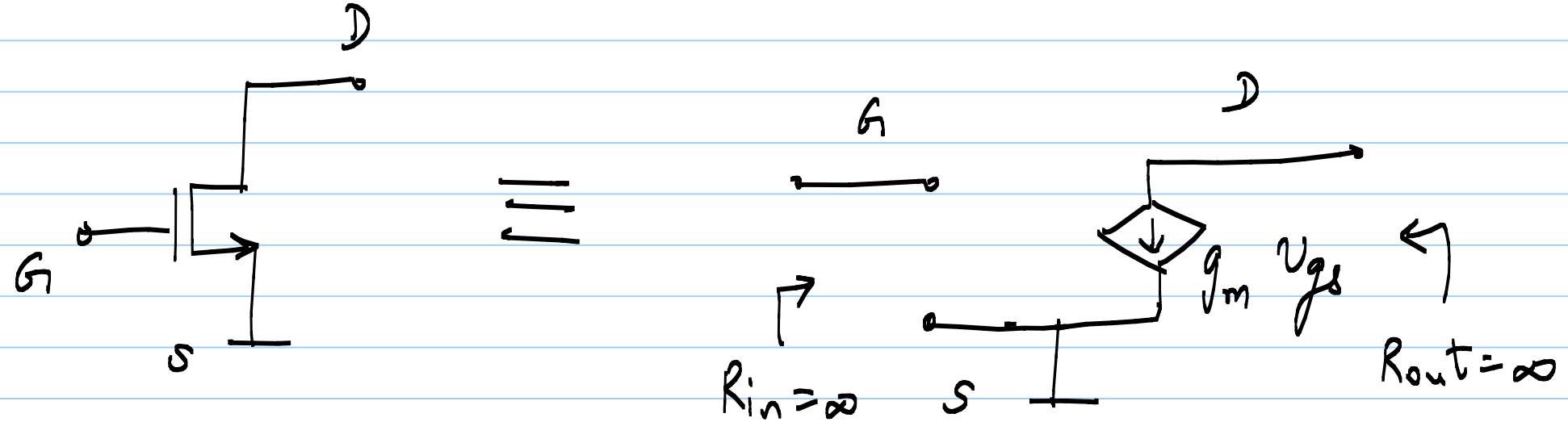
opamp

VCVS = 1



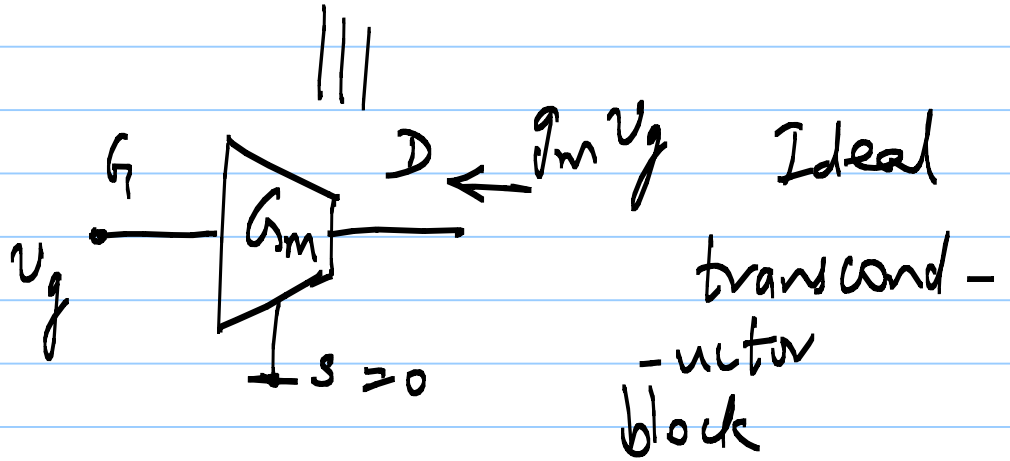
VCVS using MOSFET (gm controlled source)

1) Works only for small-signal
2) Idealized view for MOSFET:



$G_m = g_m$

allow $g_m \to \infty$



Ideal transconductance block

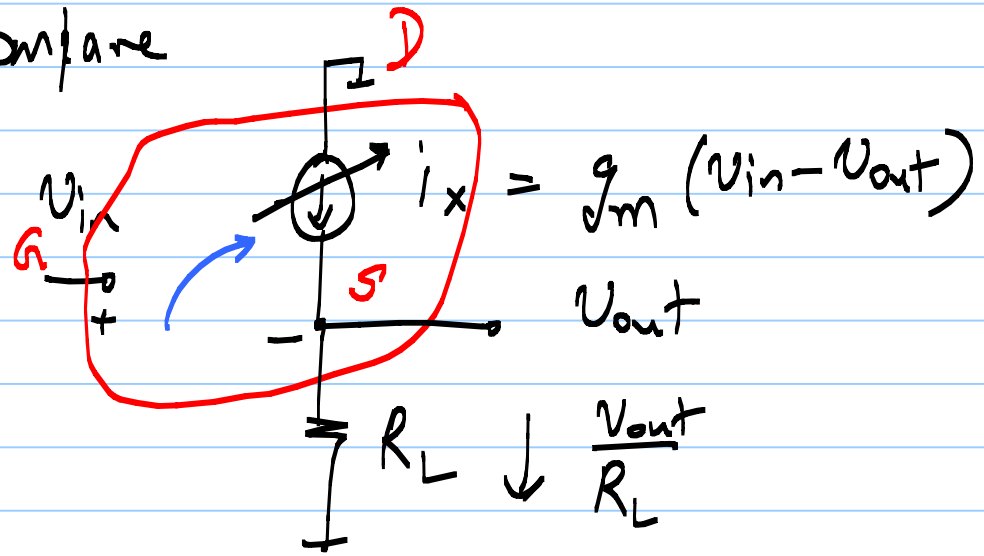
i.e. $\left(\frac{W}{L}\right)$ & I_D can be as large as required

to set g_m = as large as required.

Ideal VCVS =1 : $v_{out} = v_{in}$ $(g_m \to \infty)$

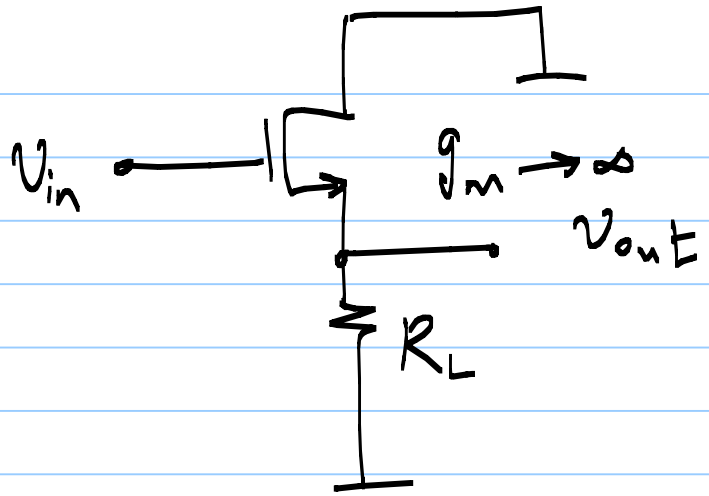
* measure v_{in}, v_{out}; compare
* change v_{out}
* If $v_{out} > v_{in}$, reduce i_x

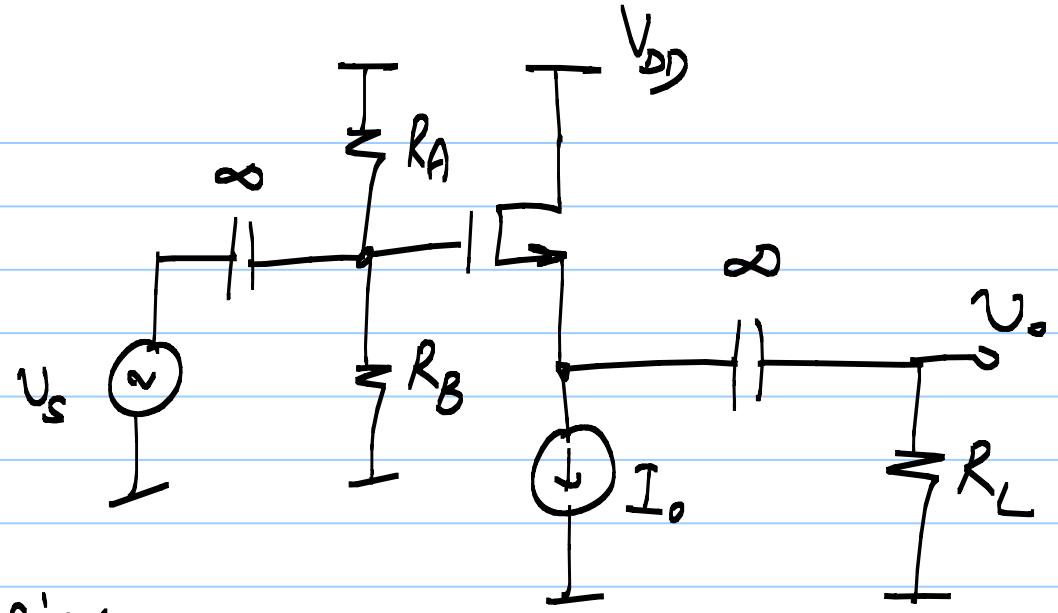
  If $v_{out} < v_{in}$, increase i_x



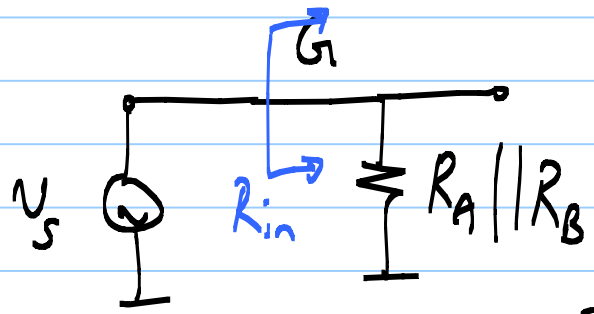
output current $\frac{v_{out}}{R_L} = g_m(v_{in} - v_{out})$ if in neg. f.b.

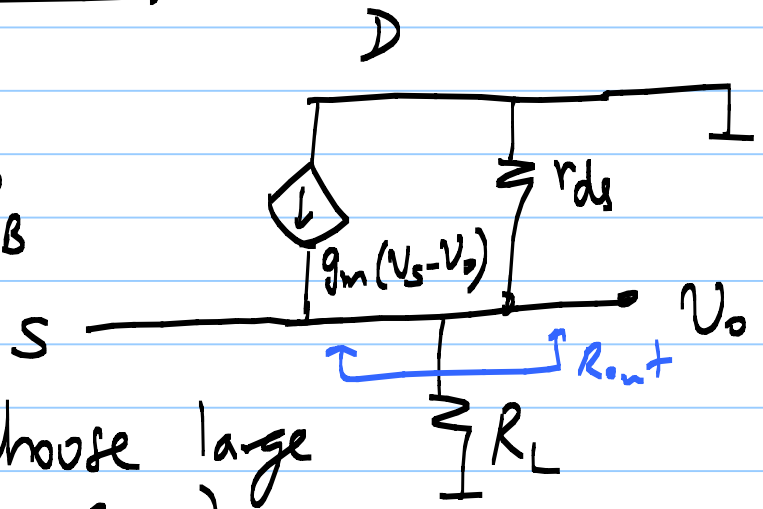
we want $v_{out} = v_{in} \Rightarrow g_m \to \infty$ so that $v_{in} - v_{out} \to 0$





Common Drain Amplifier





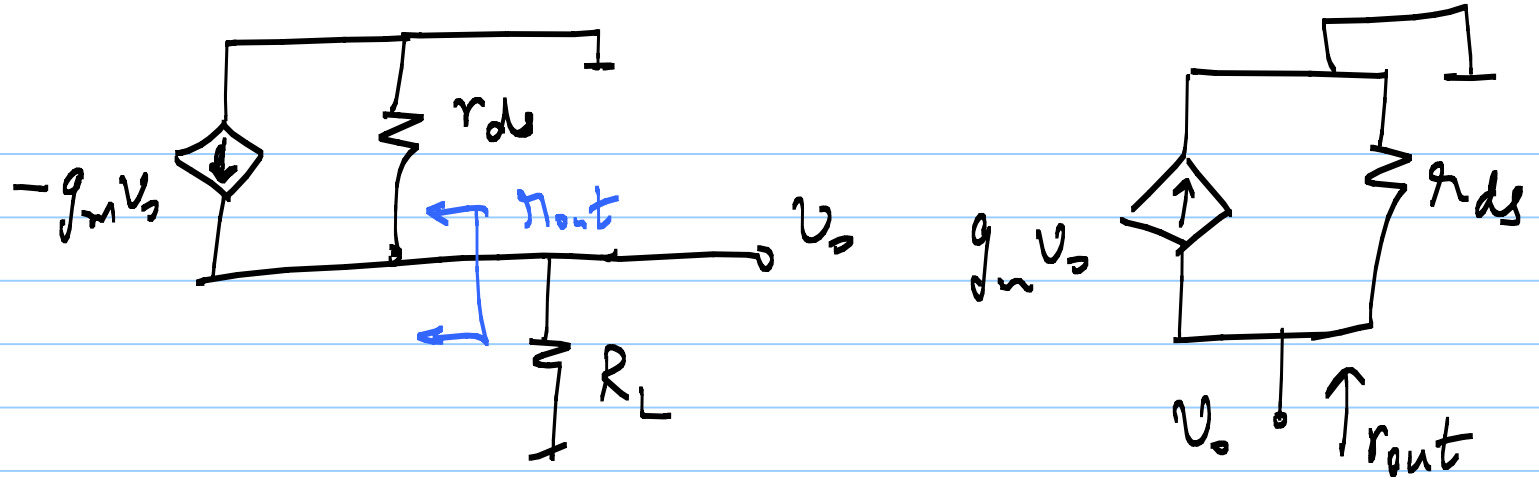
$v_{gs} = v_s - v_o$

VCVS

$Z_{in} = R_A \| R_B$ (choose large R_A, R_B)

$Z_{out} = ?$

Set $v_s = 0$



$$r_{out} = \frac{1}{g_m} \,||\, r_{ds}$$

$$Z_{out} = \frac{r_{ds}}{1 + g_m r_{ds}} = \frac{1}{g_m} \cdot \frac{g_m r_{ds}}{1 + g_m r_{ds}}$$

If $g_m r_{ds} >> 1$, $Z_{out} = 1/g_m$

KCL @ S node:

$$g_m (v_s - v_o) = v_o (G_L + g_{ds})$$

$$v_o(g_m + g_{ds} + G_L) = g_m v_s$$

$$\frac{v_o}{v_s} = \frac{g_m}{g_m + g_{ds} + G_L} < 1$$

$\to 1$ if $g_m \to \infty$

$\hookrightarrow Z_{out} \to 0$