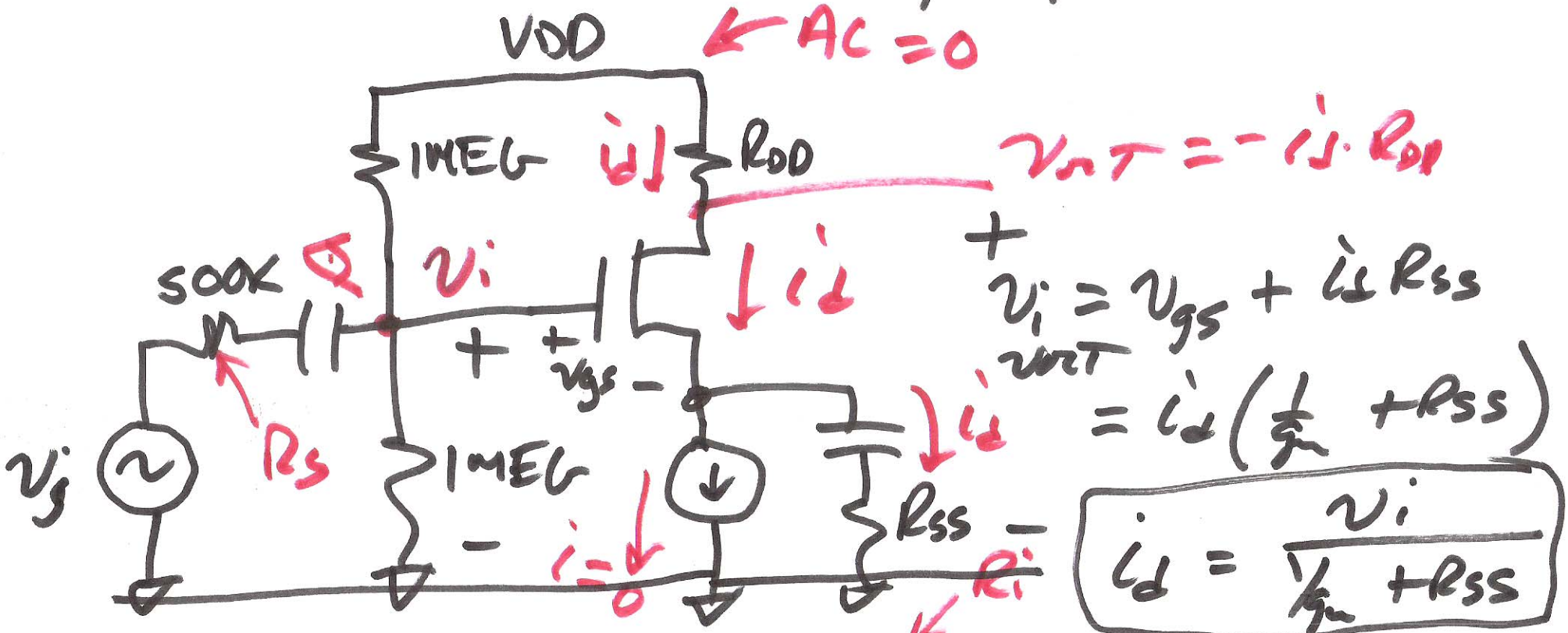
EE 320 Lecture 21

4/15/13



$$v_i = v_s \cdot \frac{500K}{500K + 500K} = \frac{v_s}{2} = v_i$$

R_i R_S

$g_m v_{gs} = i_d$

$$v_{gs} = \frac{i_d}{g_m}$$

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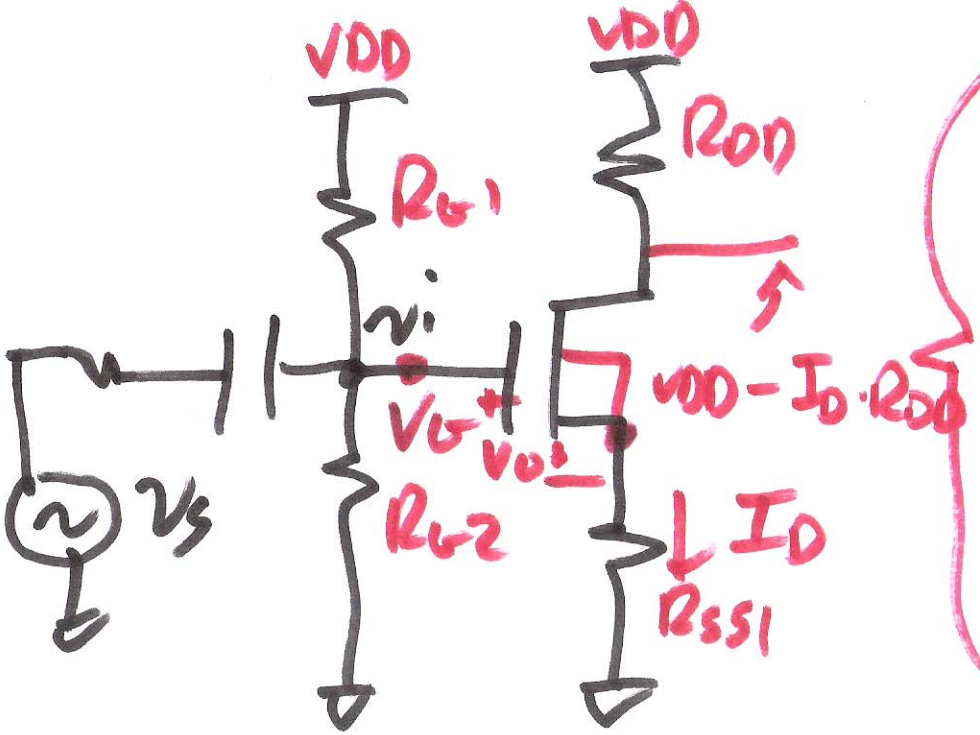
1)



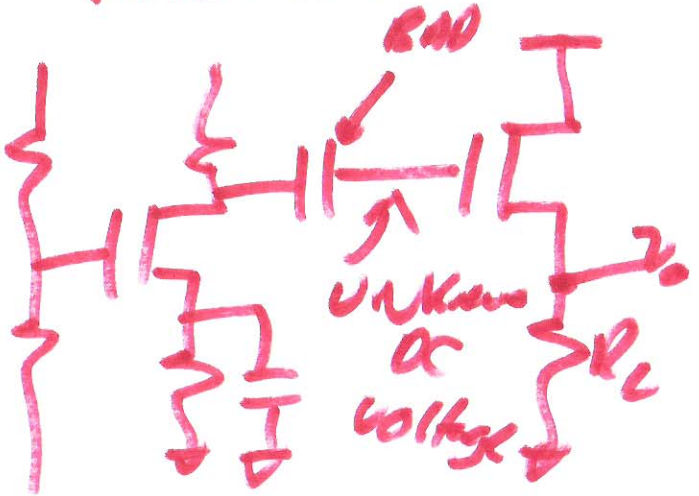
$$V_G = V_{GS} + I_D \cdot R_{SS1}$$

$$I_D = \frac{K_N'}{2} \cdot \frac{W}{L} \left(V_{GS} - V_{THN}\right)^2$$

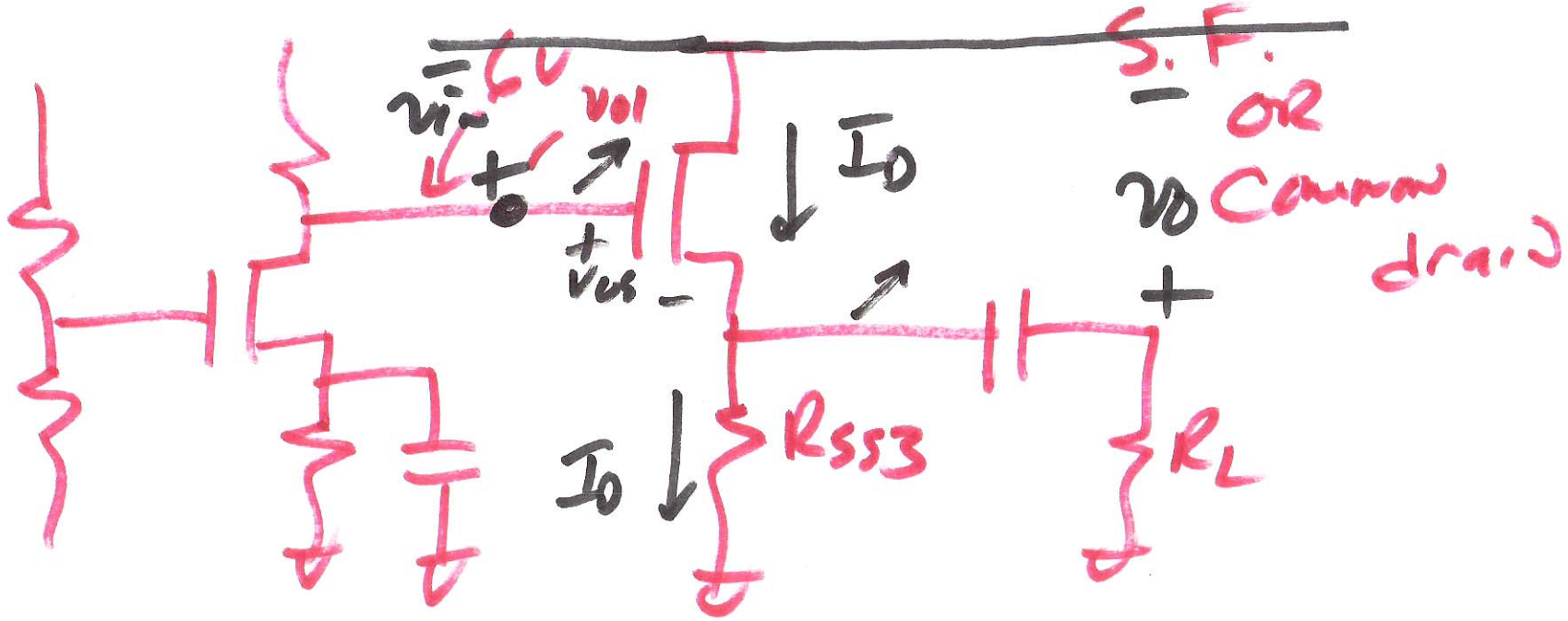
$$V_{GS} = \sqrt{\frac{2 I_D}{K_N' \cdot \frac{W}{L}}} + V_{THN}$$

$$V_G = VDD \cdot \frac{R_{G2}}{R_{G1} + R_{G2}}$$

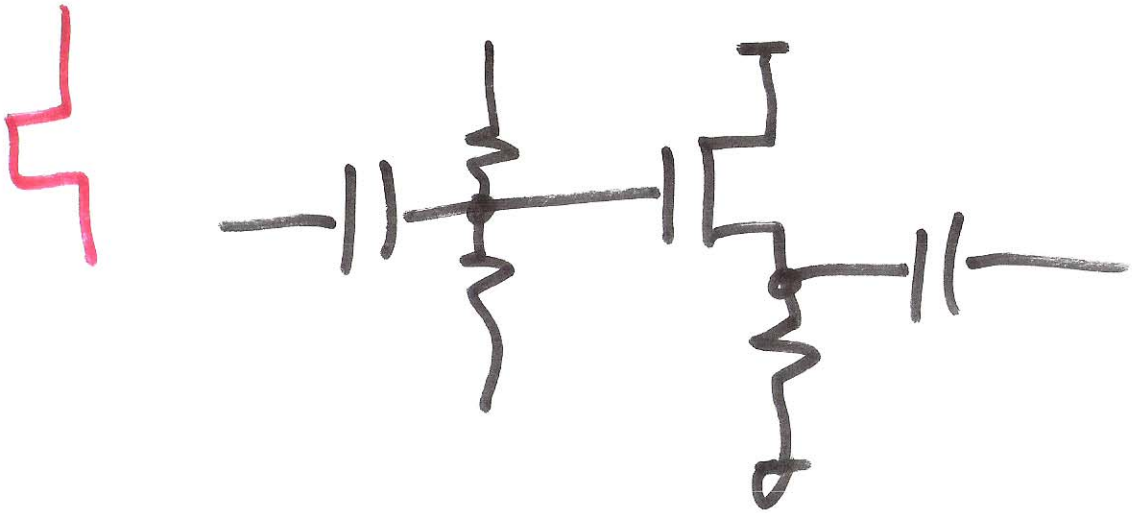
Mistake



2)



$$6 = V_{GS} + I_D \cdot R_{SS3}$$



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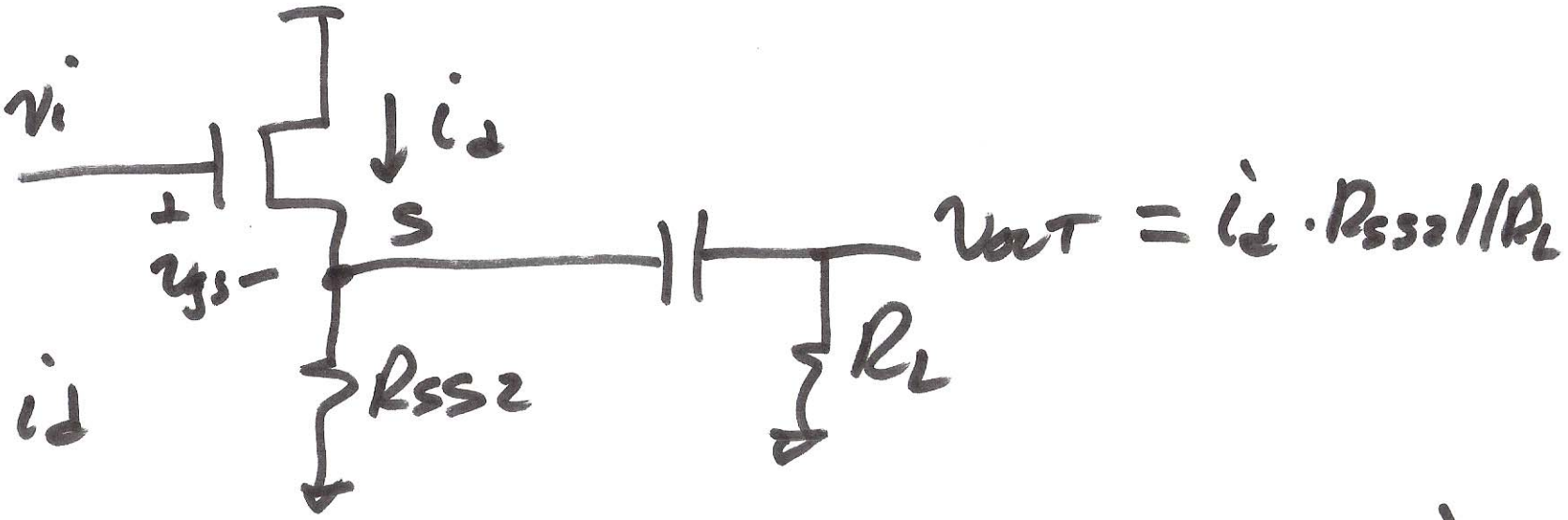
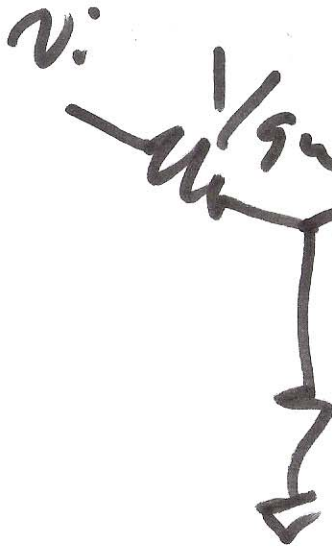




$$v_i = v_{gs} + i_d (R_{SS2} \| R_L)$$

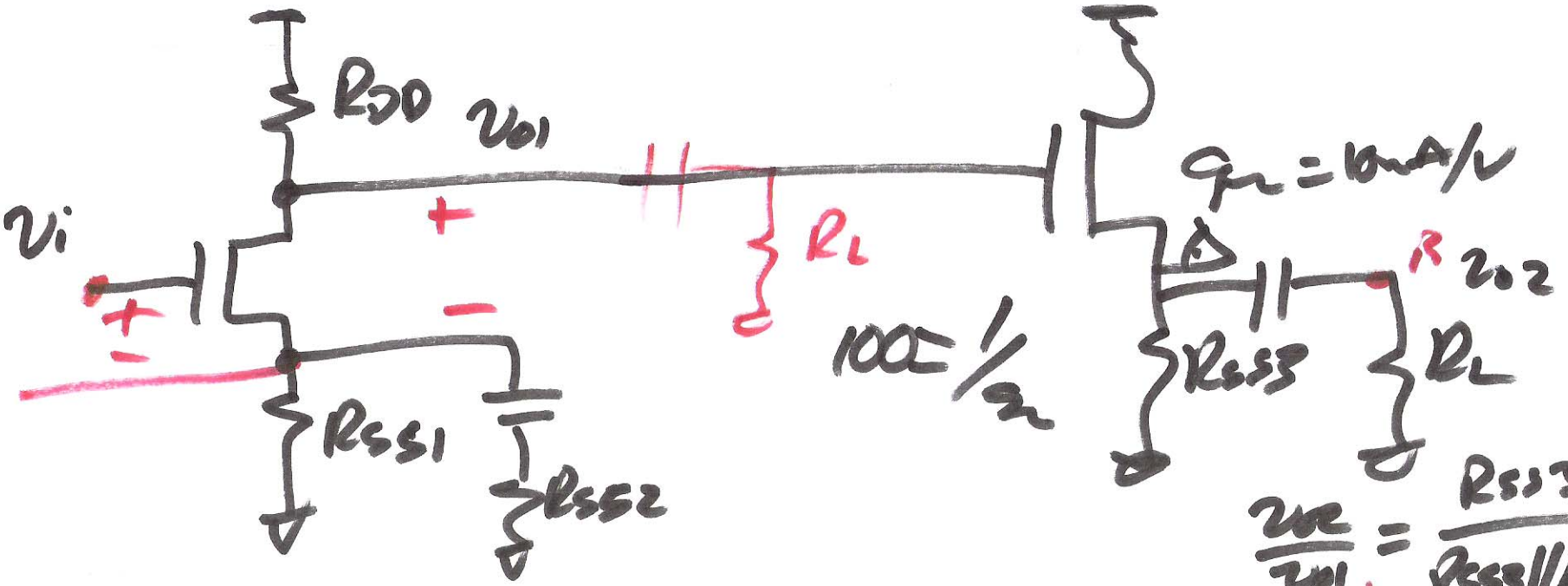
$$v_{oT} = i_d \left(\frac{1}{g_m} + R_{SS2} \| R_L \right)$$

$$\frac{v_{oT}}{v_i} = \frac{R_{SS2} \| R_L}{\frac{1}{g_m} + R_{SS2} \| R_L}$$

$$\frac{1}{g_m} \ll R_{SS2} \| R_L$$

$$\frac{v_{oT}}{v_i} \simeq 1$$

4)



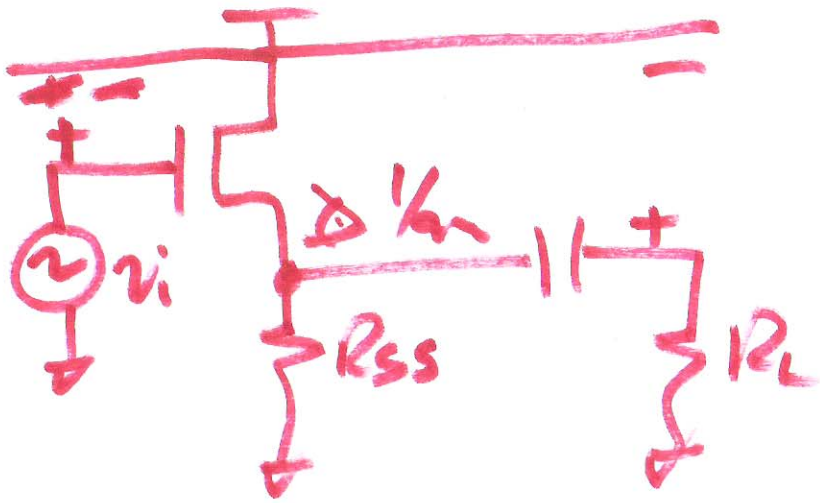
$$\frac{v_{o2}}{v_{o1}} = \frac{R_{SS3}\,||\,R_L}{R_{SS3}\,||\,R_L + 1/g_m}$$

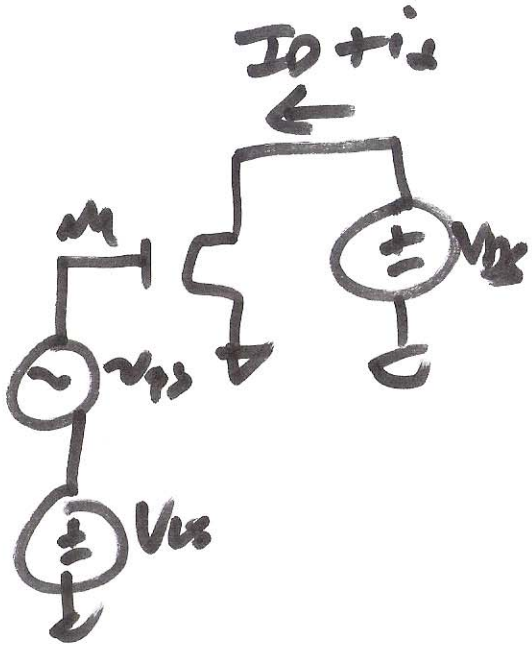
$$\frac{v_{o1}}{v_i} = \frac{-R_{DD}\,||\,R_L}{1/g_m + R_{SS1}\,||\,R_{SS2}} = \frac{-i_d \cdot R_{DD}\,||\,R_L}{i_d \cdot \left(1/g_m + R_{SS1}\,||\,R_{SS2}\right)}$$

Know how to derive g_m!

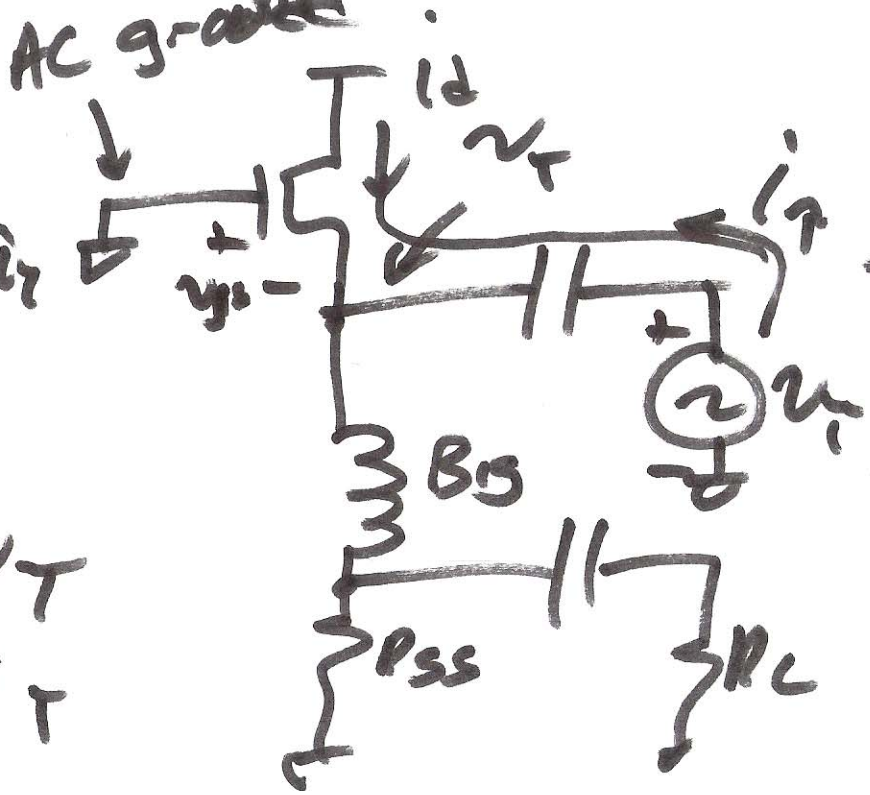
$$g_m = \sqrt{2 I_D \cdot K_n' \cdot \frac{W}{L}}$$

$$= K_n' \cdot \frac{W}{L}\left(V_{GS} - V_{TH}\right)$$





AC ground



$g(-v_T) = -i_T$

$g\, v_{gs} = i_d$

$v_{gs} = -v_T$

$i_d = -i_T$

$\Delta \quad R_{in} = \frac{v_T}{i_T} = \frac{1}{g}$

$I_D + i_d = \frac{K_n}{2}(V_{GS} + v_{gs} - V_{TH})^2$

$g = \frac{2 I_D}{V_{GS} - V_{TH}}$

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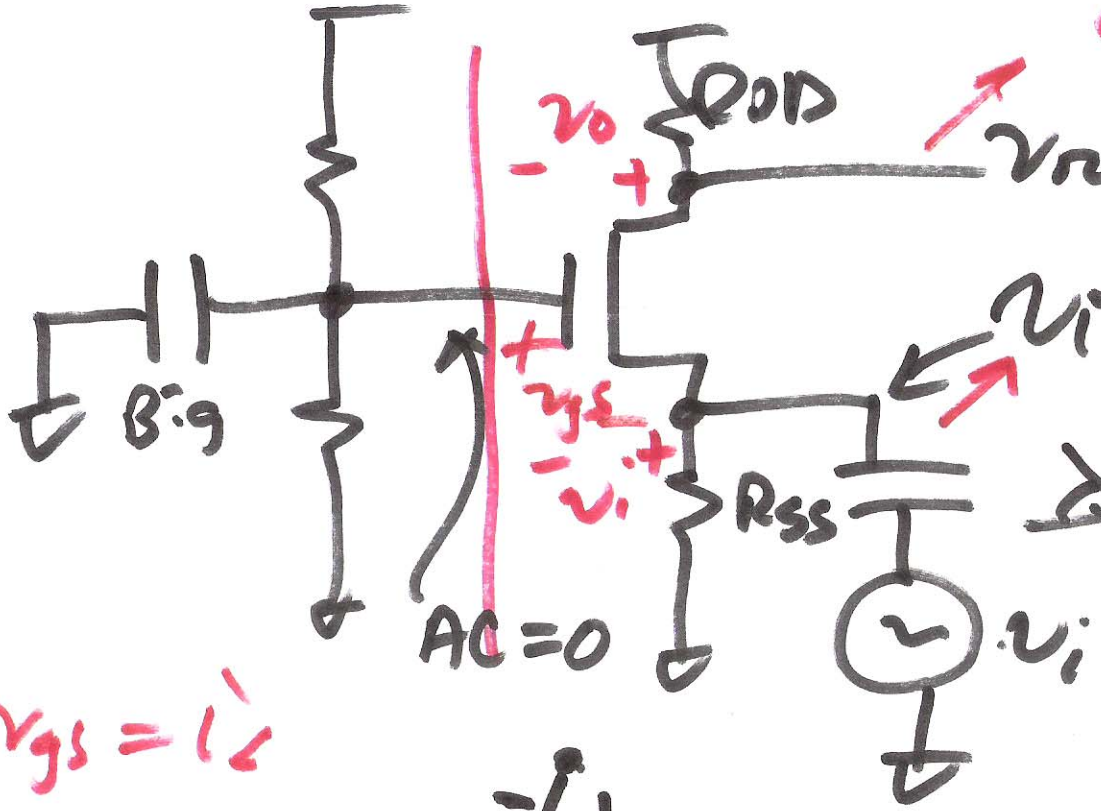
c)

Common-gate

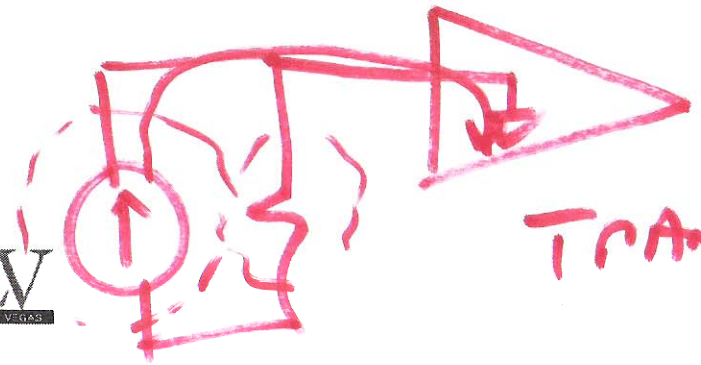


$\Rightarrow R_{in} = R_{SS} \,||\, \frac{1}{g_m}$

$g v_{gs} = i_d$

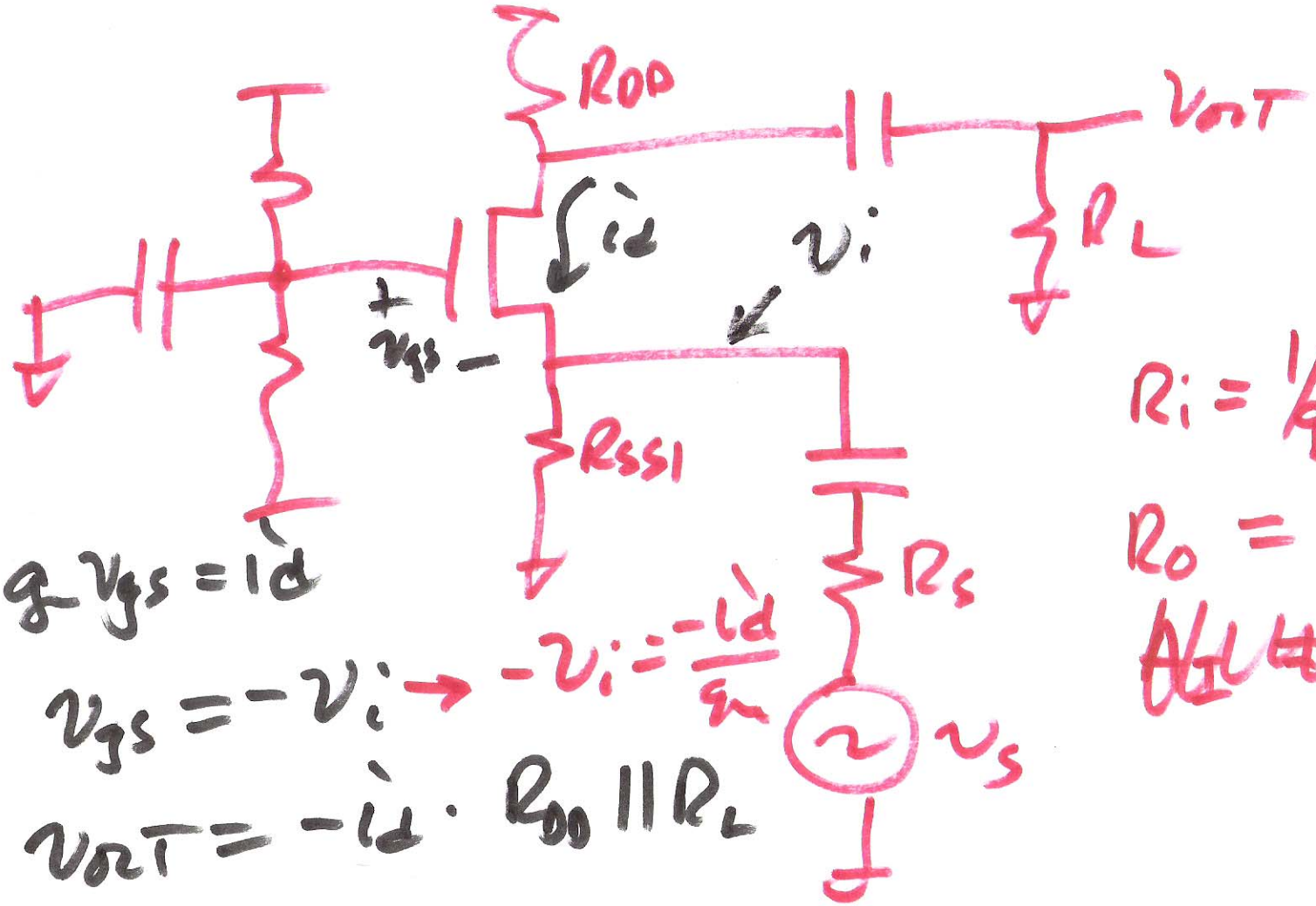
$v_{gs} = -v_i = \frac{-i_d}{g_m}$

$\frac{v_o}{v_i} = \frac{-i_d \cdot R_{DD}}{-i_d/g_m}$



$\frac{V}{I} = = g_m R_{DD}$

Transimpedance Resistance



$g_m v_{gs} = i_d$

$v_{gs} = -v_i \rightarrow -v_i = \frac{-i_d}{g_m}$

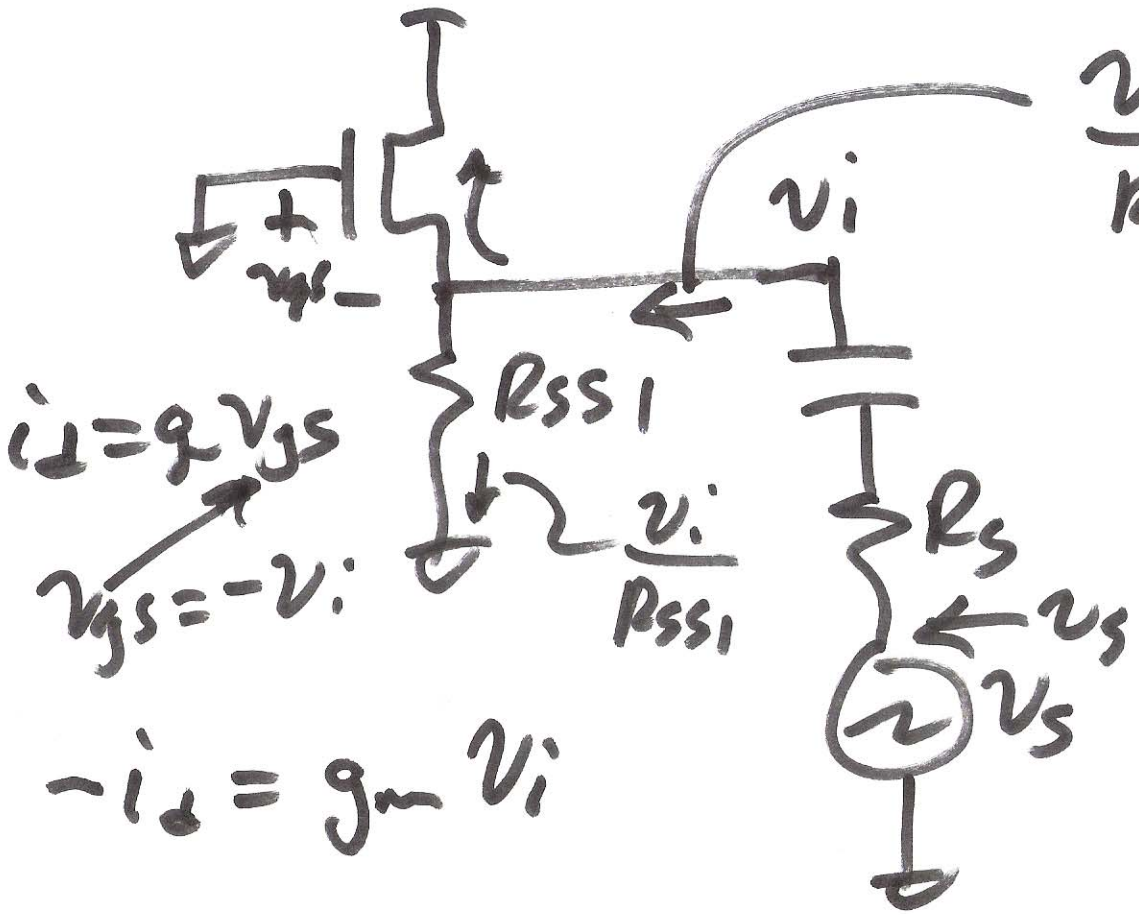
$v_{OUT} = -i_d \cdot R_{DD} \| R_L$

$R_i = \frac{1}{g_m} \| R_{SS1}$

$R_o = R_{DD}$

$\frac{v_{OUT}}{v_i} = \frac{-i_d \cdot R_{DD} \| R_L}{-i_d \cdot \frac{1}{g_m}} = \frac{R_{DD} \| R_L}{\frac{1}{g_m}}$

$v_i = v_s \cdot \frac{R_{SS1} \| \frac{1}{g_m}}{R_{SS1} \| \frac{1}{g_m} + R_S}$



$$\frac{v_i}{R_{SS1}} + (-i_d) = i_{in}$$

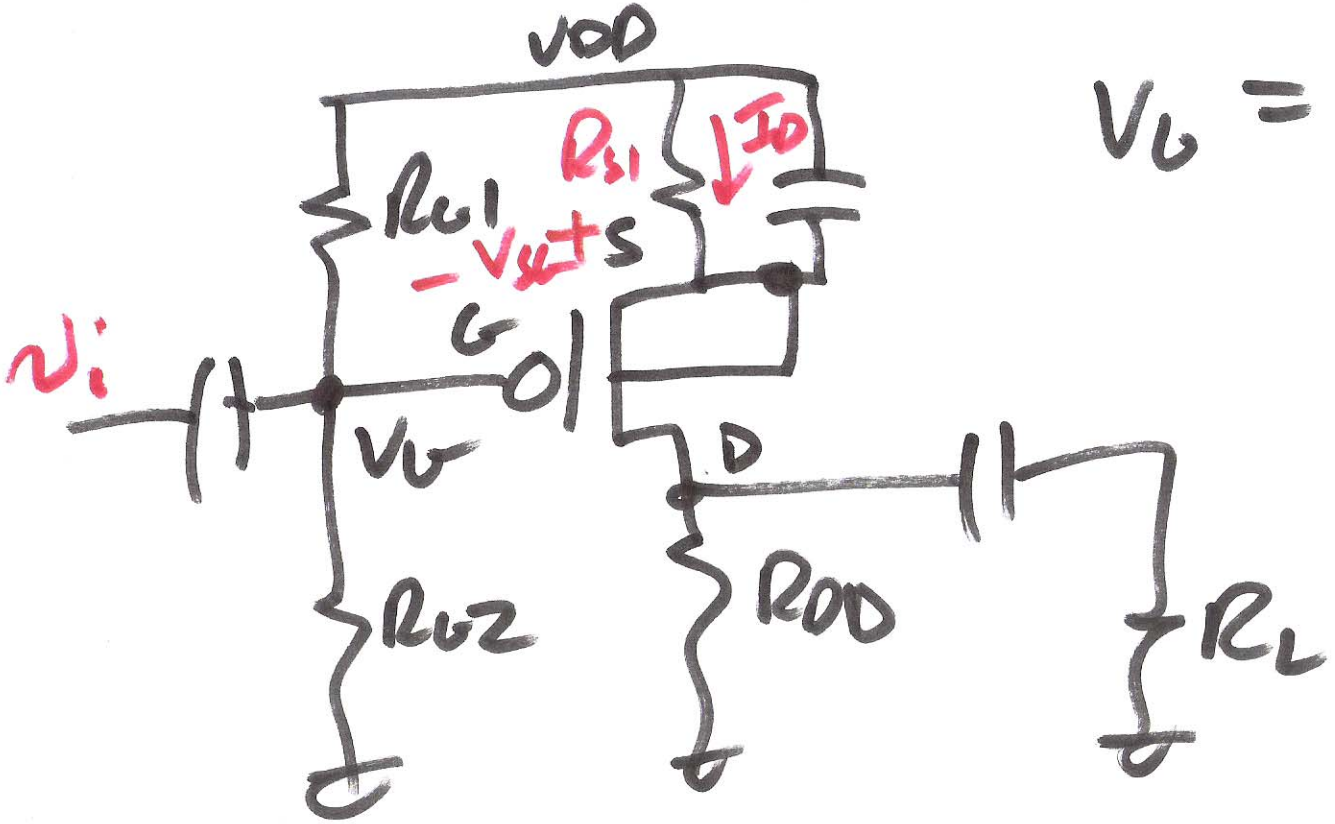
$$\frac{v_i}{R_{SS1}} + \frac{v_i}{1/g_m} = i_{in}$$

$$-i_d = g_m v_i$$

$$v_i = i_{in} \cdot R_{SS1} \,||\, 1/g_m$$

$$i_{in} = \frac{v_S - v_i}{R_S}$$

$$v_i = v_S \cdot \frac{R_{SS1} \,||\, 1/g_m}{R_{SS1} \,||\, 1/g_m + R_S}$$



$$V_G = \frac{R_{G2}}{R_{G2}+R_{G1}} \cdot V_{DD}$$

$$V_{DD} - I_D \cdot R_{S1} - V_{SG} = V_G$$

$$I_D = \frac{K_P'}{2} \cdot \frac{W}{L} \left(V_{SG} - V_{THP}\right)^2$$

$$g_m = \sqrt{2 I_D \cdot K_P' \cdot \frac{W}{L}}$$

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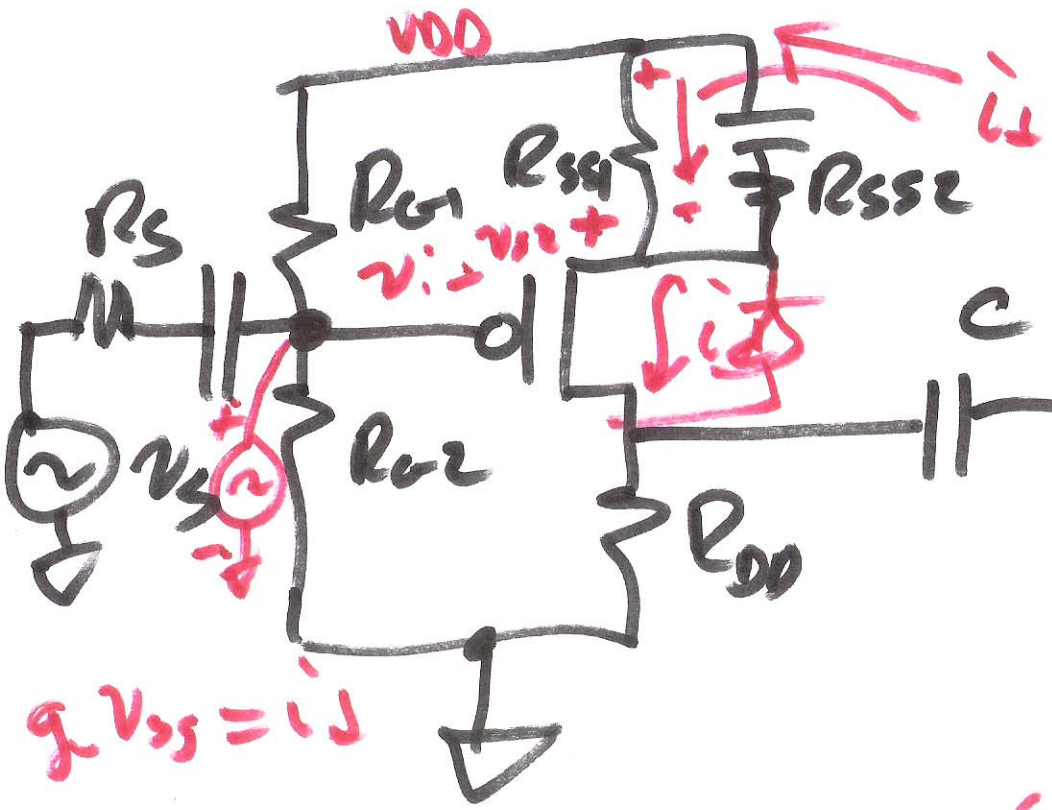
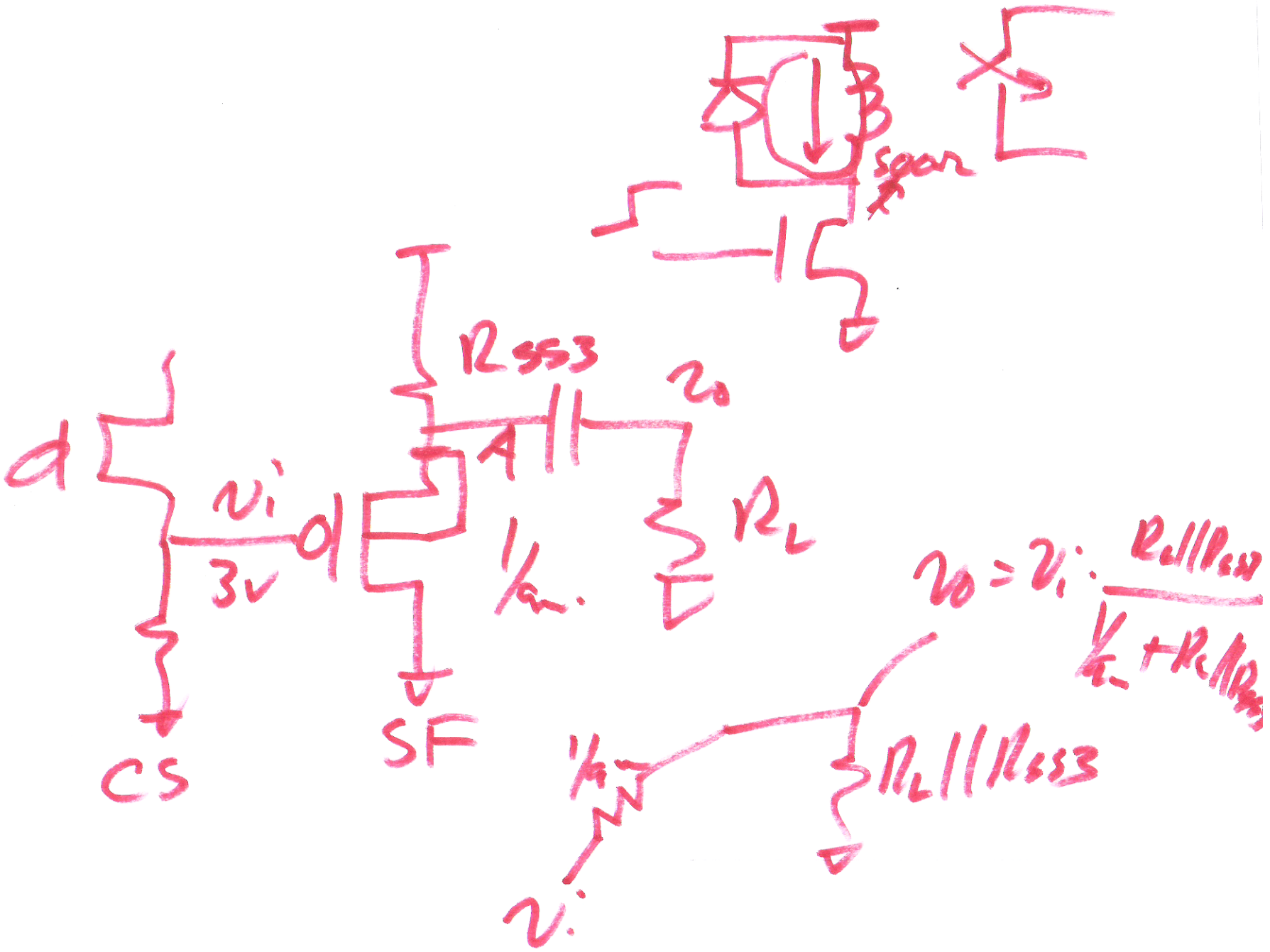


$$v_i + v_{SS} + i_d R_{SS1} \| R_{SS2} = 0$$

$$-v_i = i_d \left(\frac{1}{g_m} + R_{SS1} \| R_{SS2} \right)$$

$$\frac{v_o}{v_i} = -\frac{R_{DD} \| R_L}{\frac{1}{g_m} + R_{SS1} \| R_{SS2}}$$


R_{SS3}
v_o
v_i
3V
$\frac{1}{g_m}$
R_L
CS
SF
$v_o = v_i \cdot \frac{R_L \| R_{SS3}}{\frac{1}{g_m} + R_L \| R_{SS3}}$
$\frac{1}{g_m}$
$R_L \| R_{SS3}$
v_i