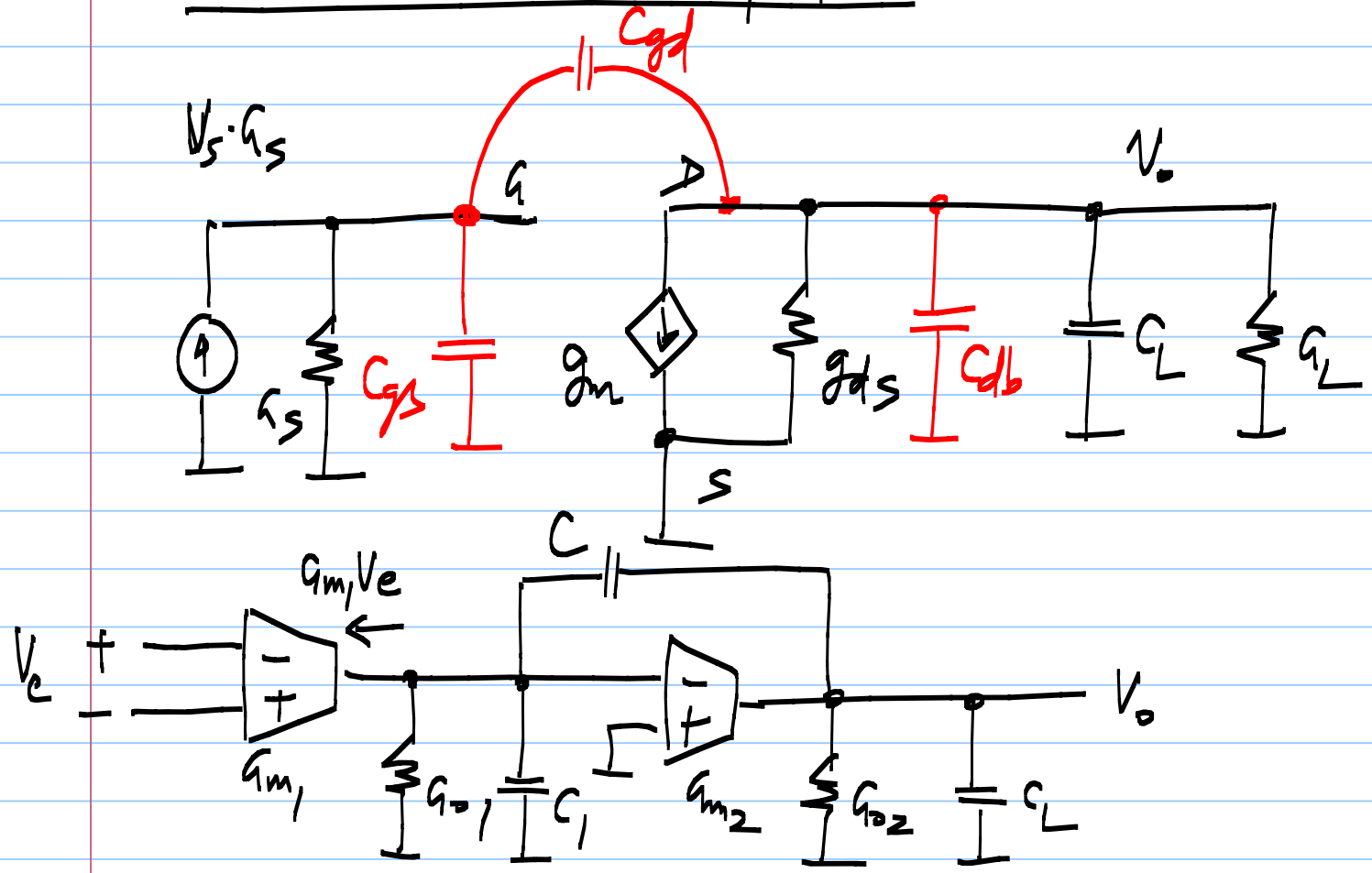
Lecture 28

Common source amplifier

$C_L' = C_L + C_{db}$

$G_L' = G_L + g_{ds}$



$$\frac{V_o}{V_s} = \frac{-G_s\left(g_m - sC_{gd}\right)}{s^2\left(C_{gs}C_{gd} + C_{gd}C_L' + C_L'C_{gs}\right) + s\left(C_{gd}\left(g_m + G_s + G_L'\right) + C_L'G_s + C_{gs}G_L'\right) + G_sG_L'}$$

V_s	G_s
C_L'	C_L
C_{gs}	C_1
C_{gd}	C
g_m	G_{m_2}

$-G_{m_1}V_e$

RHP pole: $+\frac{g_m}{C_{gd}}$ → Extra phase shift

$$p_1' \simeq -\frac{G_S}{C_{gd}\left(\frac{g_m}{G_L'} + 1 + \frac{G_S}{G_L'}\right) + C_{gs} + C_L' \cdot \frac{G_S}{G_L'}}$$

$$p_2' \simeq -\frac{G_L' + g_m \cdot \frac{C_{gd}}{C_{gd}+C_{gs}} + G_S \cdot \frac{C_{gd}+C_L'}{C_{gd}+C_{gs}}}{C_L' + \frac{C_{gd} \cdot C_{gs}}{C_{gs}+C_{gd}}}$$

lower freq.

W/o C_{gd}

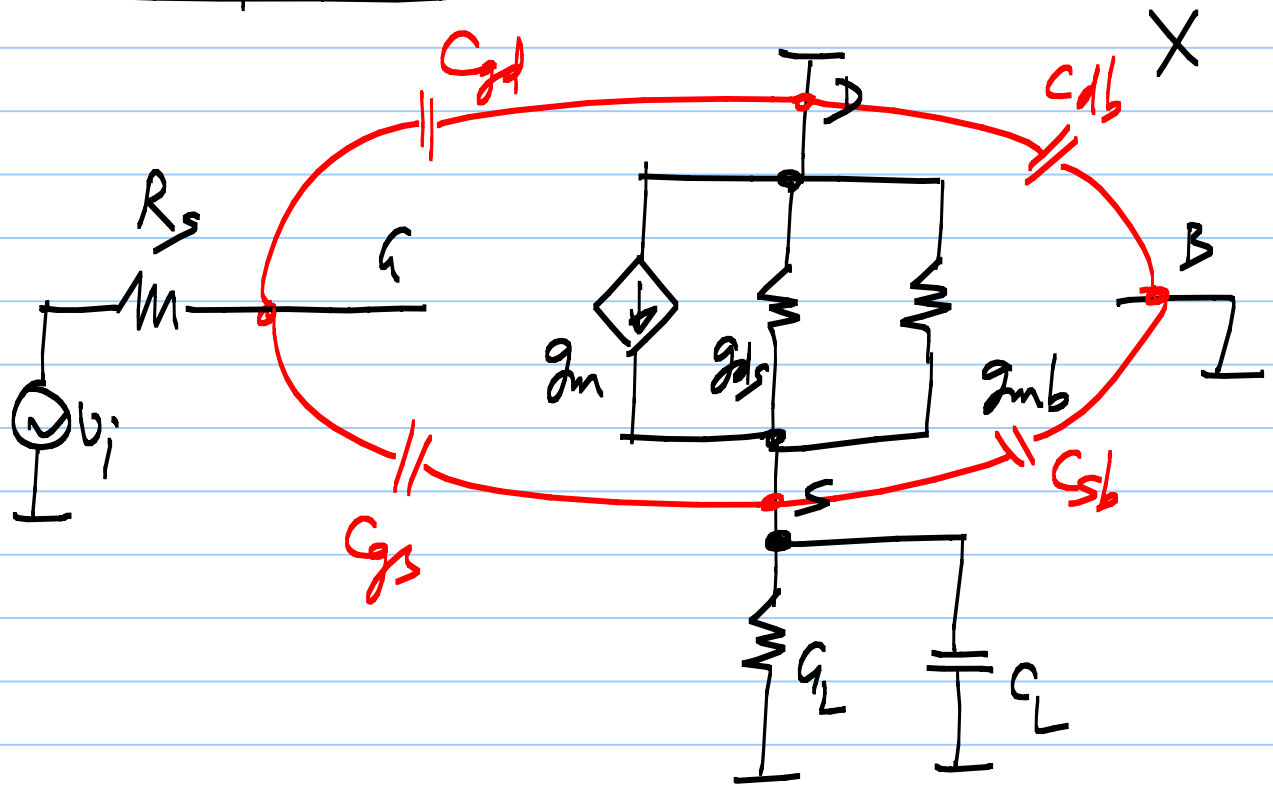
$-\frac{G_S}{C_{gs}}$

$-\frac{G_L'}{C_L'}$

higher freq.

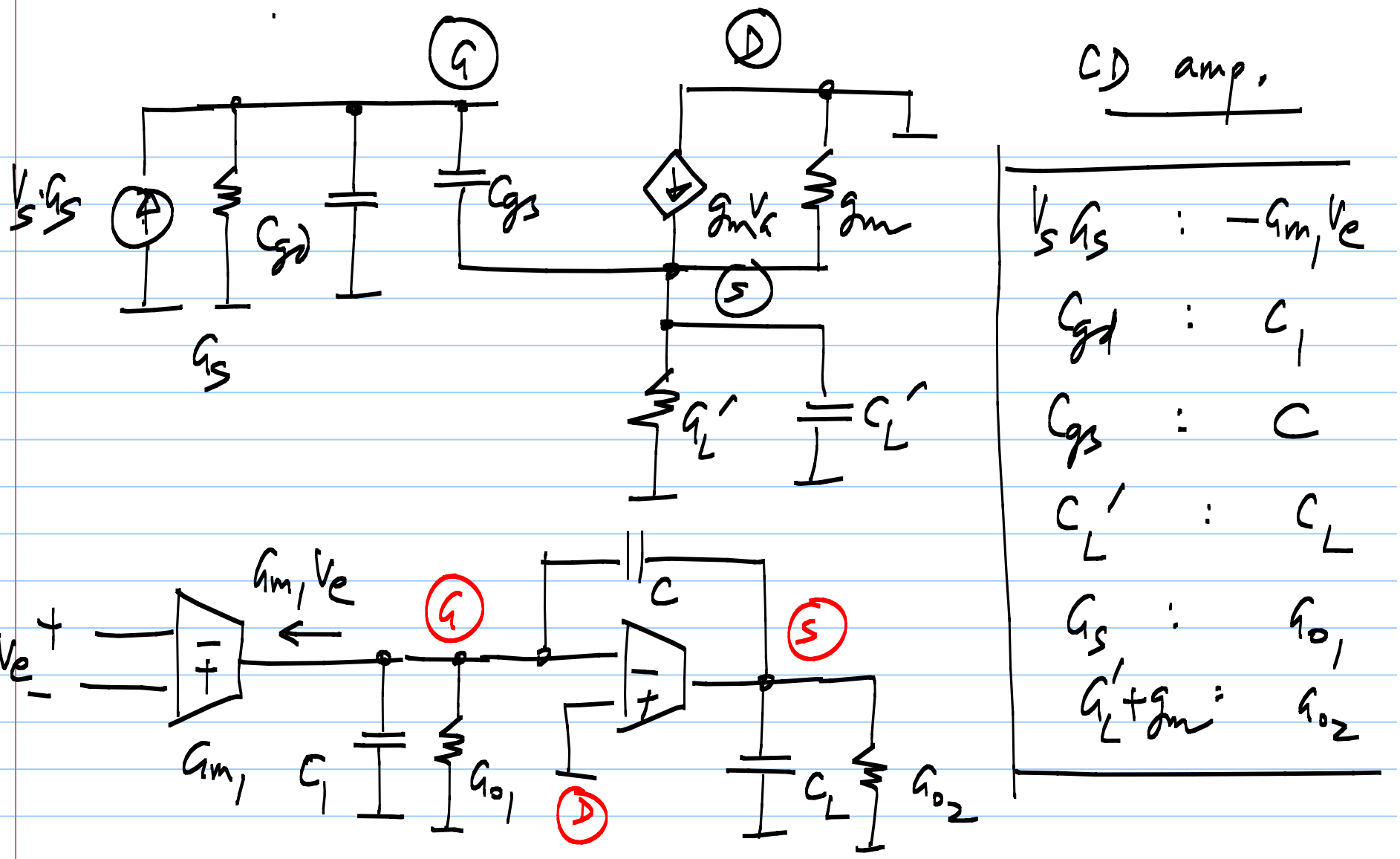
POLE SPLITTING

CD amplifier:



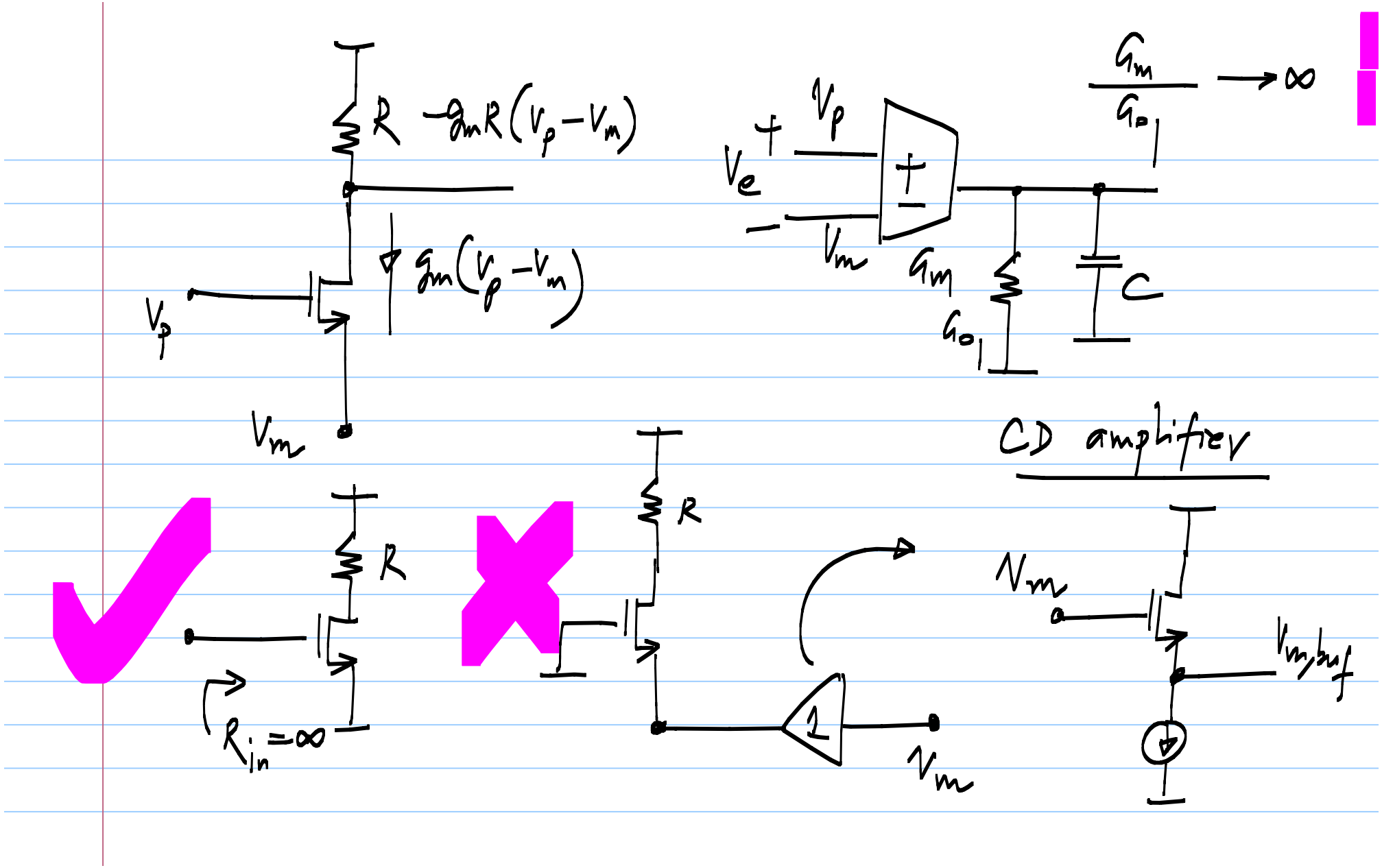
$$C_L' = C_{sb} + C_L$$

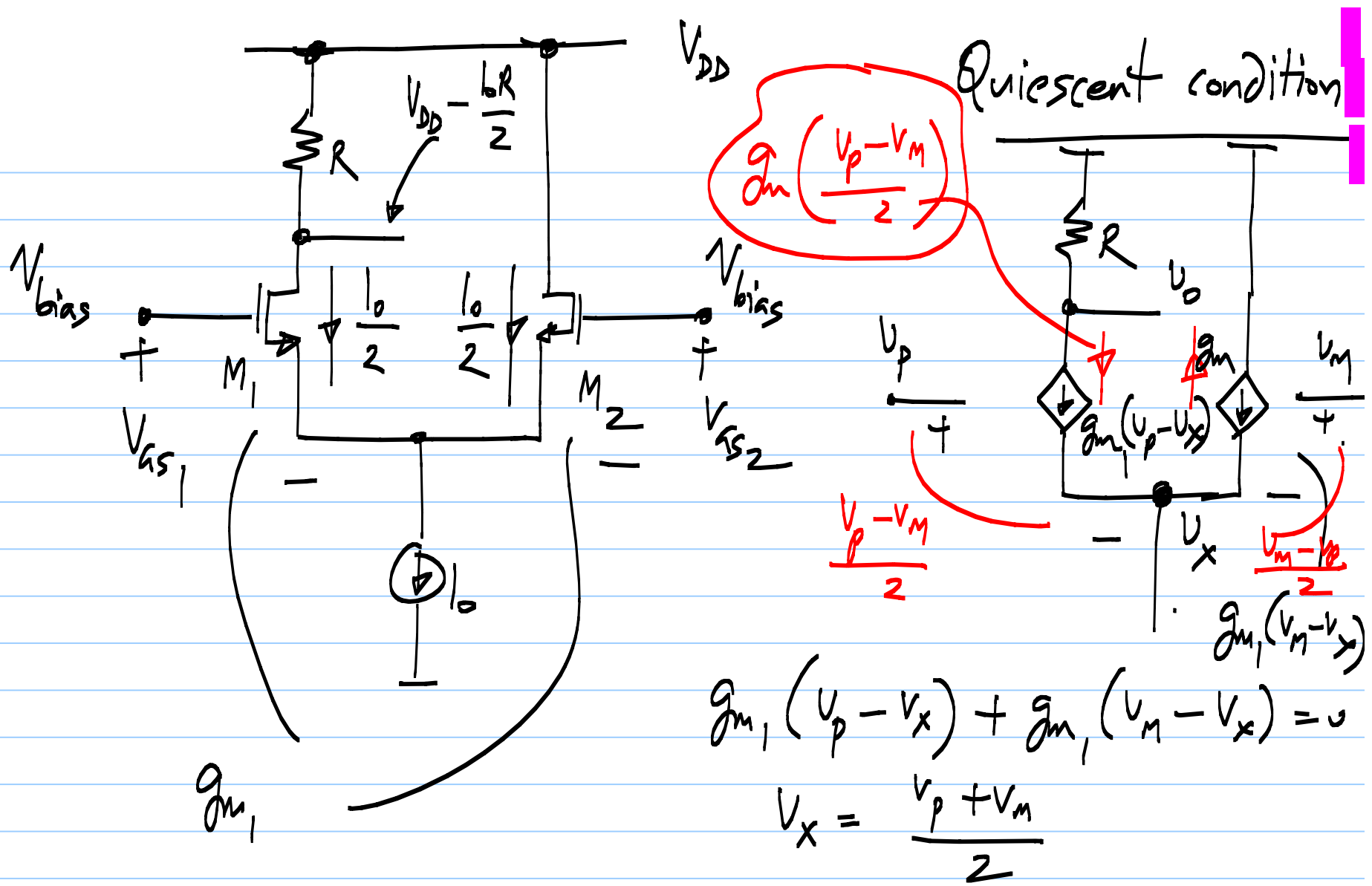
$$G_L' = G_L + g_{mb} + g_{ds}$$



CD amp.

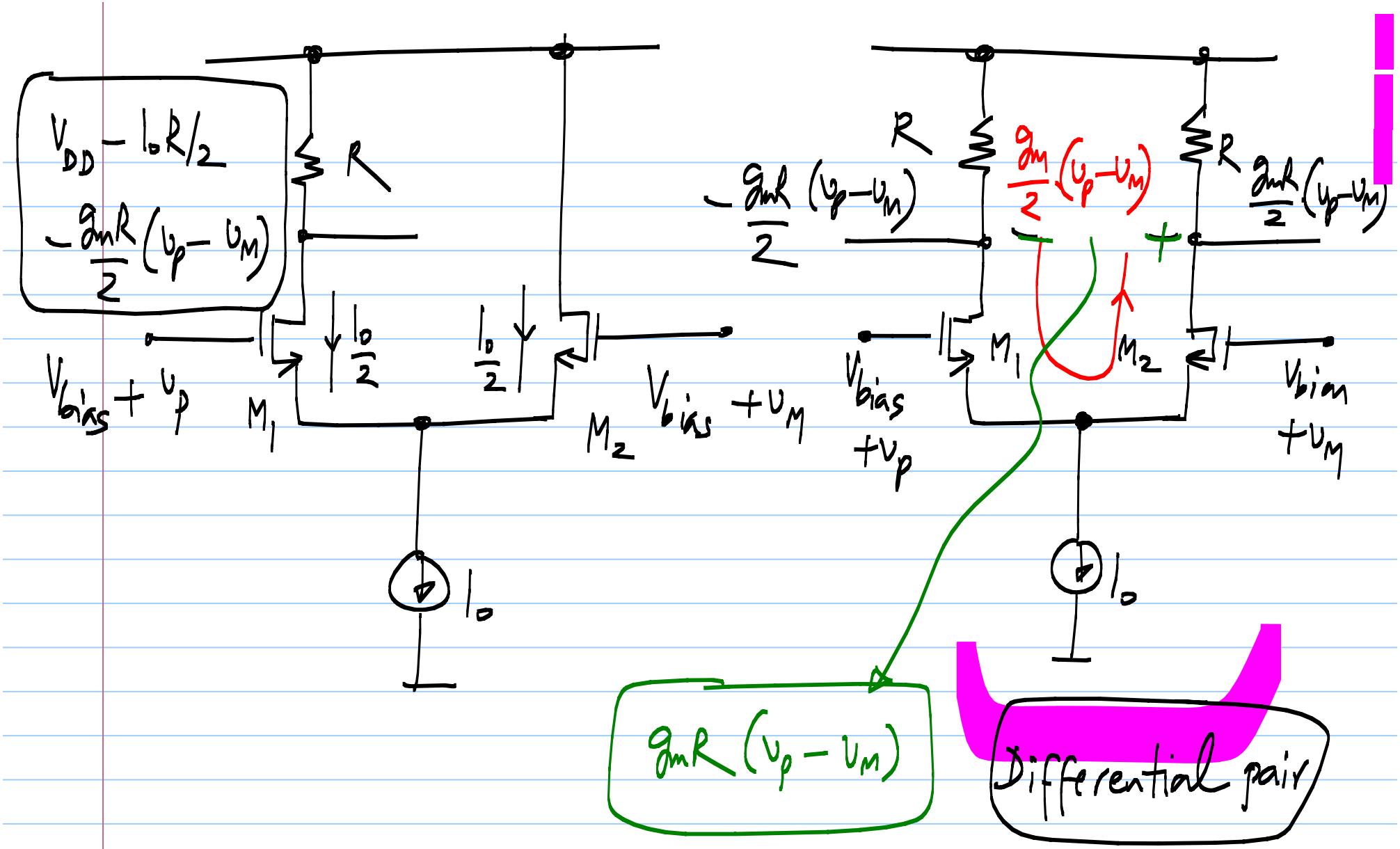
$V_s G_s$	:	$-G_{m1} V_e$
C_{gd}	:	C_1
C_{gs}	:	C
C_L'	:	C_L
G_s	:	G_{o1}
$G_L' + g_m$	:	G_{o2}


R
$-g_m R(V_p - V_m)$
$+ g_m(V_p - V_m)$
V_p
V_m
V_e
$+$
$-$
V_p
V_m
G_m
G_o
C
$\frac{G_m}{G_o} \to \infty$
$R_{in} = \infty$
1
V_m
CD amplifier
V_m
$V_{m,buf}$

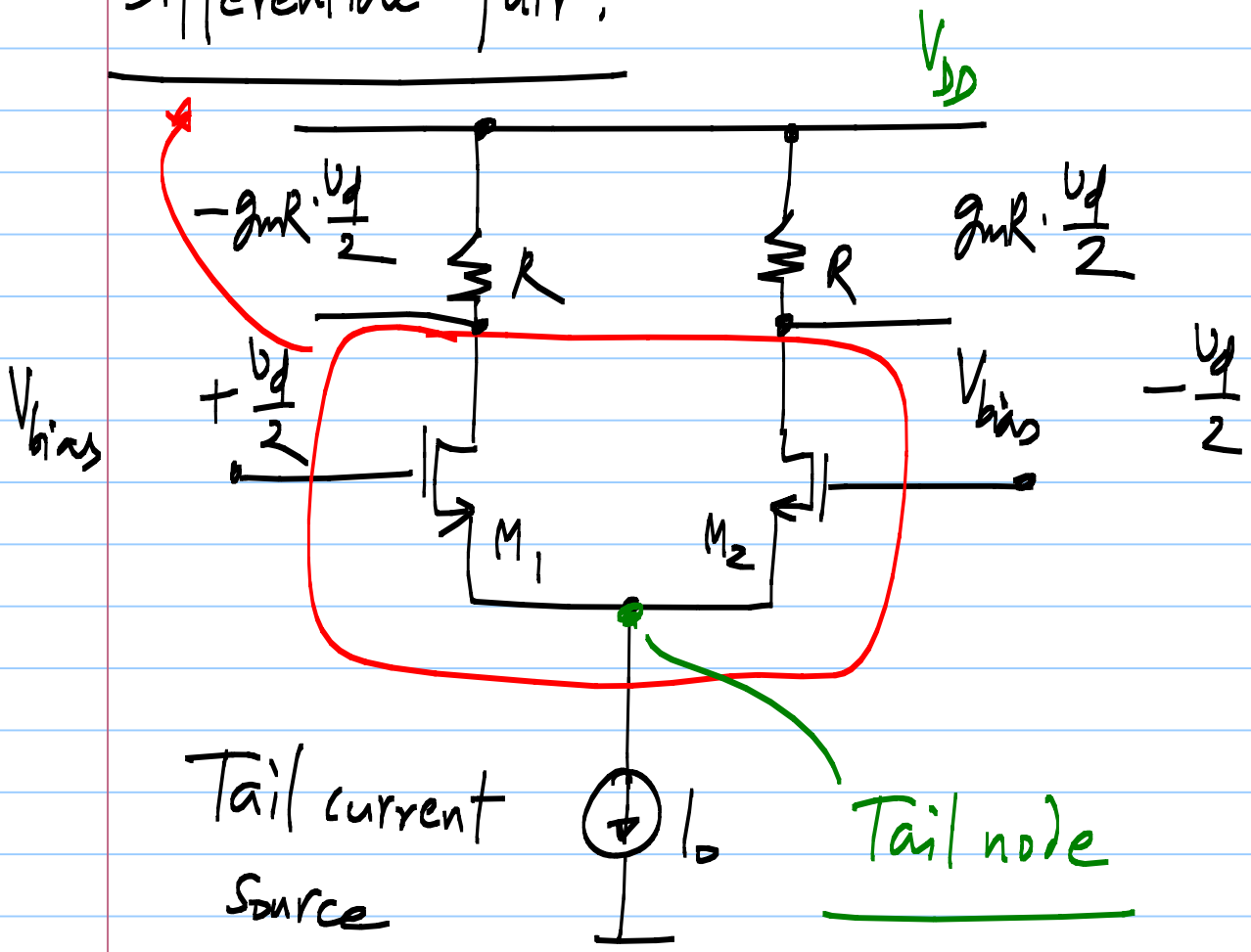


$$g_{m_1}(V_p - V_x) + g_{m_1}(V_M - V_x) = 0$$

$$V_x = \frac{V_p + V_M}{2}$$


$V_{DD} - I_0 R/2$
$-\frac{g_m R}{2}(v_p - v_M)$
R
$\frac{I_0}{2}$
$\frac{I_0}{2}$
$V_{bias} + v_p$
M_1
M_2
$V_{bias} + v_M$
I_0
$-\frac{g_m R}{2}(v_p - v_M)$
R
$\frac{g_m}{2}(v_p - v_M)$
R
$\frac{g_m R}{2}(v_p - v_M)$
$V_{bias} + v_p$
M_1
M_2
$V_{bias} + v_M$
I_0
$g_m R (v_p - v_M)$
Differential pair

Differential pair:



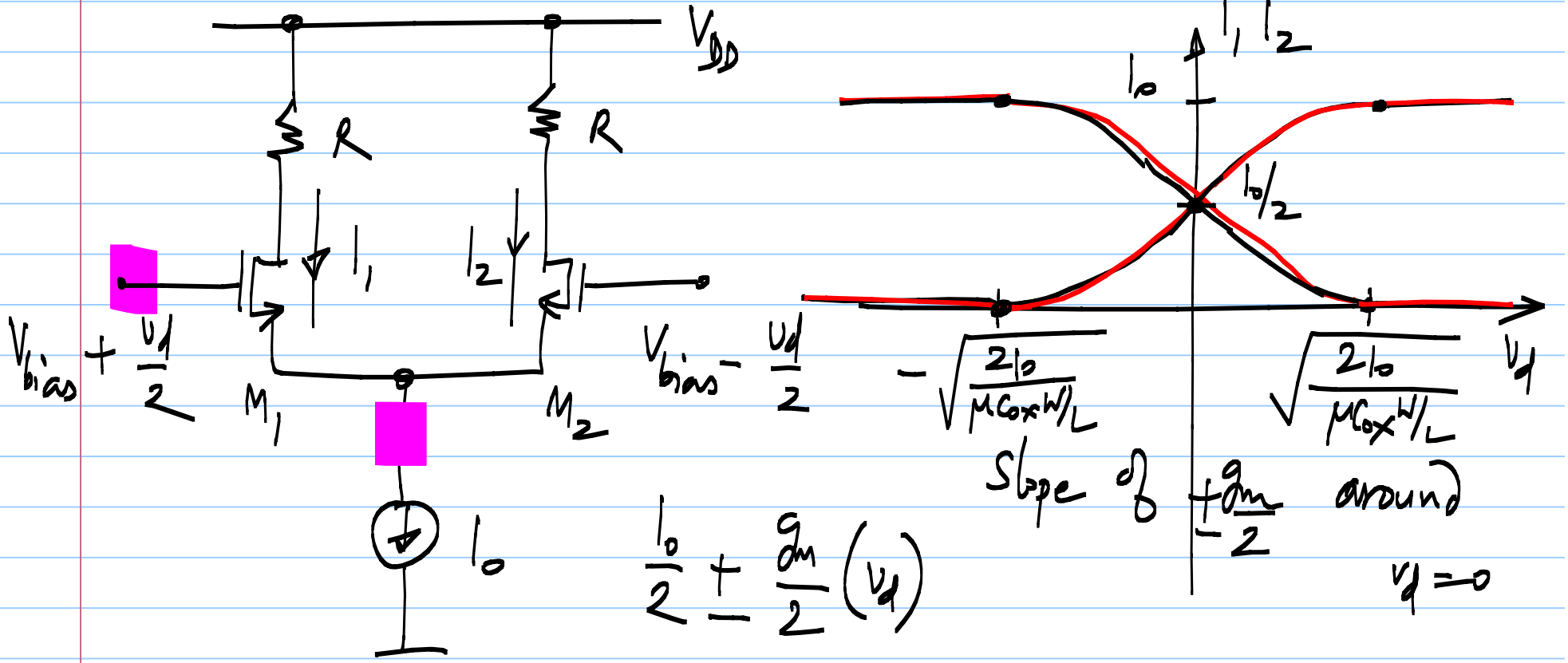
Large signal & Small signal analysis

$$\frac{v_p + v_M}{2} \pm \left(\frac{v_p - v_M}{2}\right)$$

Common mode voltage

$\frac{1}{2}\cdot$ differential voltage

Large signal analysis of the differential pair



Quiescent V_{as} of M_1 & M_2: $V_T + \sqrt{\frac{2 \cdot I_0/2}{\mu C_{ox} W/L}}$

V_{as} of M_1 at a current of I_0: $V_T + \sqrt{\frac{2 \cdot I_0}{\mu C_{ox} W/L}}$

V_{as} of M_2 when M_1 is carrying I_0: V_T

$$v_1 = \sqrt{\frac{2 I_0}{\mu C_{ox} W/L}}$$