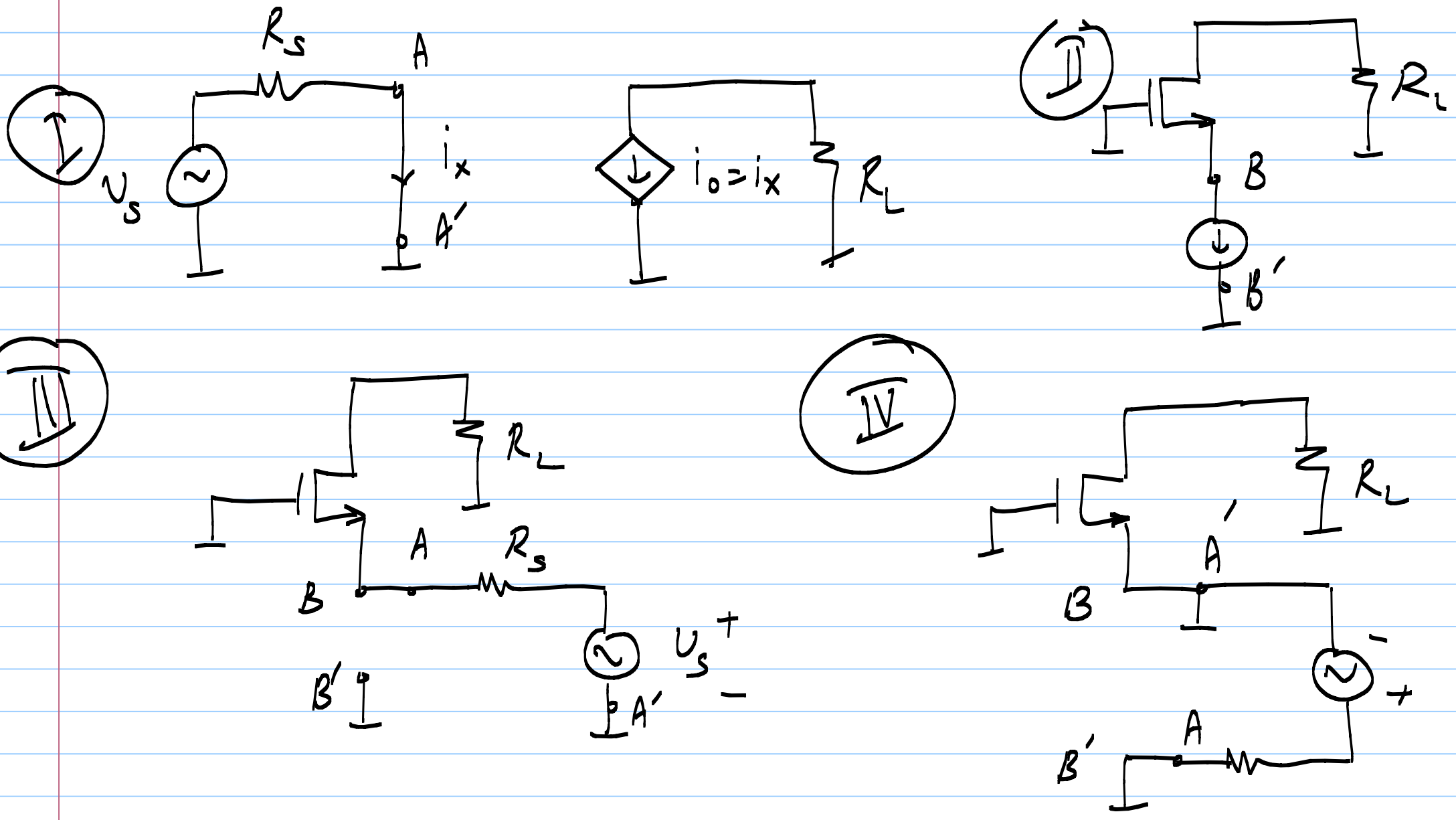
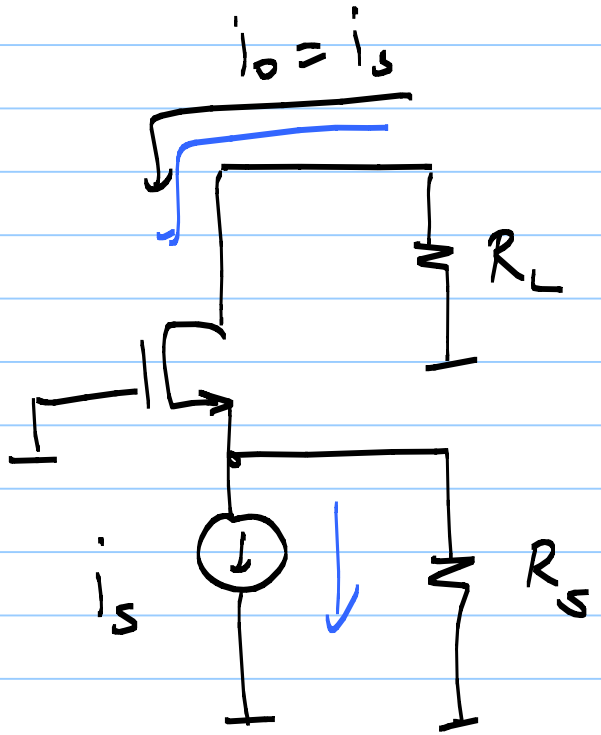
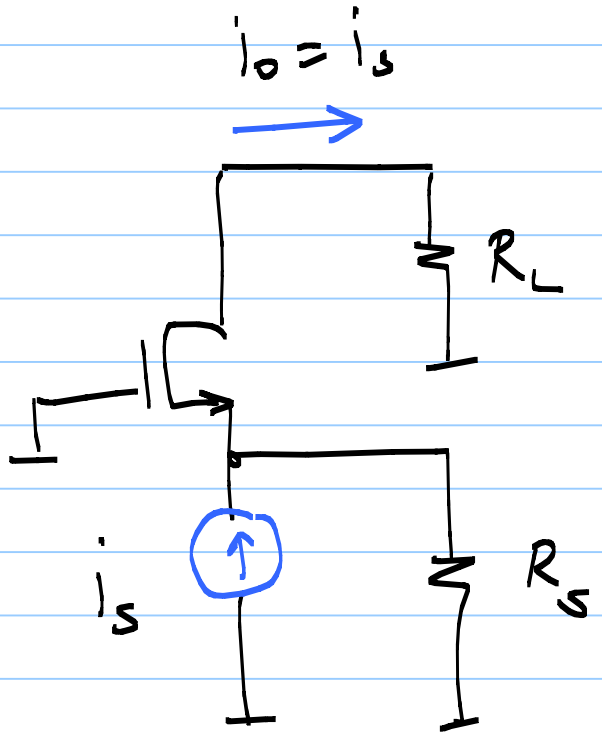
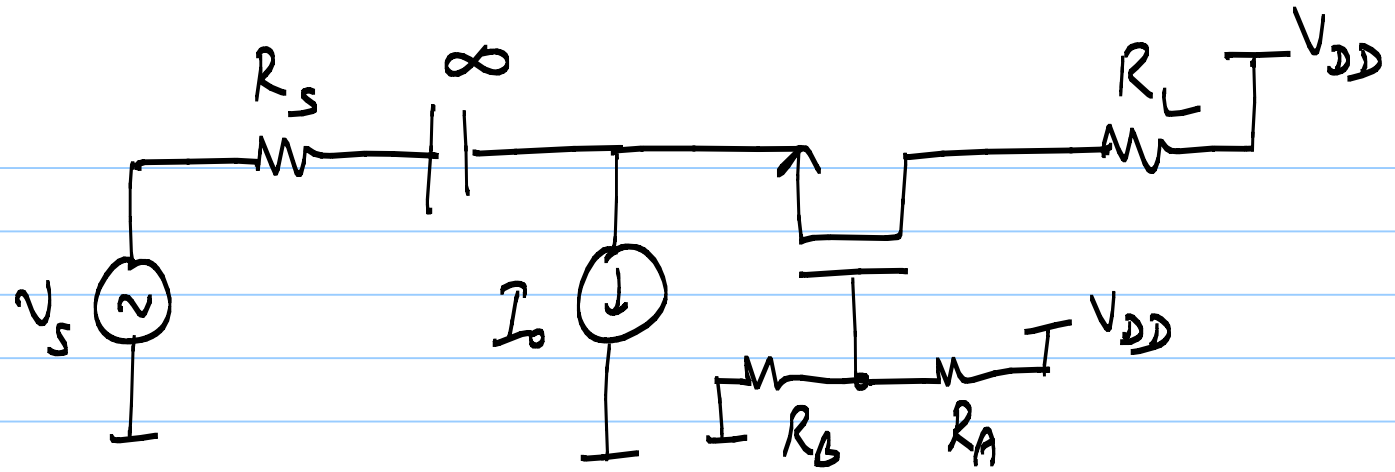
11/9/2020

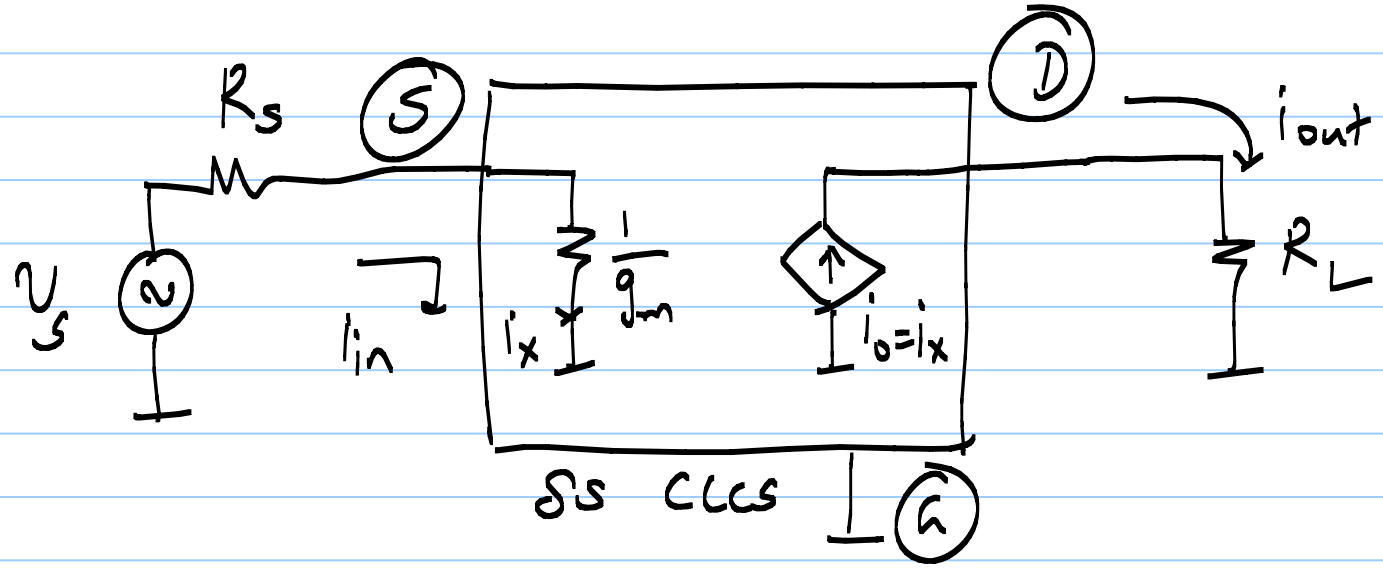
Lecture 23




$i_o = i_s$
R_L
i_s
R_S


$i_o = i_s$
R_L
i_s
R_S

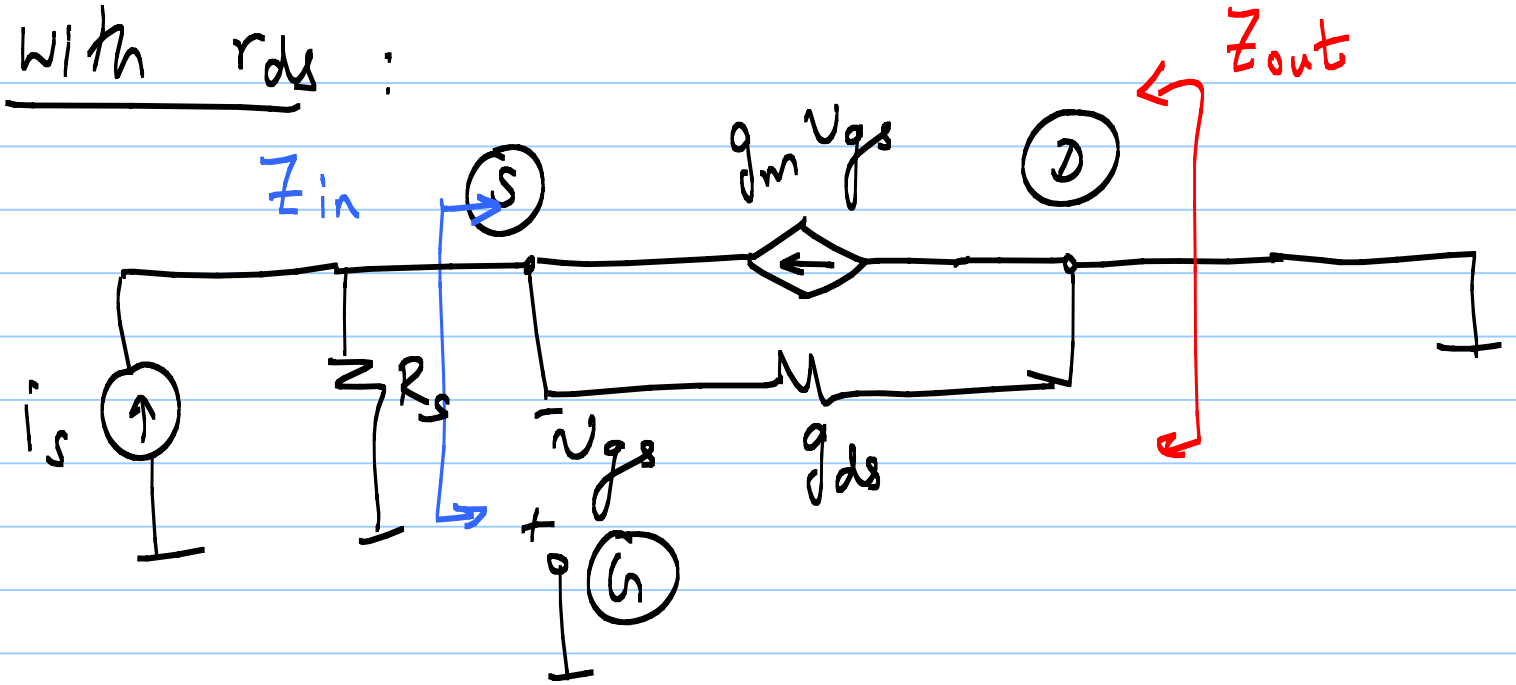




$$i_{in} \simeq \frac{v_s}{R_s} \quad \text{if} \quad g_m \gg \frac{1}{R_s}$$

$$\frac{i_{out}}{v_s} = \frac{1}{R_s} \quad ; \quad \frac{v_{out}}{v_s} = \frac{R_L}{R_s}$$

With r_{ds} :



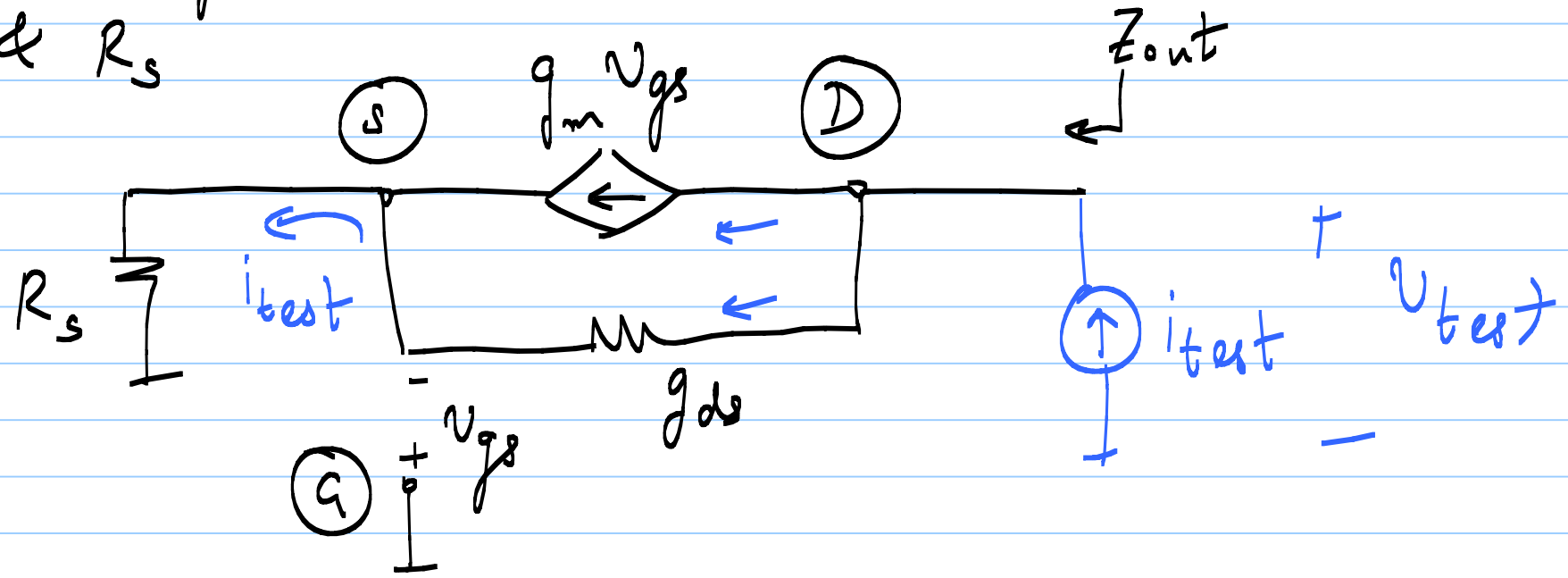
without g_{ds} : $Z_{in} = 1/g_m$

with g_{ds}, without R_L : $Z_{in} = \dfrac{1}{g_m + g_{ds}}$

with g_{ds}, R_L : (HW 8) $Z_{in} = ?$

without g_{ds} : $Z_{out} = \infty$

with g_{ds} :
& R_S



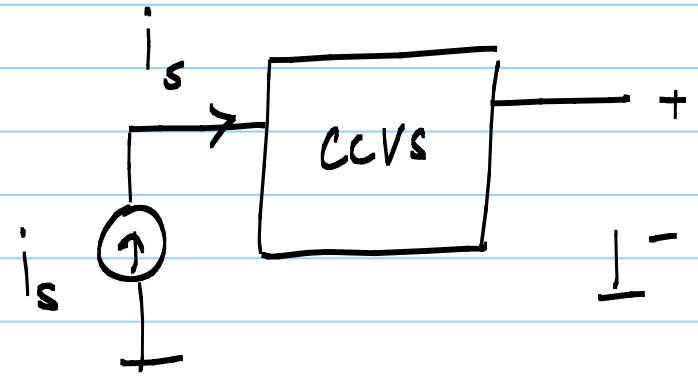
$$Z_{out} = R_S + r_{ds} + g_m r_{ds} R_S$$

$v_S = R_S \cdot i_{test} = -v_{gs}$ ...

(HW9) : swing limits for CGA

MOSFET incremental CCVS

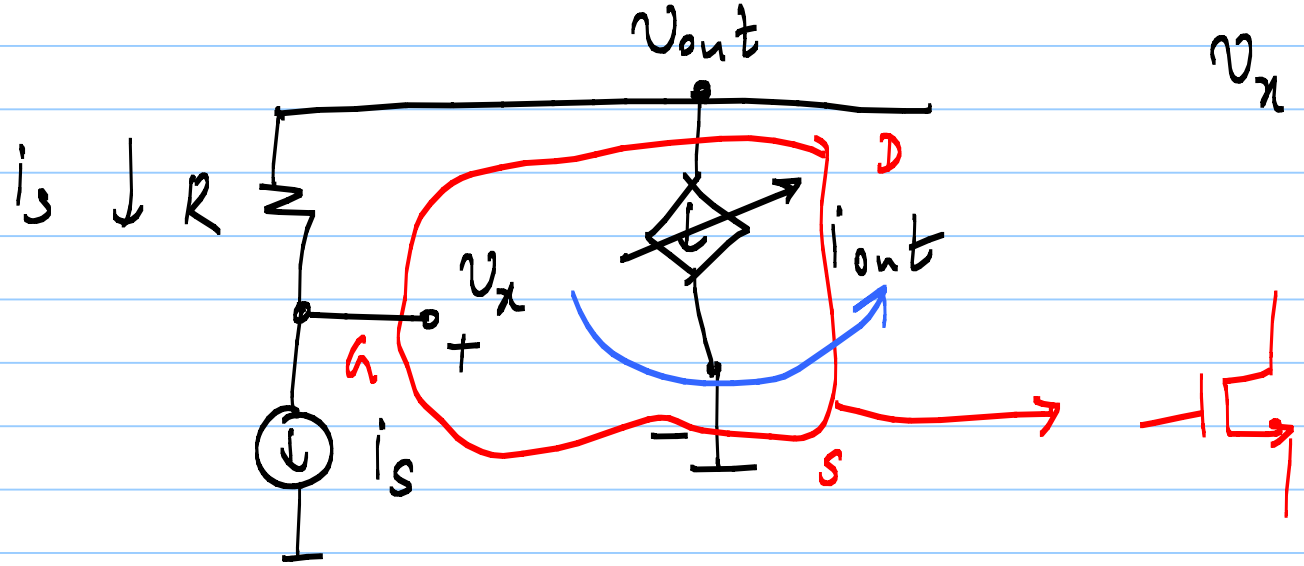
Trans-impedance amplifier



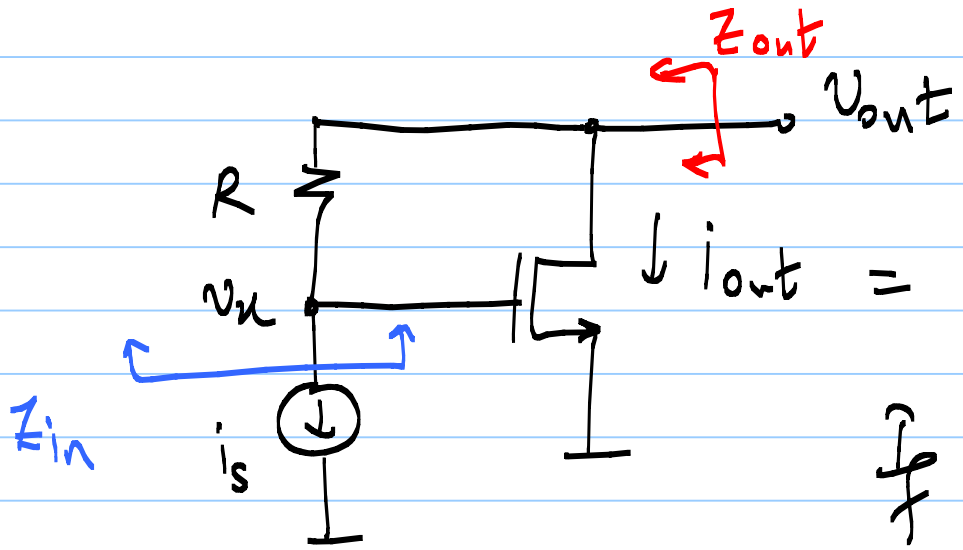
$v_{out} = R i_s$; $Z_{in} = 0$

$Z_{out} = 0$ (if $g_m \to \infty$)

$v_{out} = R i_s \Rightarrow v_{out} - R i_s = 0$

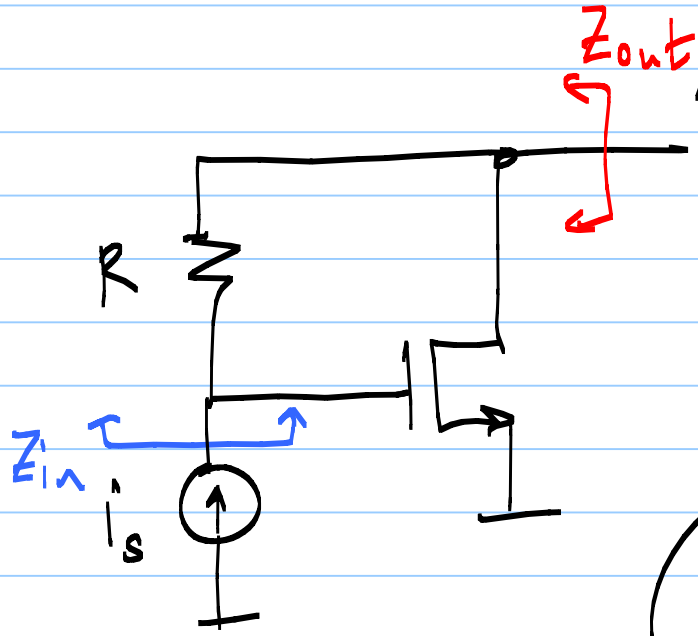


$v_x = v_{out} - R i_s$



$i_{out} = g_m v_x$

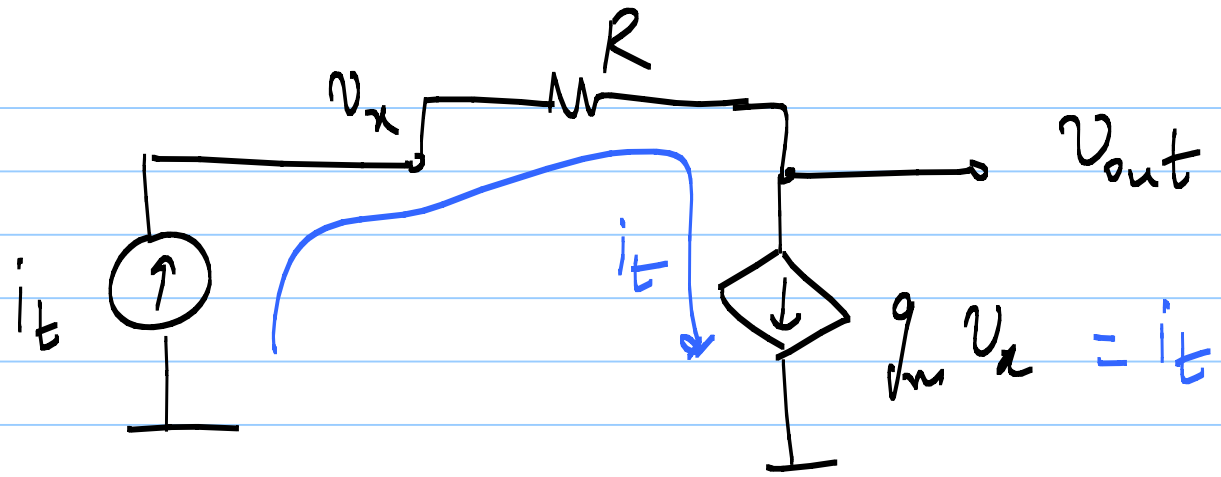
If $g_m \to \infty$, $v_x \to 0$



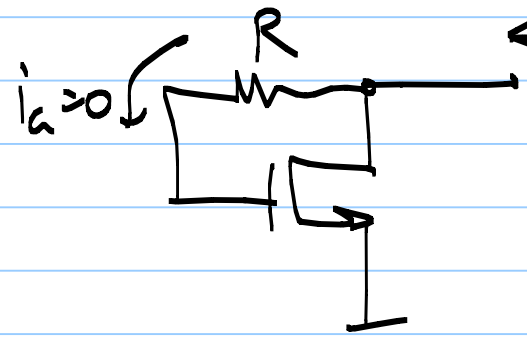
$v_{out} = -R i_s$

In class: Z_{in} & Z_{out} without R_s & R_L

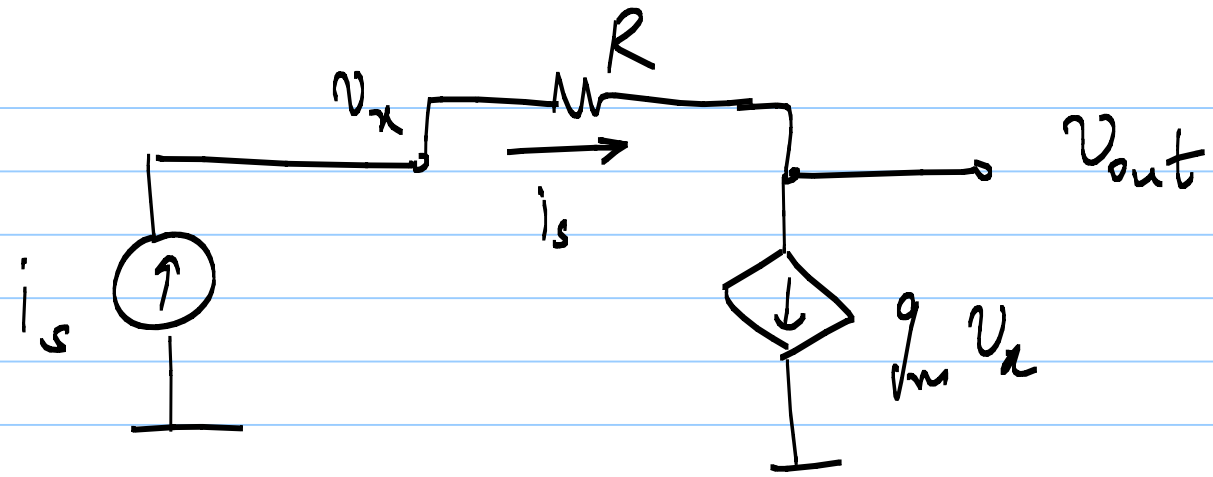
HW9: Z_{in} & Z_{out} with R_s & R_L



$$i_t = g_m v_x \Rightarrow Z_{in} = \frac{v_x}{i_t} = \frac{1}{g_m}$$



$$\leftarrow Z_{out} = \frac{1}{g_m}$$



$$i_s = g_m v_x$$

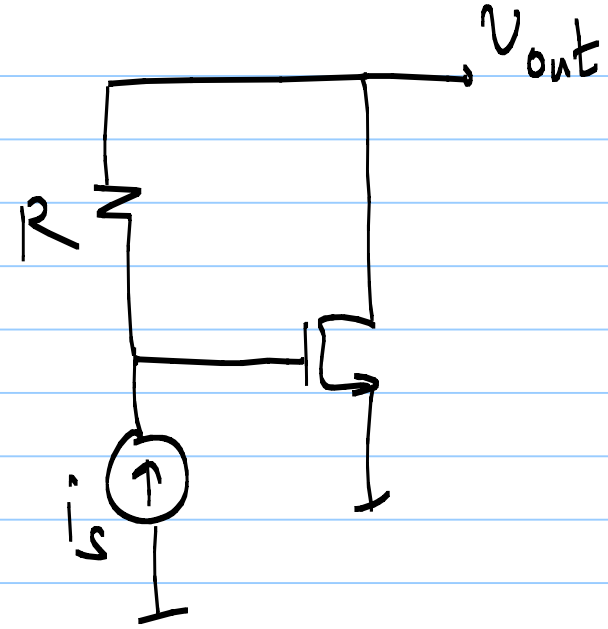
$$v_{out} = v_x - i_s \cdot R$$

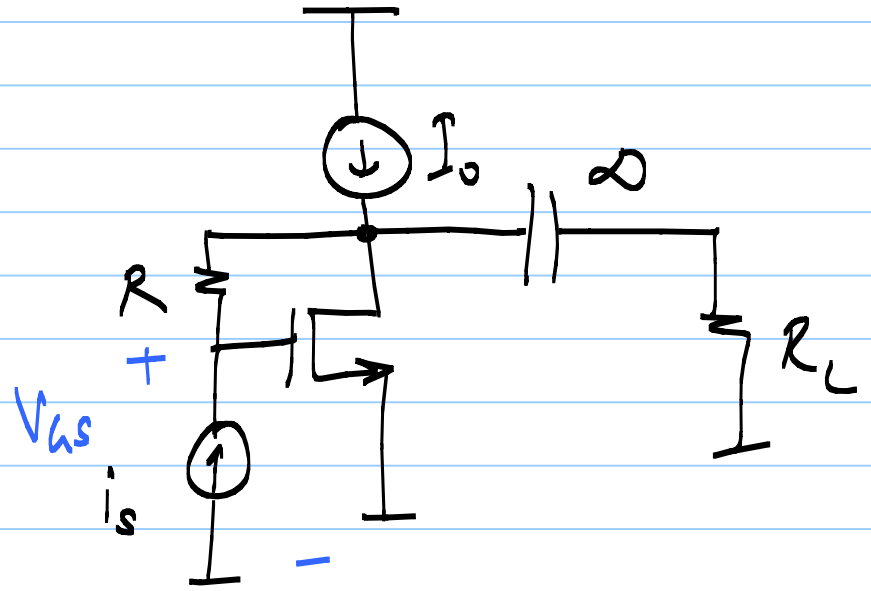
$$v_{out} = i_s \left[\frac{1}{g_m} - R \right]$$

$$\frac{v_{out}}{i_s} = \left[\frac{1}{g_m} - R \right] = -R \left[1 - \frac{1}{g_m R} \right]$$

If $g_m R \to \infty$, $\frac{v_{out}}{i_s} \to -R$

large $g_m \Rightarrow g_m R >> 1$ (or) $\boxed{g_m >> \frac{1}{R}}$





with biasing