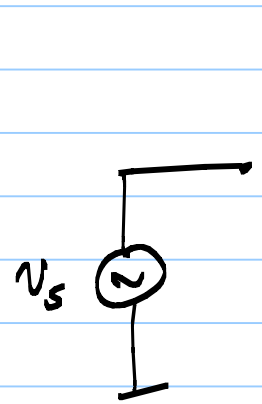
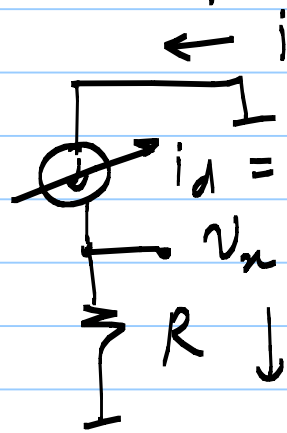
10/9/20

Lecture 22

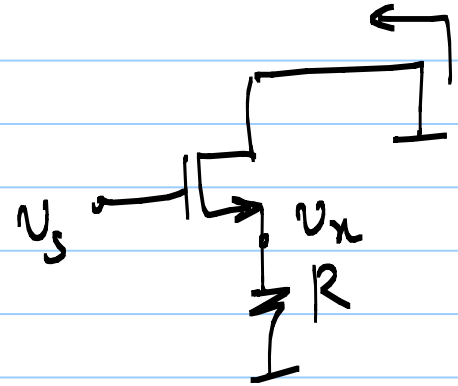
VCCS : $i_o = \frac{v_s}{R} = G \cdot v_s$





g_m large : $v_x = v_s$

$\frac{v_x}{R} = \frac{v_s}{R}$



$i_o = \frac{v_s}{R}$ if $g_m \to \infty$

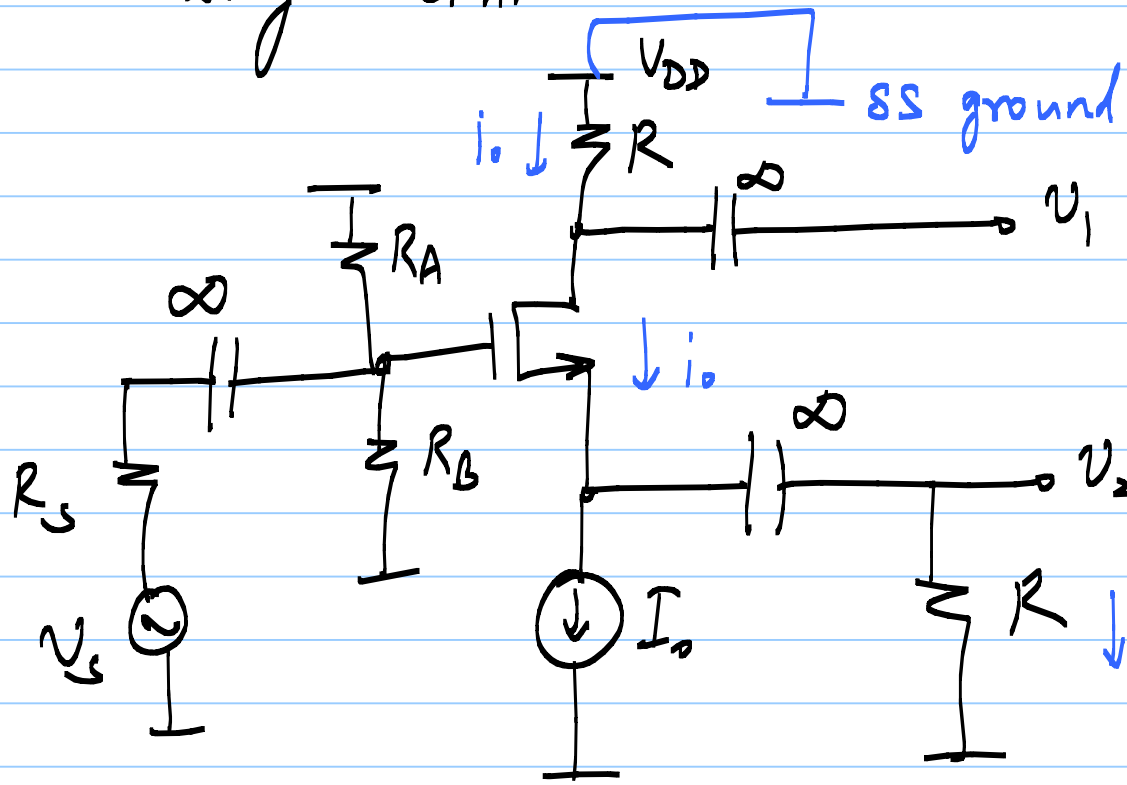
actual $i_o = \frac{v_x}{R} = \frac{v_s}{R} \cdot \left(\frac{g_m}{g_m + G} \right)$

$$\boxed{i_o = \frac{g_m}{1 + g_m R} \cdot v_s}$$

Large $g_m \Rightarrow g_m R \gg 1$ (or) $g_m \gg G_s$

HW7 : Swing limits

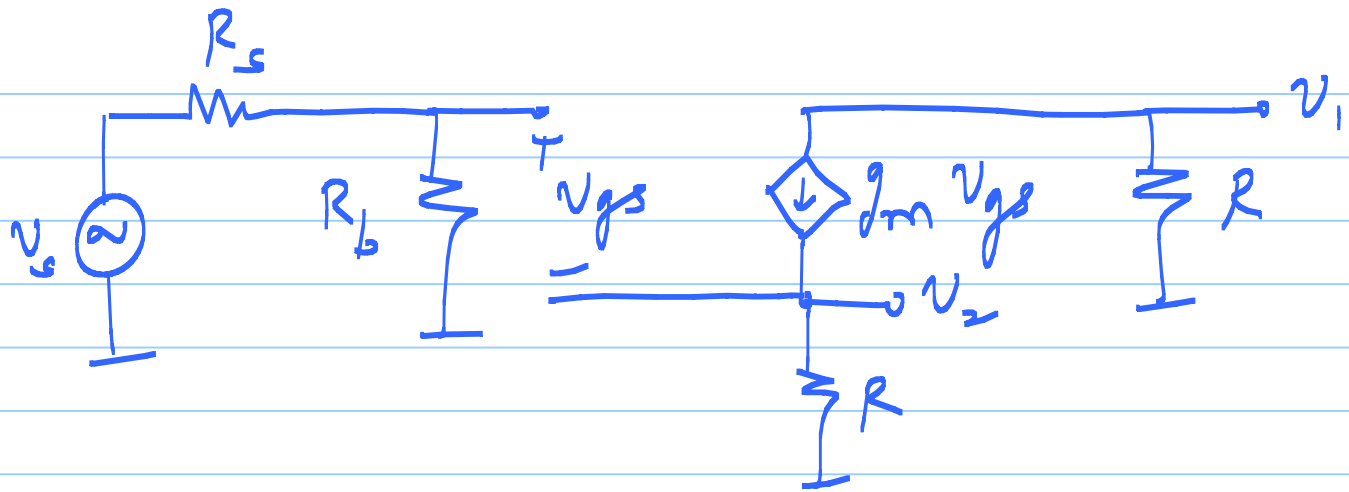
Phase Splitter

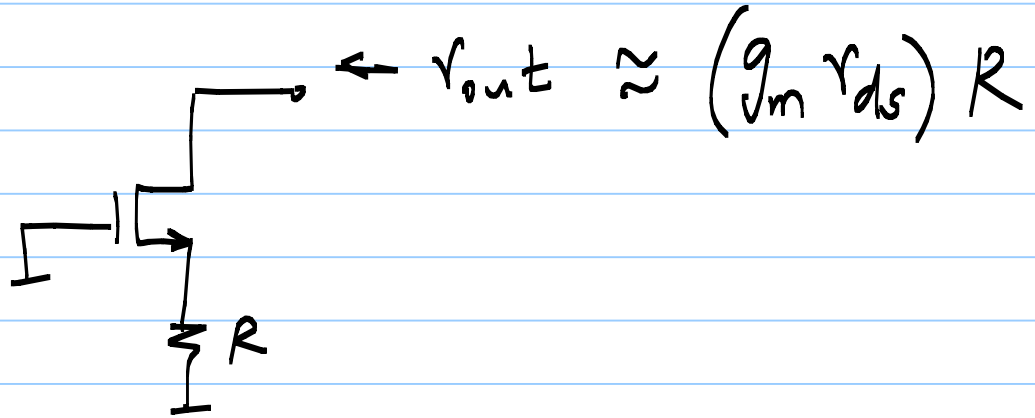


$$v_1 = -\frac{g_m R}{1+g_m R} \cdot v_s = -v_2$$

$$v_2 = \frac{g_m R}{1+g_m R} \cdot v_s$$

$$i_o = \frac{g_m}{1+g_m R} \cdot v_s$$

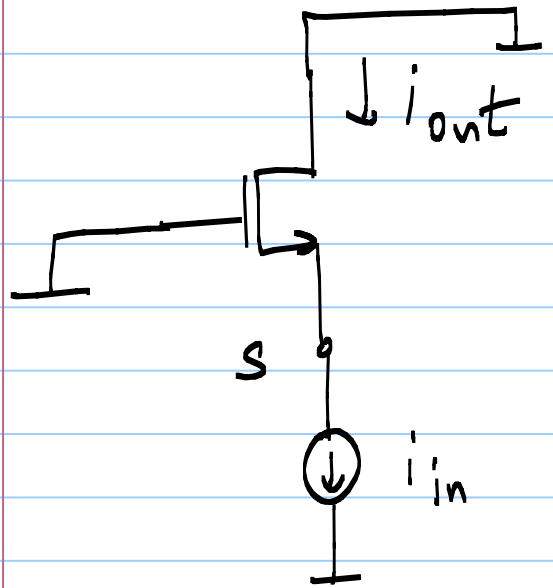

R_s
v_s
R_b
v_{gs}
$g_m v_{gs}$
v_1
v_2
R
R


$r_{out} \simeq (g_m r_{ds}) R$
R

MOSFET incremental CCCS

$i_o = i_{in}$

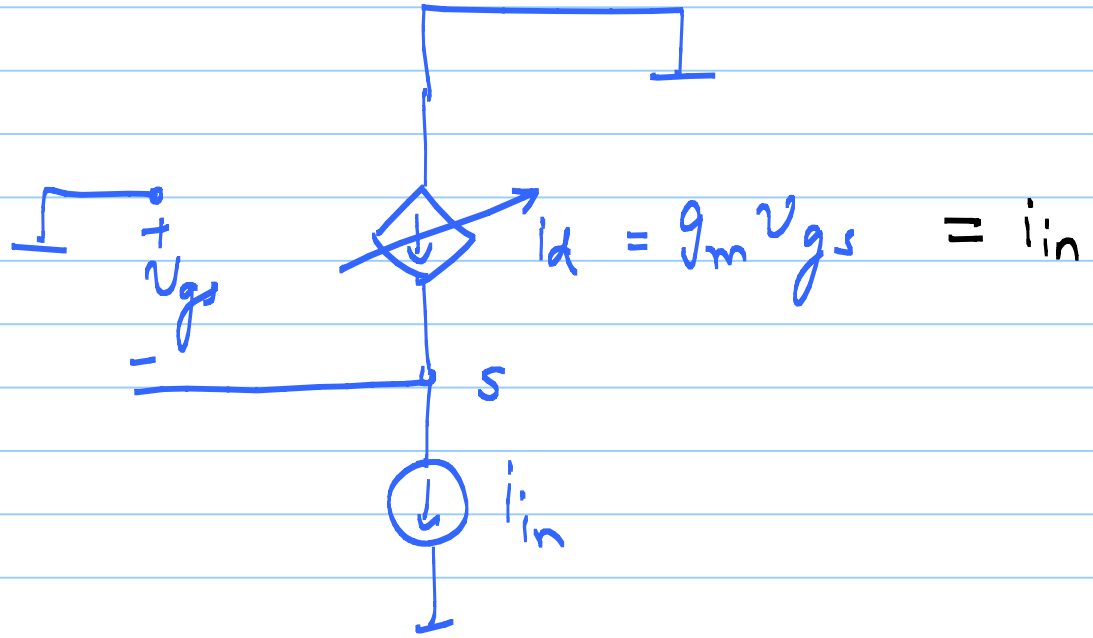
$Z_{in} = 0$; $Z_{out} = \infty$



$i_g = 0$

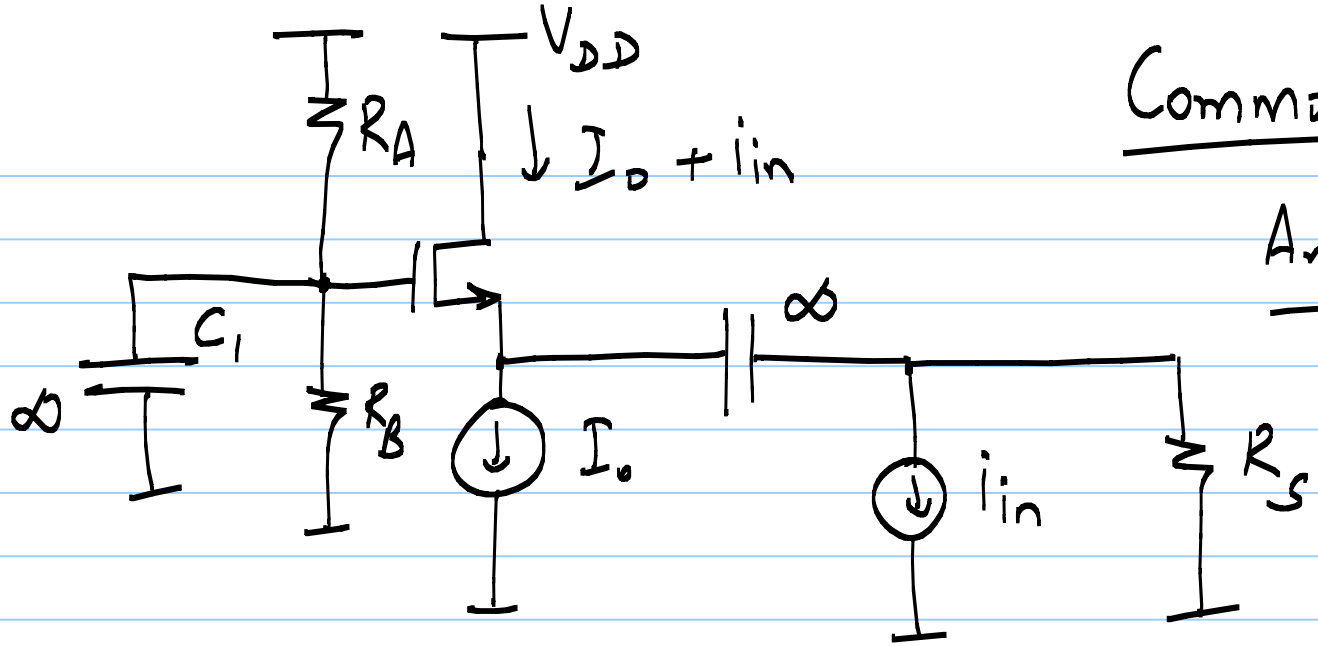
$i_d = i_s$

v_{gs} – cause

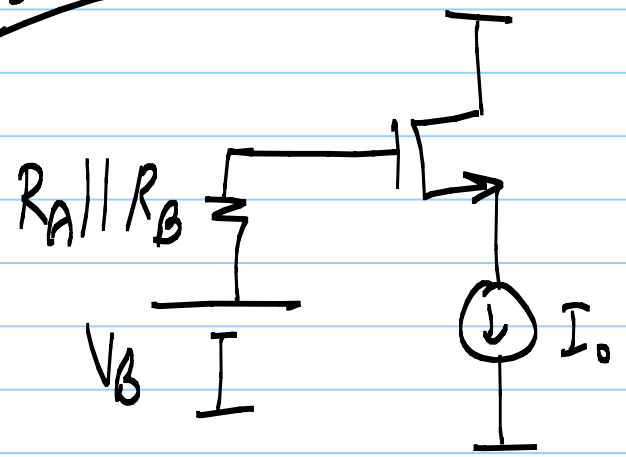


Neg. f.b. biasing : Source f.b.

Common Gate Amplifier

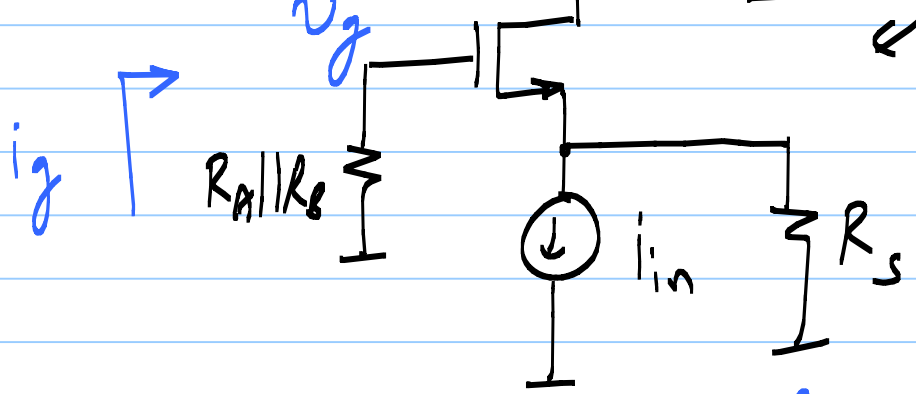


DC



AC

No C_1



$v_g = 0$ if $i_g = 0$

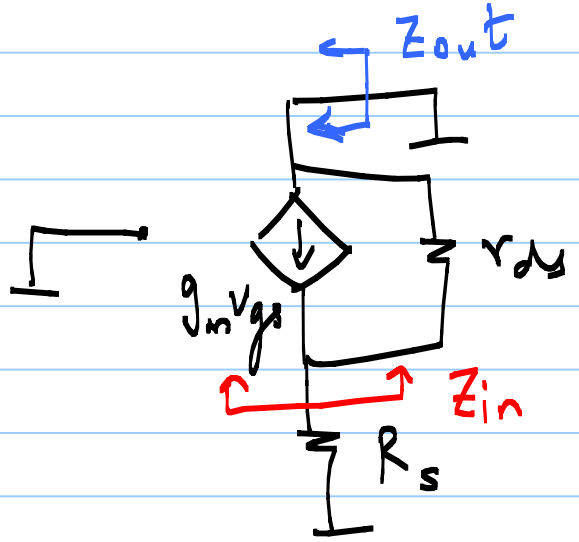
Unfortunately AC $i_g \neq 0$

C_1 is necessary

$$\frac{i_{out}}{i_{in}} = 1 \quad \text{independent of } g_m$$

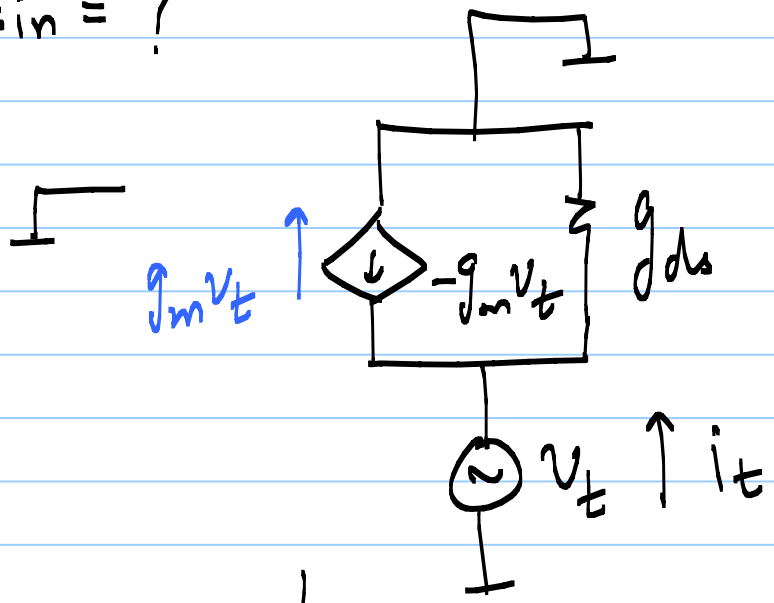
$$Z_{out} = R_s + r_{ds} + g_m R r_{ds} \approx g_m R_s r_{ds}$$

(very high)



$Z_{in} = ?$

$v_{gs} = -v_t$



$$Z_{in} = \frac{1}{g_m + g_{ds}}$$

large intrinsic gain : $g_m r_{ds} >>$

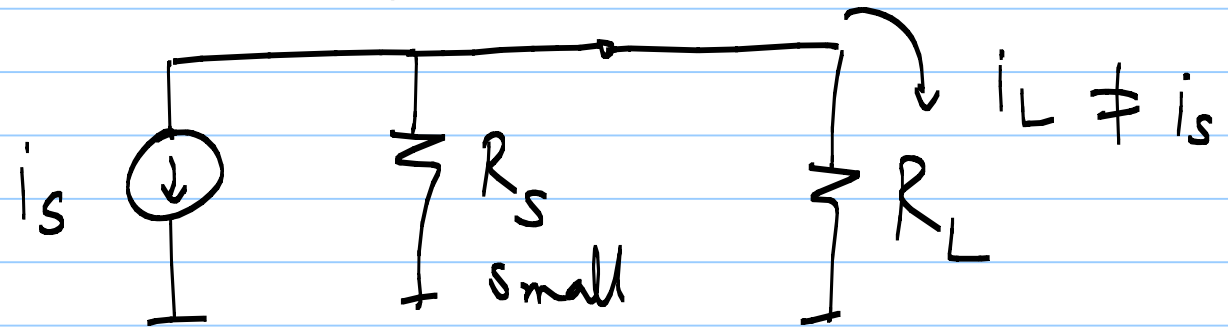
$g_m >> g_{ds}$

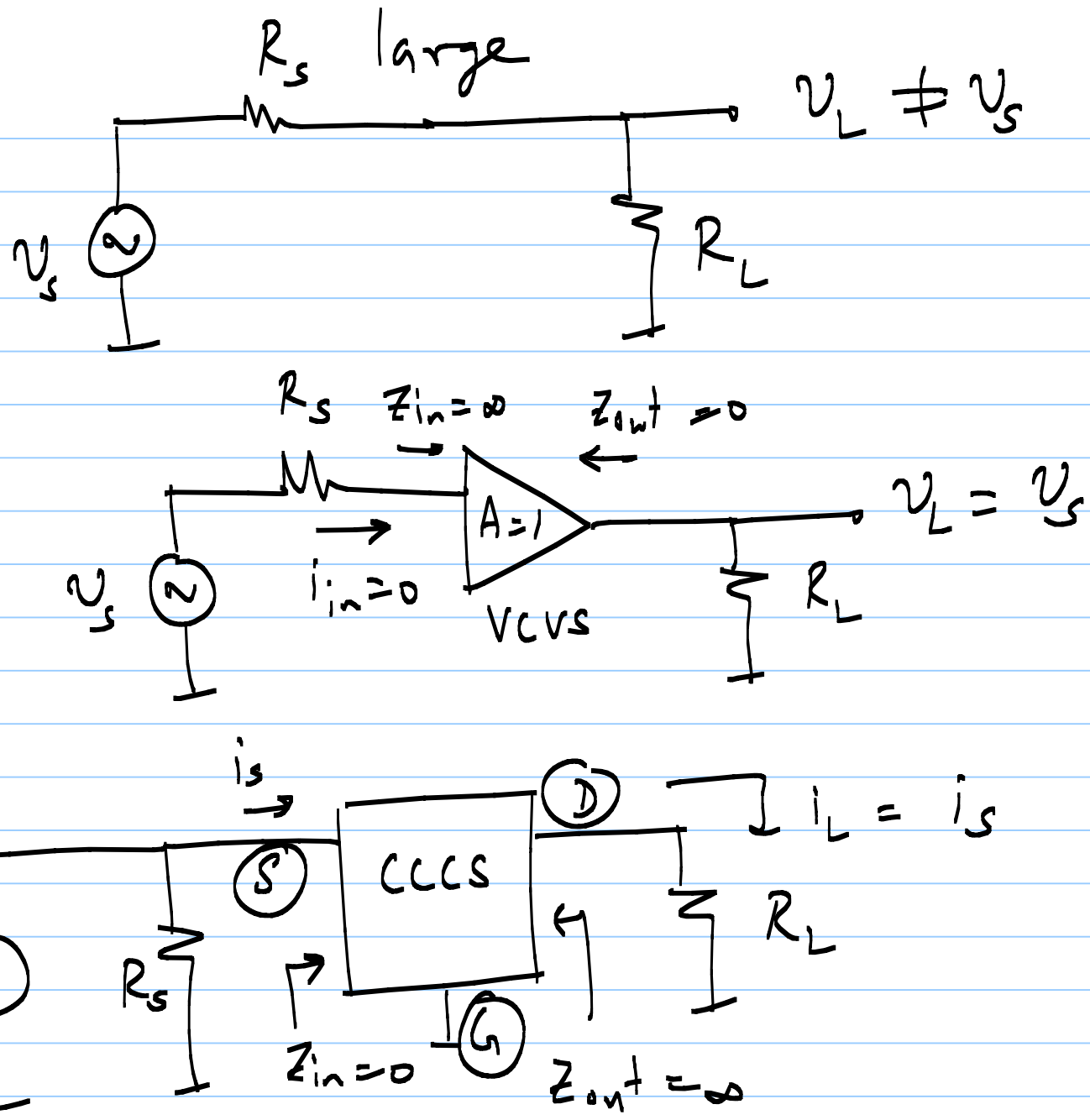
$$Z_{in} \simeq \frac{1}{g_m}$$

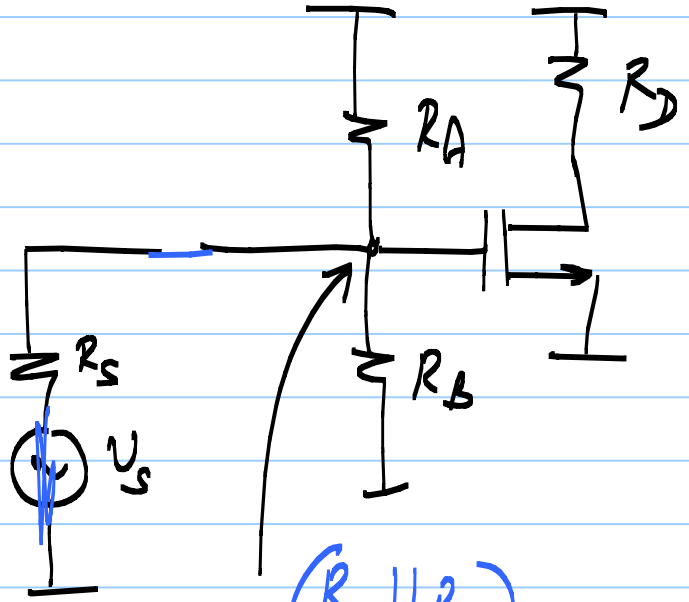
large g_m : Z_{in} as small as required

Z_{out} as large as required.

Why do you need a CCCS of gain 1?




R_s large
$v_L \neq v_s$
v_s
R_L
R_s
$z_{in}=\infty$
$z_{out}=0$
$v_L = v_s$
A=1
v_s
$i_{in}=0$
VCVS
R_L
i_s
D
$i_L = i_s$
S
CCCS
R_L
i_s
R_s
$z_{in}=0$
G
$z_{out}=\infty$



$$\frac{(R_B \| R_S)}{R_A + (R_B \| R_S)} \cdot V_{DD}$$