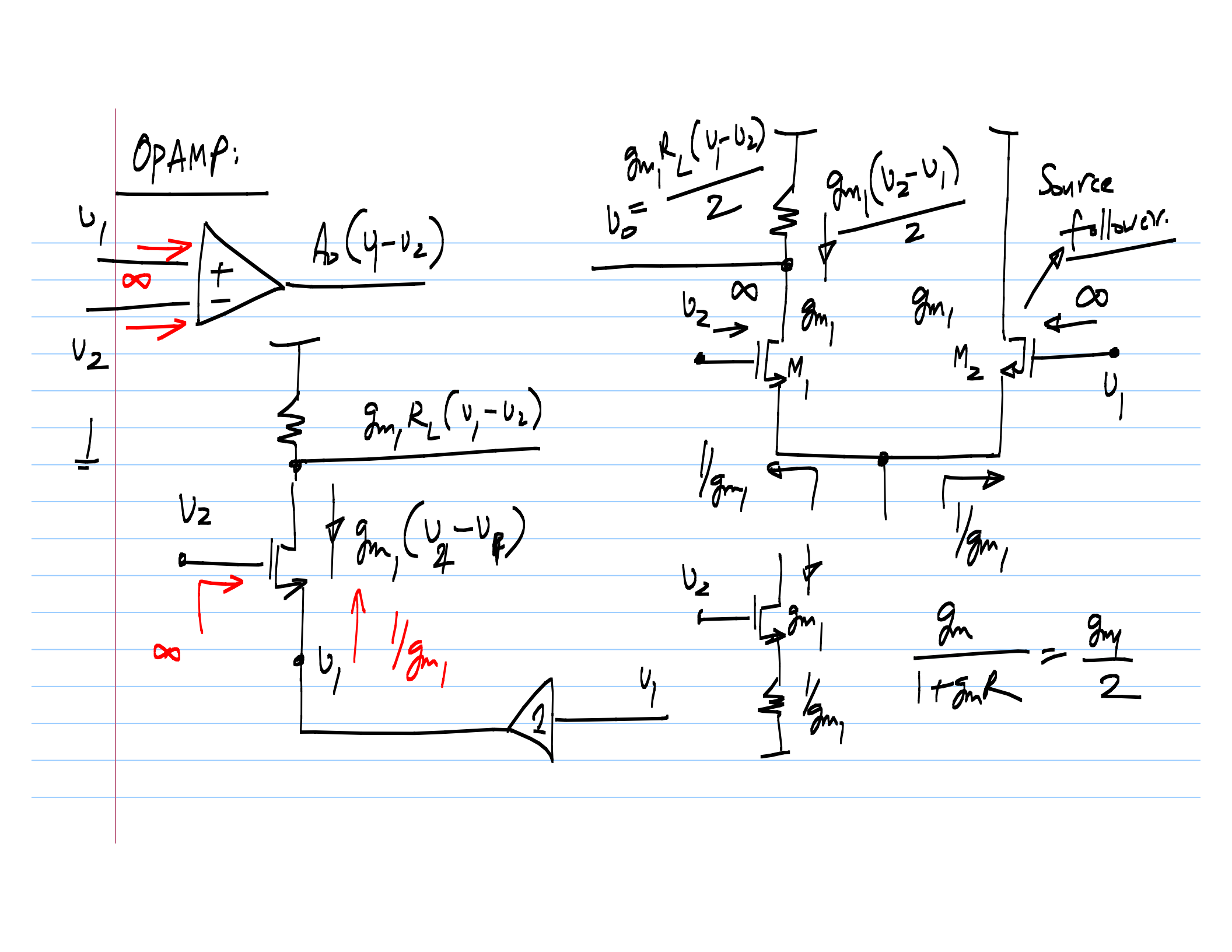
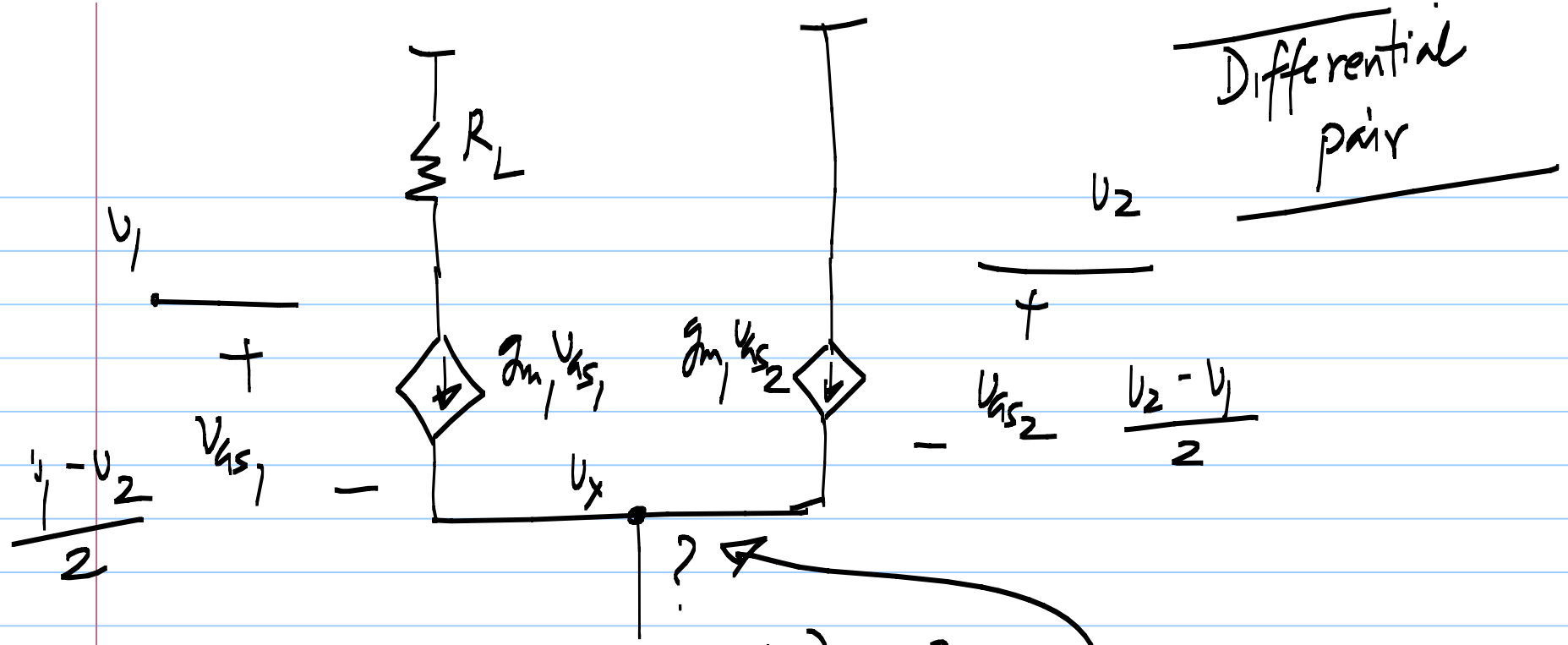
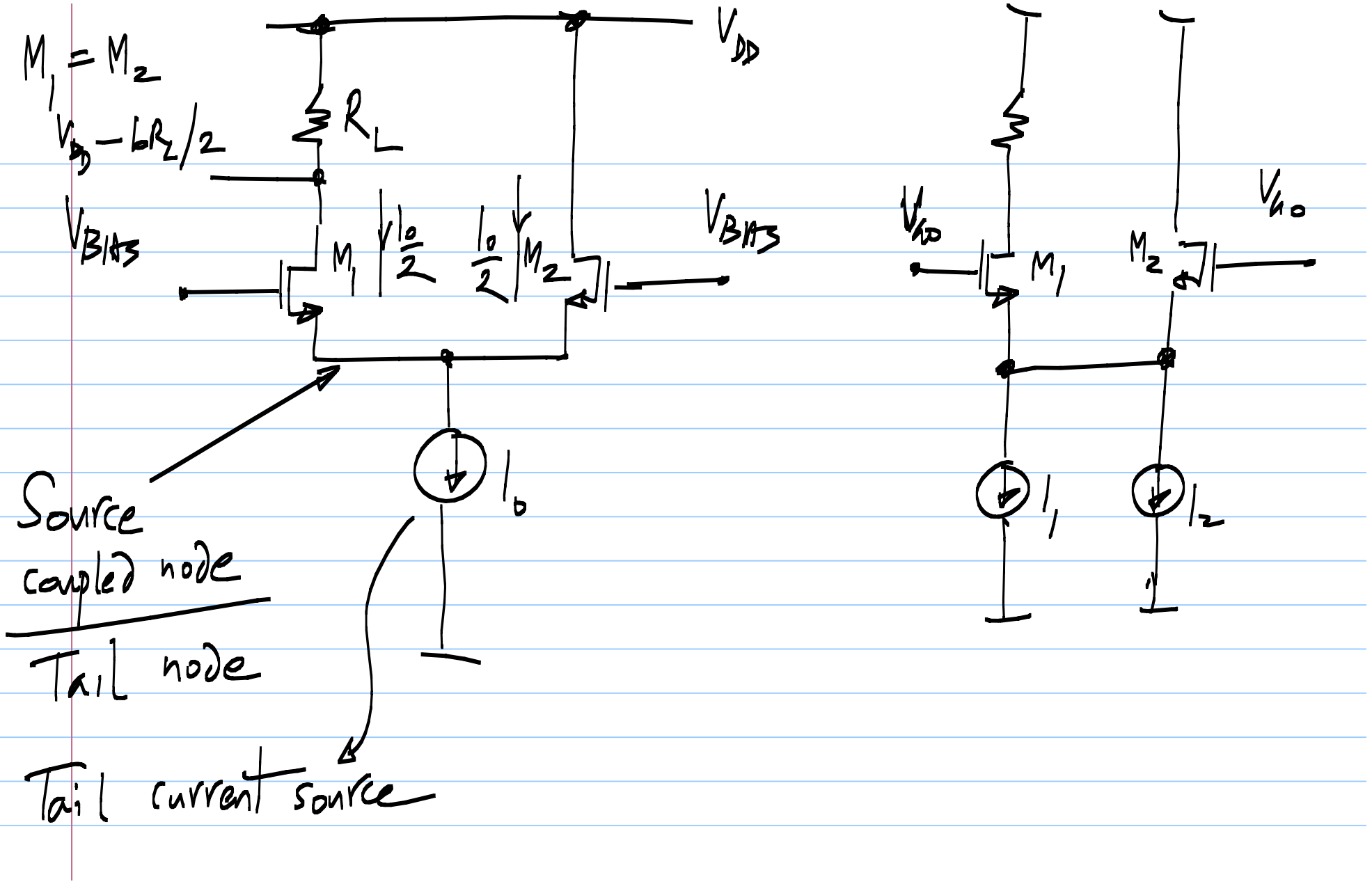

OpAMP:
v_1
∞
$A_0(v_1-v_2)$
v_2
$g_{m_1}R_L(v_1-v_2)$
v_2
$g_{m_1}(v_2-v_1)$
∞
v_1
$1/g_{m_1}$
1
$g_{m_1}R_L(v_1-v_2)$ / 2
$v_o =$
$g_{m_1}(v_2-v_1)$ / 2
v_2
∞
g_{m_1}
M_1
g_{m_1}
M_2
Source follower.
∞
v_1
$1/g_{m_1}$
$1/g_{m_1}$
v_2
g_{m_1}
$1/g_{m_1}$
$\frac{g_m}{1+g_mR} = \frac{g_m}{2}$

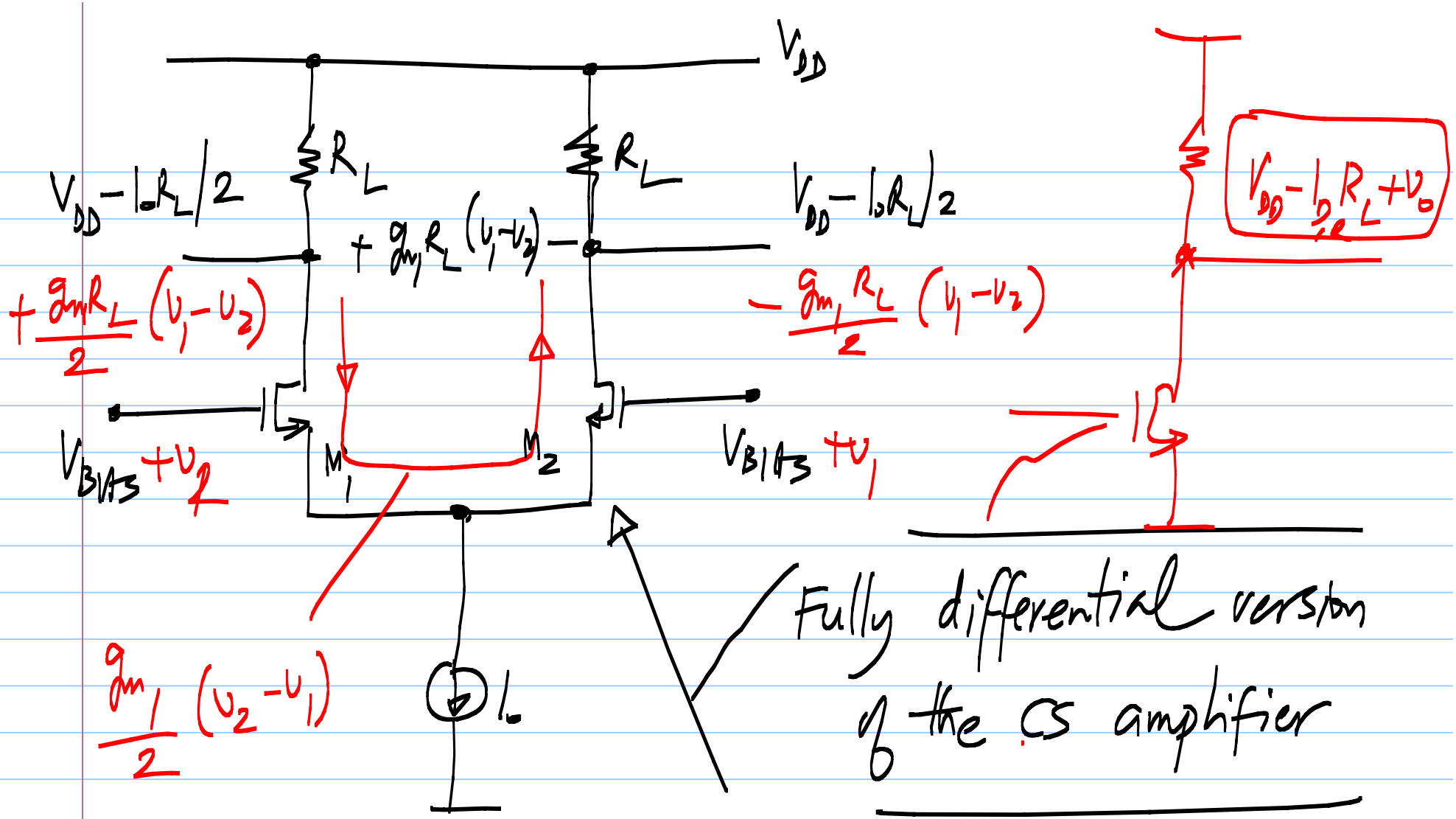
Differential pair



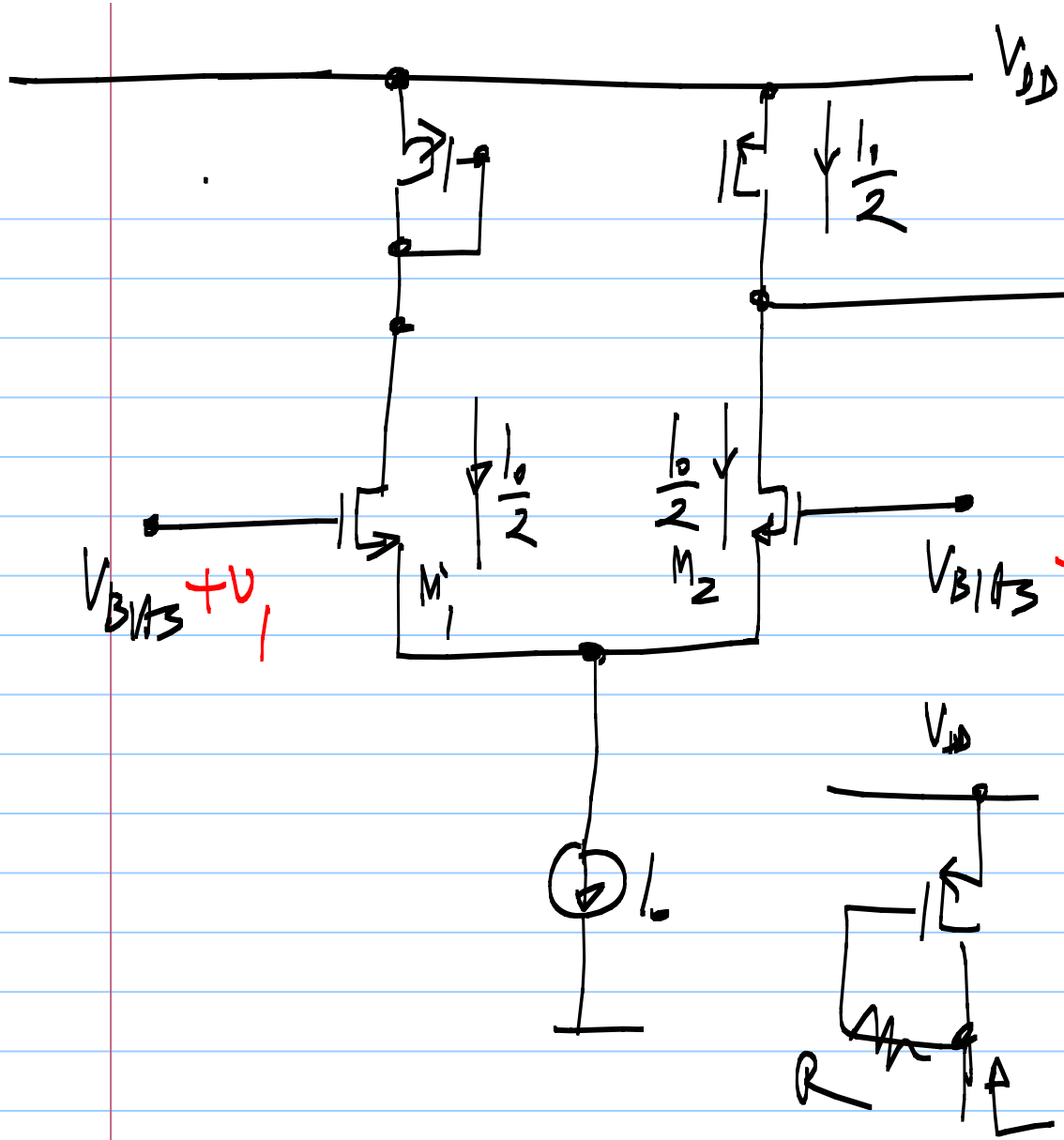
$$g_{m1}(v_1 - v_x) + g_{m1}(v_2 - v_x) = 0$$

$$v_x = \frac{v_1 + v_2}{2}$$


$M_1 = M_2$
$V_D - I_D R_L/2$
V_{BIAS}
V_{DD}
R_L
M_1
$\frac{I_0}{2}$
$\frac{I_0}{2}$
M_2
V_{BIAS}
I_0
Source coupled node
Tail node
Tail current source
V_{in1}
V_{in2}
M_1
M_2
I_1
I_2



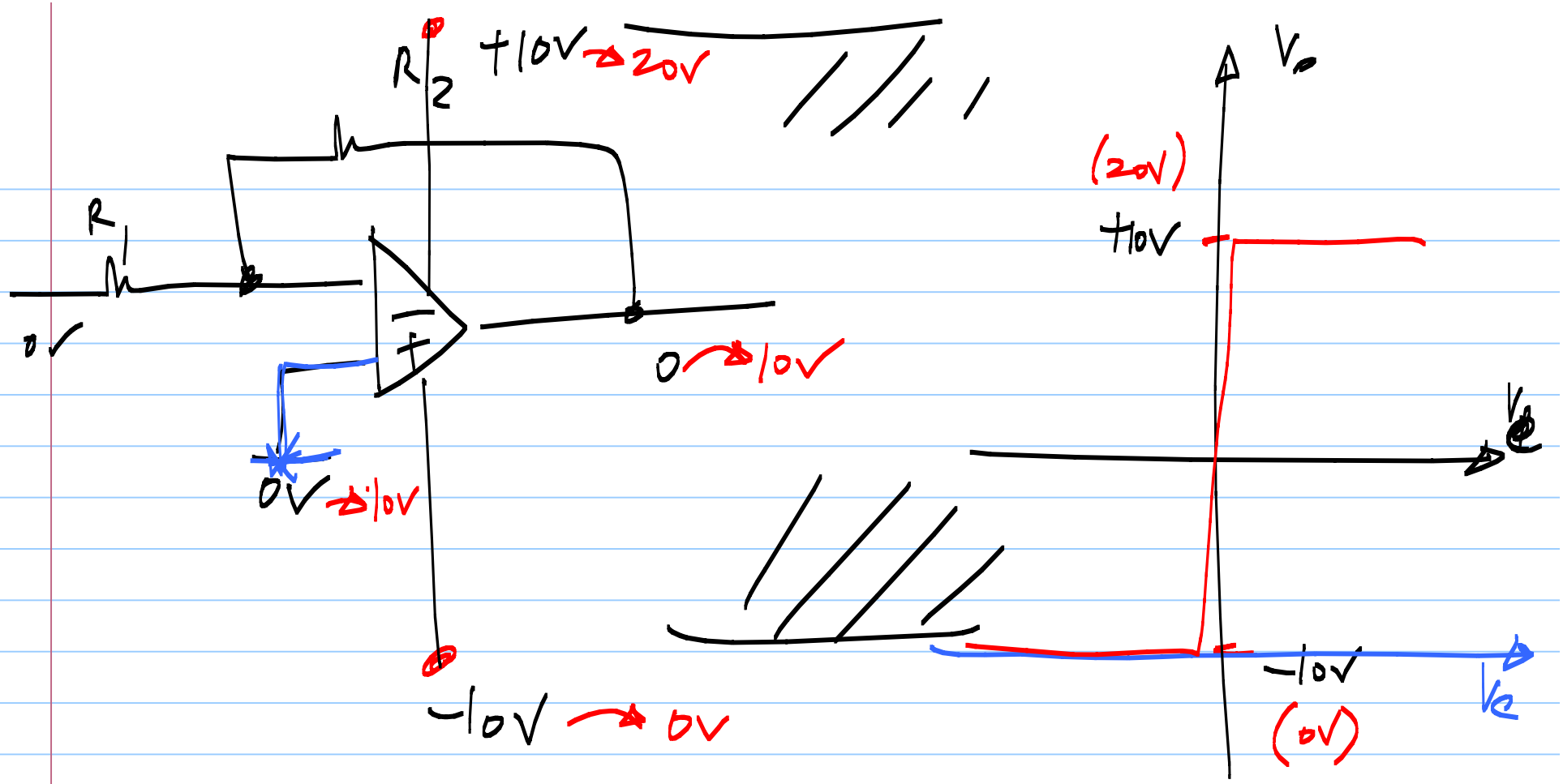
Fully differential version of the CS amplifier



$$V_{DD} - \frac{I_0 R_L}{2} + \underbrace{\frac{g_{m_1} R_L}{2}(v_1 - v_2)}$$

$* \frac{g_{m_1} R_L}{2}$: limited

$*$ Use an active load.


R2
+10V → 20V
R1
0V
0 → 10V
0V → 10V
-10V → 0V
Vo
(20V)
+10V
Vi
-10V
(0V)