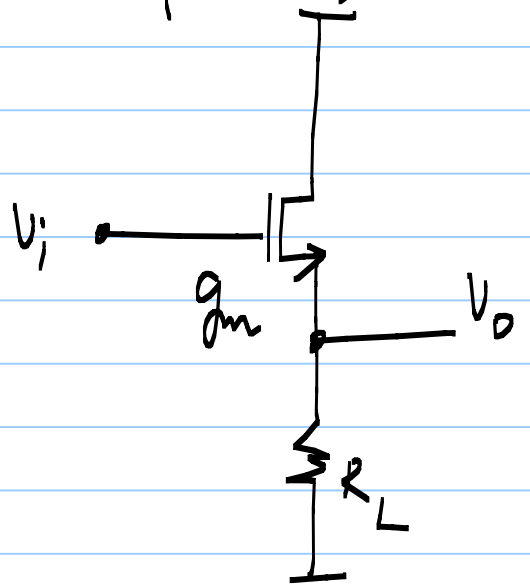
Lecture 27:

Common drain amplifier: (Source follower)



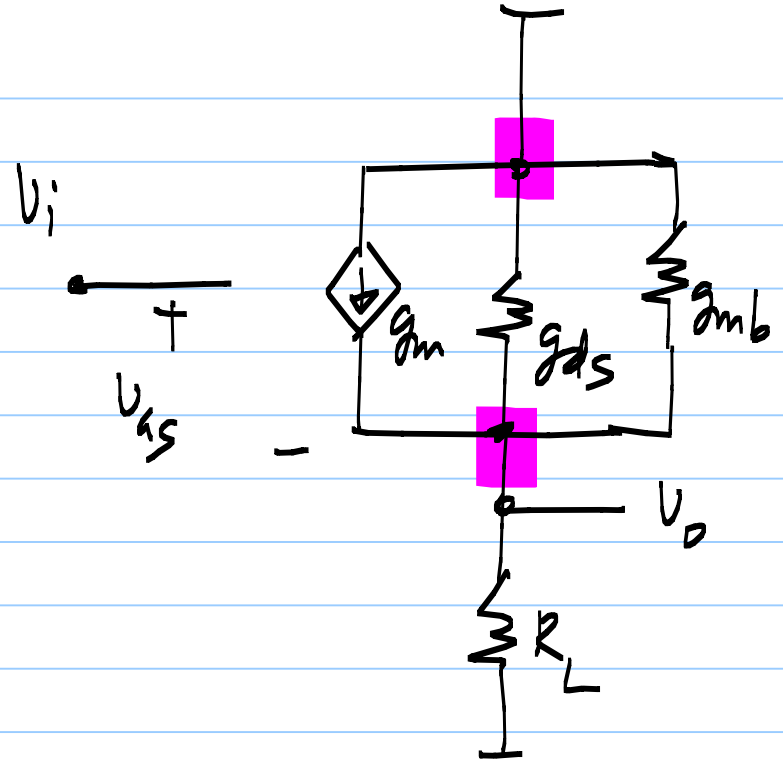
* Voltage buffer $v_o = v_i$

* $R_i = \infty$; $R_o = \frac{1}{g_m} \| \frac{1}{g_m + g_{ds}}$

* $\left.\frac{v_o}{v_i}\right|_{R_L=\infty} = 1$; $\frac{v_o}{v_i} = \frac{g_m R_L}{1 + g_m R_L}$

$\simeq 1$ if $g_m R_L \gg 1$

$$\frac{v_o}{v_i} = \frac{g_m}{g_m + g_L + g_{ds}}$$



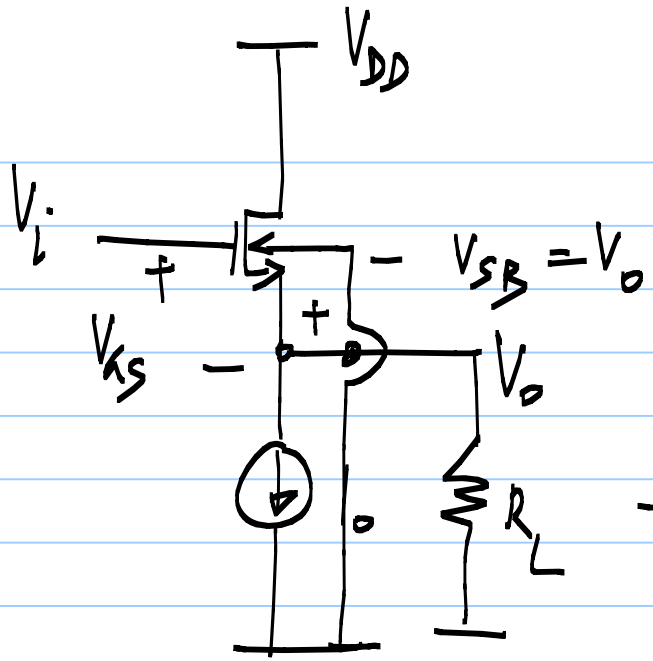
$$\frac{v_o}{v_i} = \frac{g_m}{g_m + G_L + g_{mb} + g_{ds}}$$

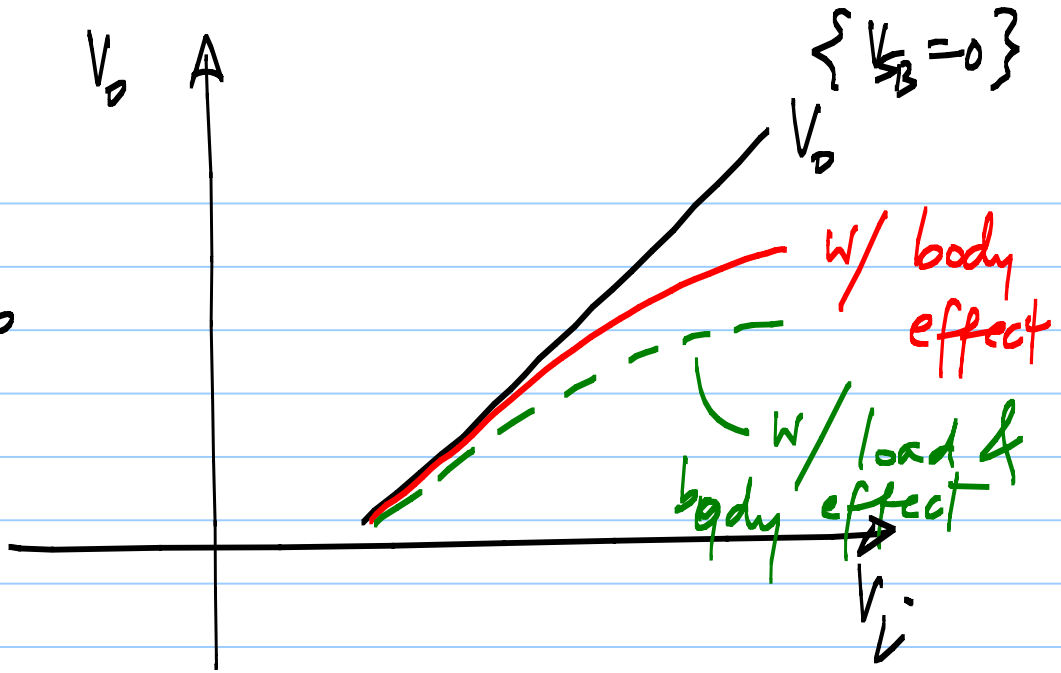
$R_L \to \infty$, $r_{ds} \to \infty$

$(G_L \to 0 \;,\; g_{ds} \to 0)$

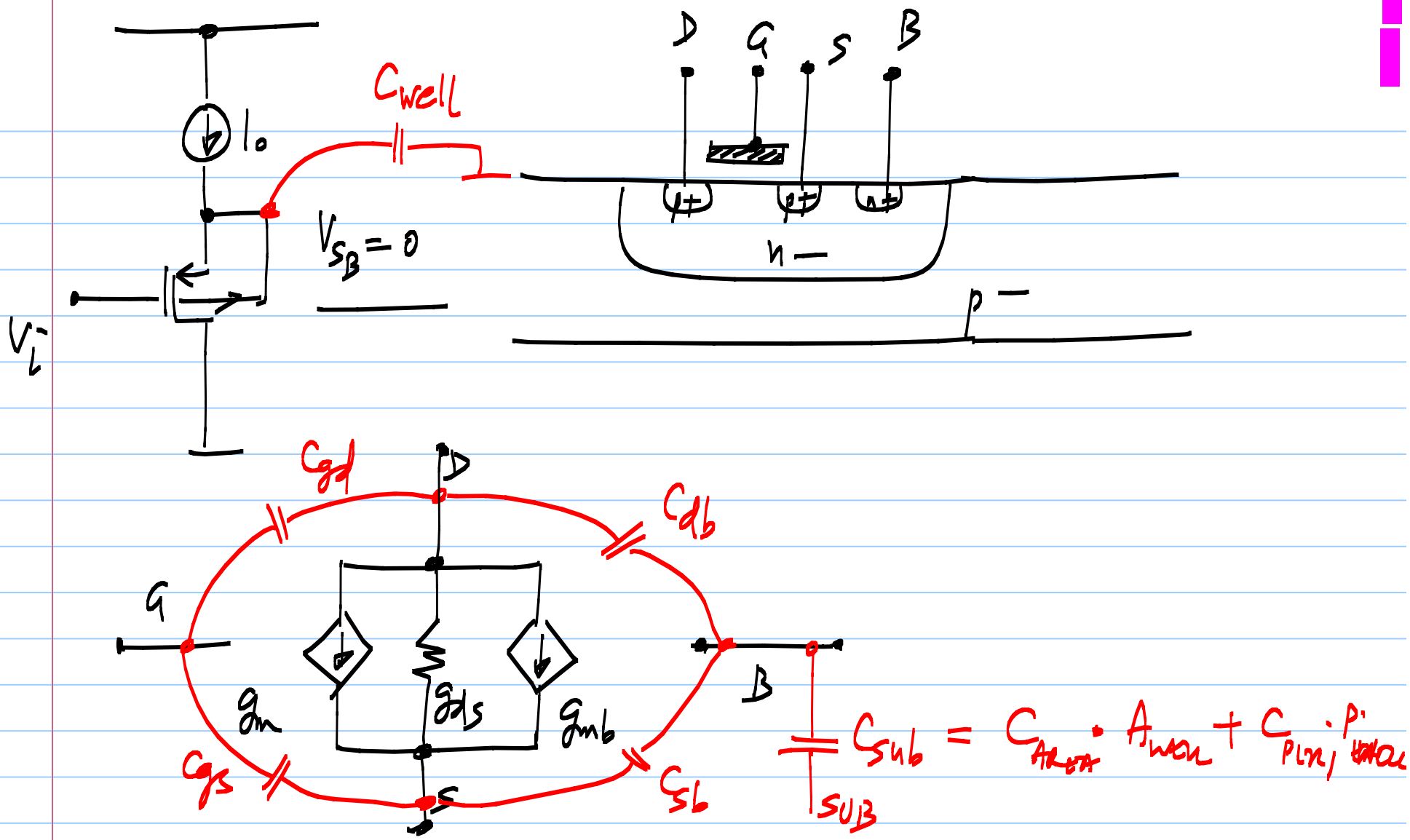
$$\left[\frac{v_o}{v_i} = \frac{g_m}{g_m + g_{mb}} < 1\right]$$

$$R_o \simeq \frac{1}{g_m} \qquad \frac{1}{g_m + g_{mb}}$$

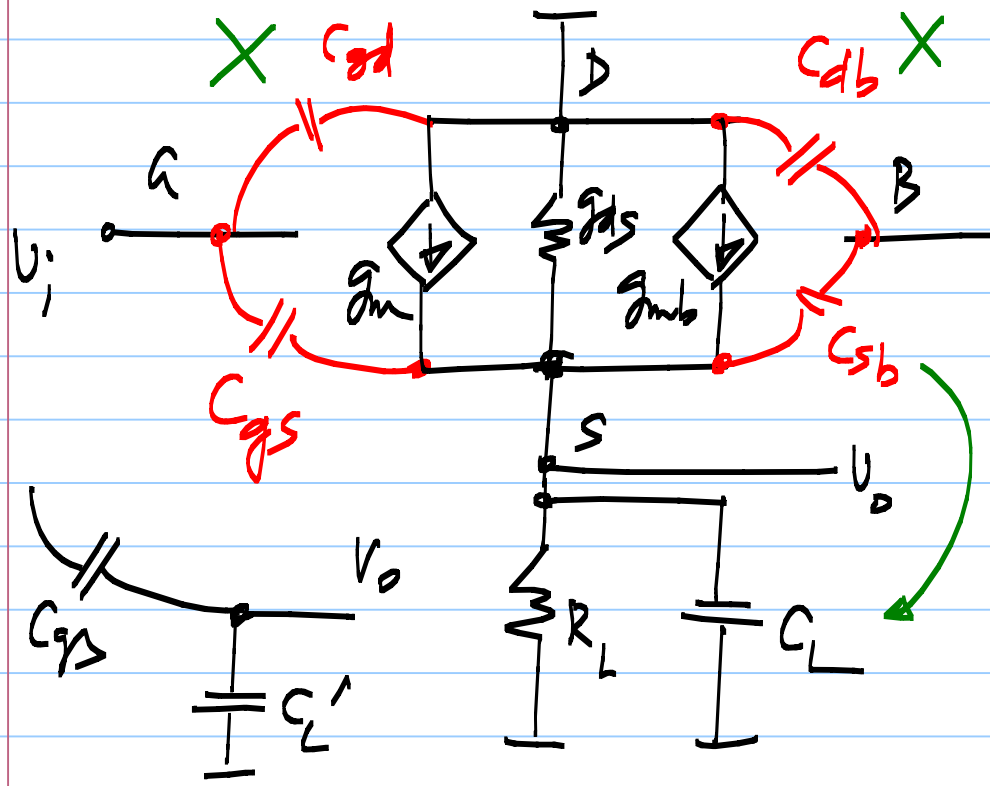




$$V_{GS} = V_T + \sqrt{\frac{2I_o}{\mu C_{ox} W/L}}$$


C_{well}
I_0
$V_{SB} = 0$
V_i
D
G
S
B
n+
p+
n−
p−
C_{gd}
C_{db}
G
g_m
g_{ds}
g_{mb}
B
C_{gs}
C_{sb}
S
$C_{sub} = C_{Area} \cdot A_{well} + C_{Perim} \cdot P_{well}$
SUB

C-D amplifier at high frequencies

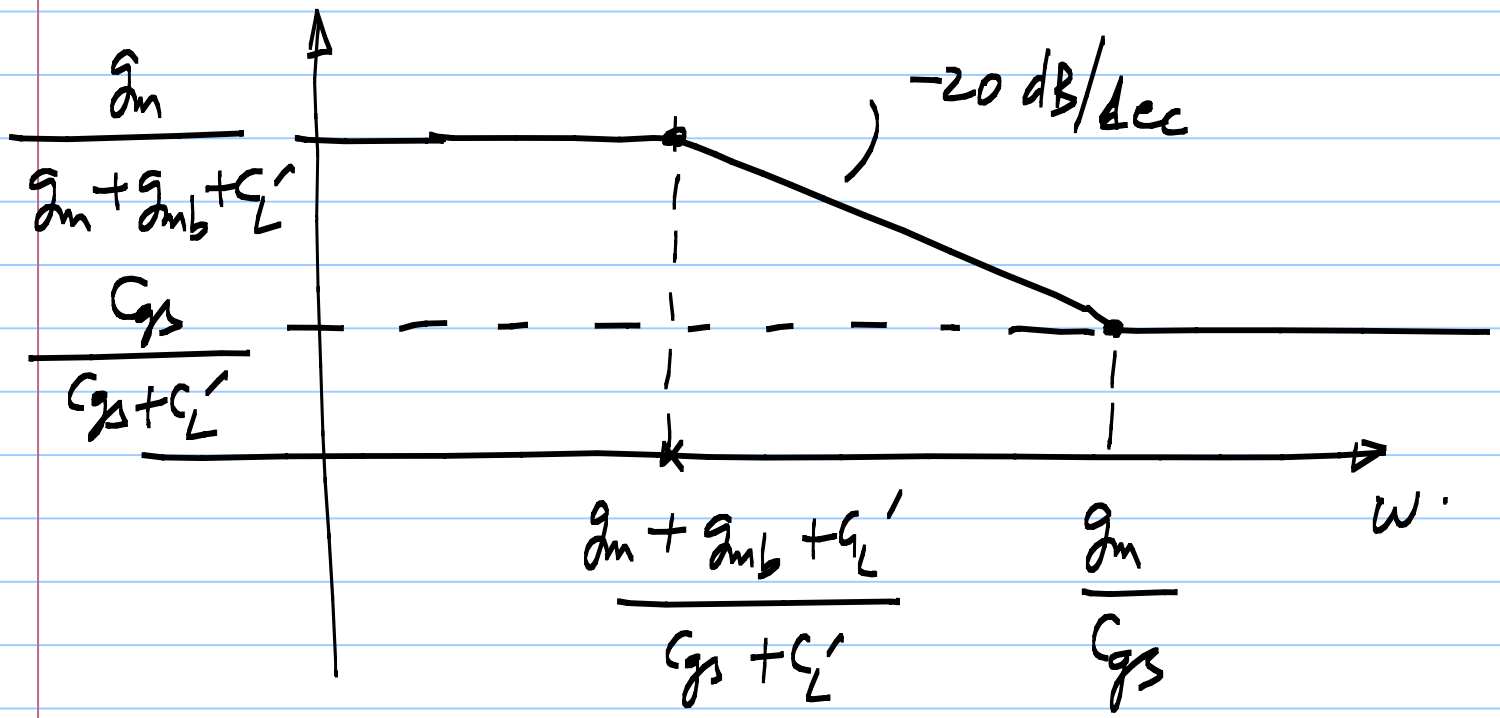


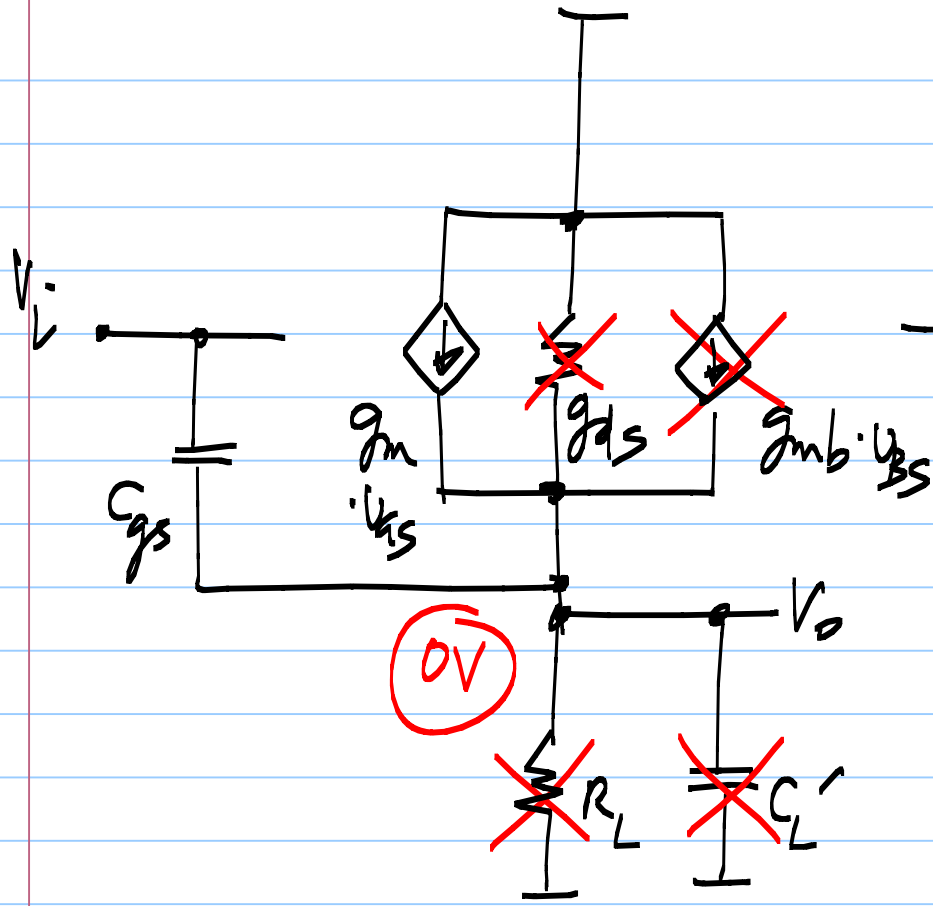
$$\frac{V_o(s)}{V_i(s)} = \frac{(g_m + sC_{gs})}{g_m + G_L' + g_{mb} + sC_L' + sC_{gs}}$$

$$= \frac{g_m + sC_{gs}}{g_m + G_L' + g_{mb} + s(C_{gs} + C_L')}$$

$$(V_i - V_o)(sC_{gs} + g_m) = V_o\left(\underbrace{G_L + g_{ds}}_{G_L'} + s\underbrace{(C_L + C_{sb})}_{C_L'}\right) + g_{mb} \cdot V_o$$

$$\frac{V_o}{V_i} = \frac{g_m + sC_{gs}}{g_m + g_{mb} + G_L' + s(C_{gs} + C_L')}$$





Poles: $V_i = 0$

$$-\frac{g_m + g_{mb} + g_{ds} + G_L}{C_{gs} + C_L'}$$

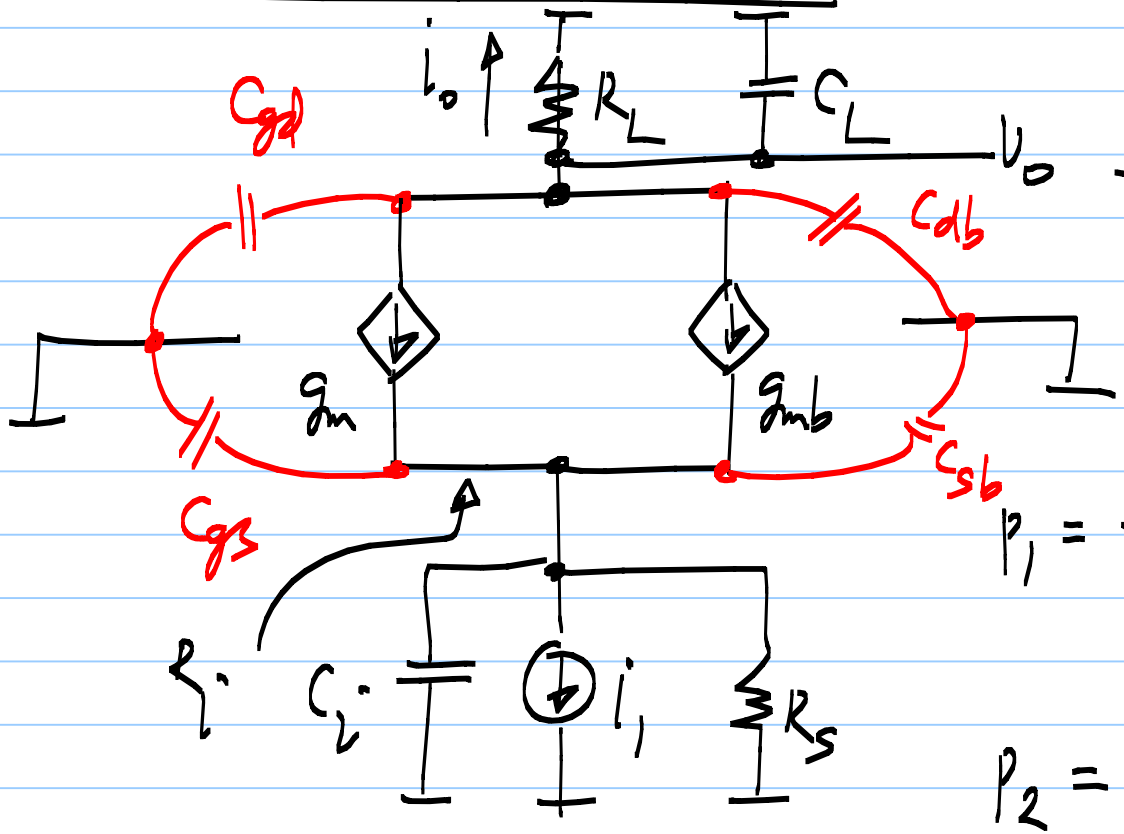
Zeros:

$$g_m \cdot V_i + sC_{gs} \cdot V_i = 0$$

$s = z_1$

$$z_1 = -\frac{g_m}{C_{gs}}$$

Common gate amplifier:



$$C_L' = C_L + C_{db} + C_{gd}$$

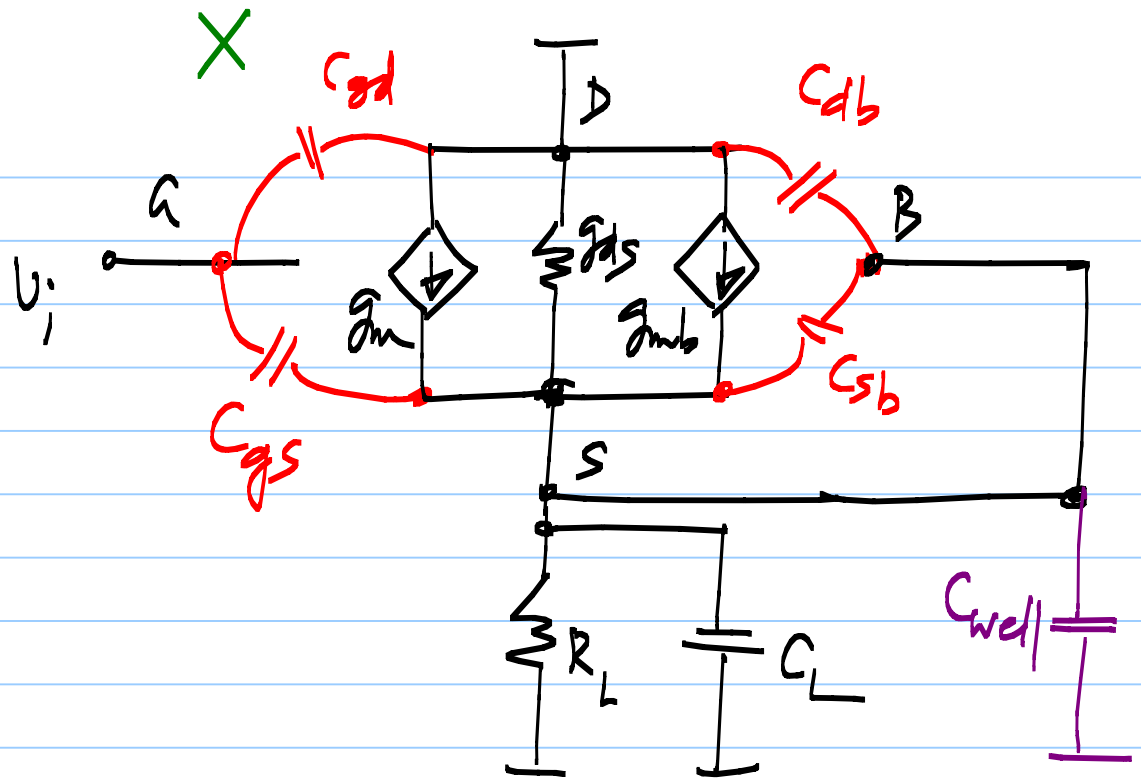
$$C_i' = C_{gs} + C_{sb} + C_i$$

2 poles; No zeros

$$p_1 = -\frac{g_m + g_{mb} + G_s}{C_i'}$$

$$p_2 = -\frac{1}{R_L C_L'} = -\frac{G_L}{C_L'}$$

$$\frac{i_o}{i_i} = \frac{g_m + g_{mb}}{g_m + g_{mb} + g_s} \cdot \frac{1}{\left(1 + s \cdot \frac{C_i''}{g_s + g_m + g_{mb}}\right)\left(1 + \frac{sC_L'}{g_L}\right)}$$



Bulk was @ s.s. gnd

$$C_L' = C_L + C_{sb}$$

Bulk: tied to source

$$C_L' = C_L + C_{db} + C_{well}$$

PMOS CD amplifier:

CS amplifier :

$$C_L' = C_{db} + C_L$$

$$G_L' = G_L + g_{ds}$$