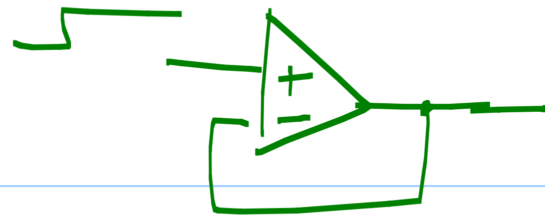
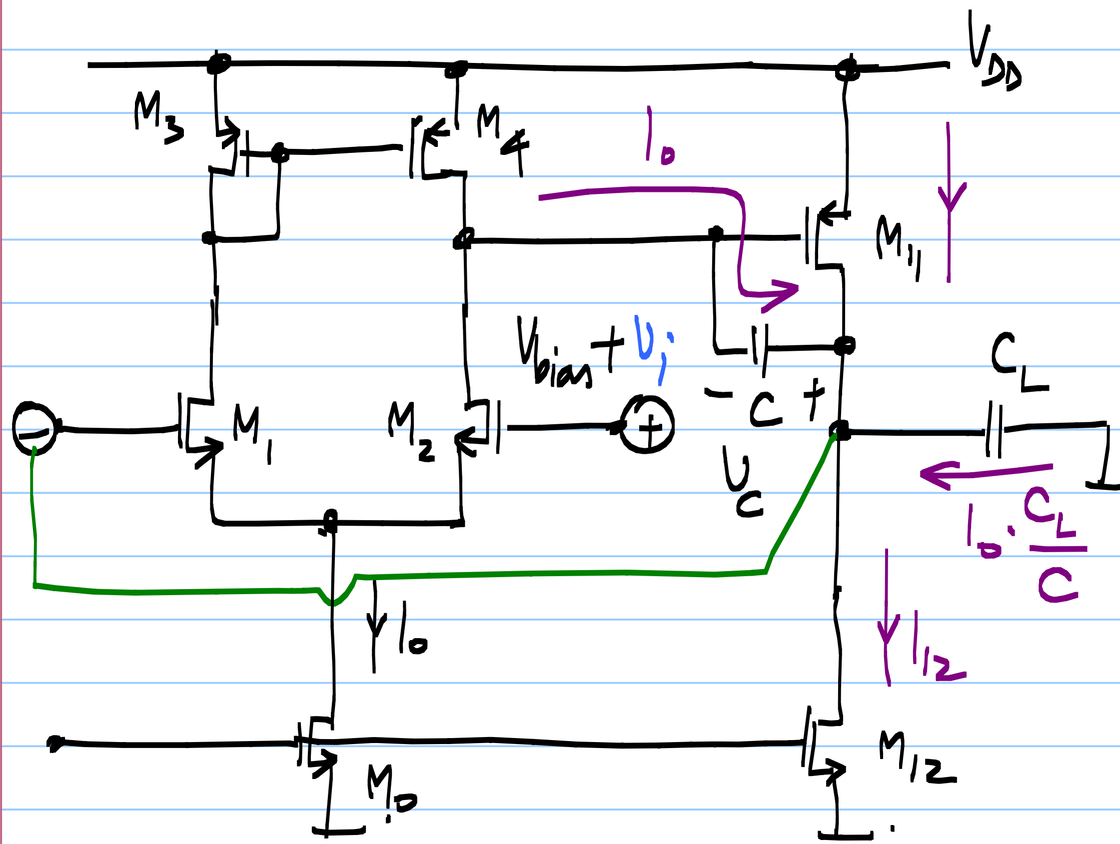
Lecture 37:

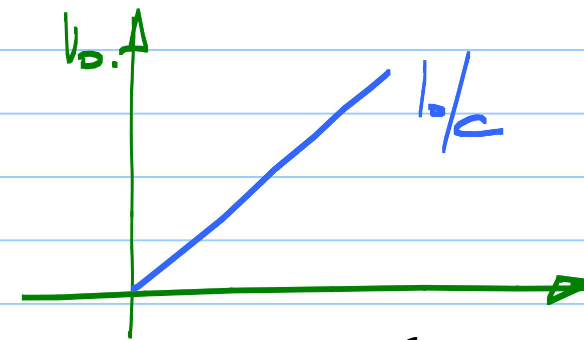


Slew rate:

Rate of change of Voltage across C

$$(V_C) = \pm \frac{I_0}{C}$$





$$I_{D_{11}} = I_{12} - I_0\left(1 + \frac{C_L}{C}\right)$$

$$I_{D11} = I_{12} - I_0\left(1 + \frac{C_L}{C}\right) > 0$$

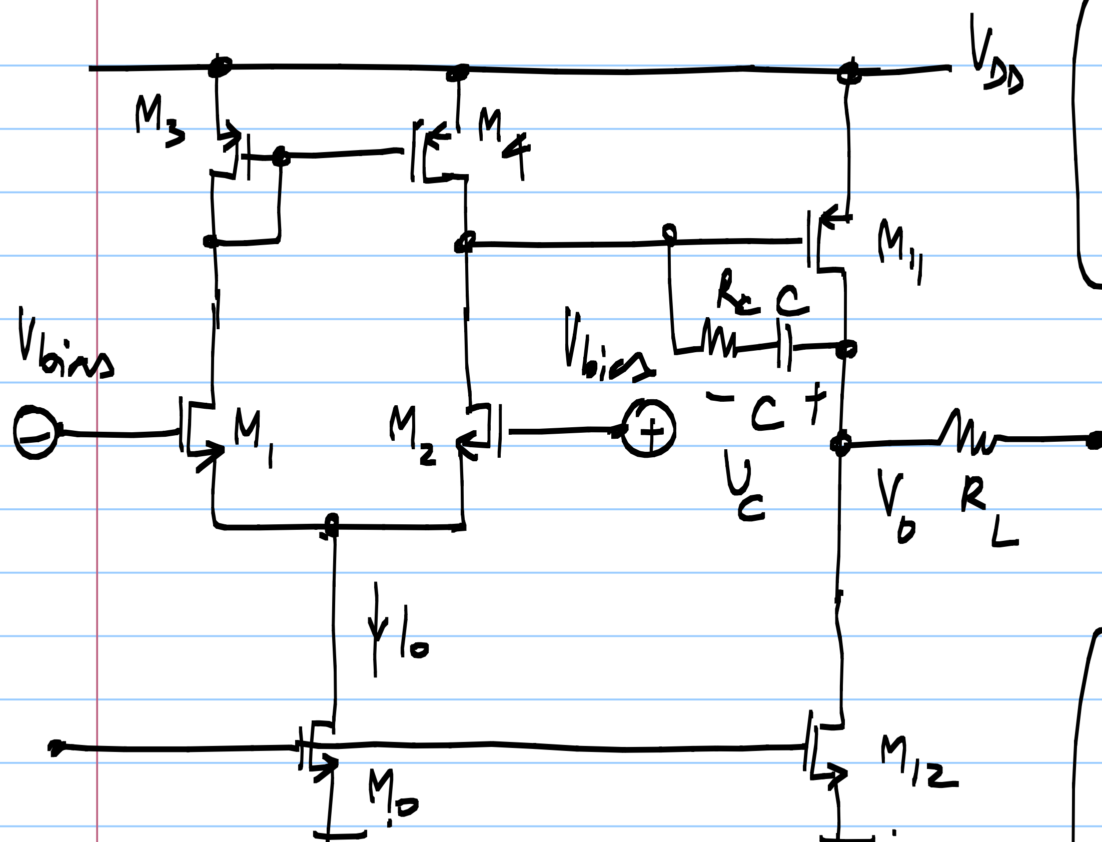
If $I_{12} > I_0\left(1 + \frac{C_L}{C}\right)$; output will reduce @ $\frac{I_0}{C}$

$I_{12} < I_0\left(1 + \frac{C_L}{C}\right)$?

output slew rate $= \frac{I_{12}}{C_L + C}$ } Total current in C & C_L $= I_{12}$

$$SR_+ = \frac{I_0}{C}$$

$$SR_- = \min\left[\frac{I_0}{C}, \frac{I_{12}}{C_L + C}\right]$$



$$V_{T_1} + V_{DSAT_1} < V_{bias} < V_{DD} - V_{SG3} + V_{T_1} + V_{DSAT_0}$$

$$V_{DSAT_{12}} < V_o < V_{DD} - V_{DSAT_{11}}$$

R_c in series with C to cancel the RHP zero

Two stage opamp:

$$A_0 = \frac{g_{m1}}{g_{ds1} + g_{ds3}} \cdot \frac{g_{m11}}{g_{ds11} + g_{ds12} + G_L}$$

$$H(s) = A_0 \left(\frac{1 + s\frac{C_{d3}}{2 g_{m3}}}{1 + s \cdot \frac{C_{d3}}{g_{m3}}} \right) \cdot \frac{1 - s/z_1}{\left(1 + \frac{s}{p_1}\right)\left(1 + \frac{s}{p_2}\right)}$$

$$S_{V_{in}} = \frac{16}{3} \cdot \frac{kT}{g_{m1}} \left(1 + \frac{g_{m3}}{g_{m1}}\right)$$

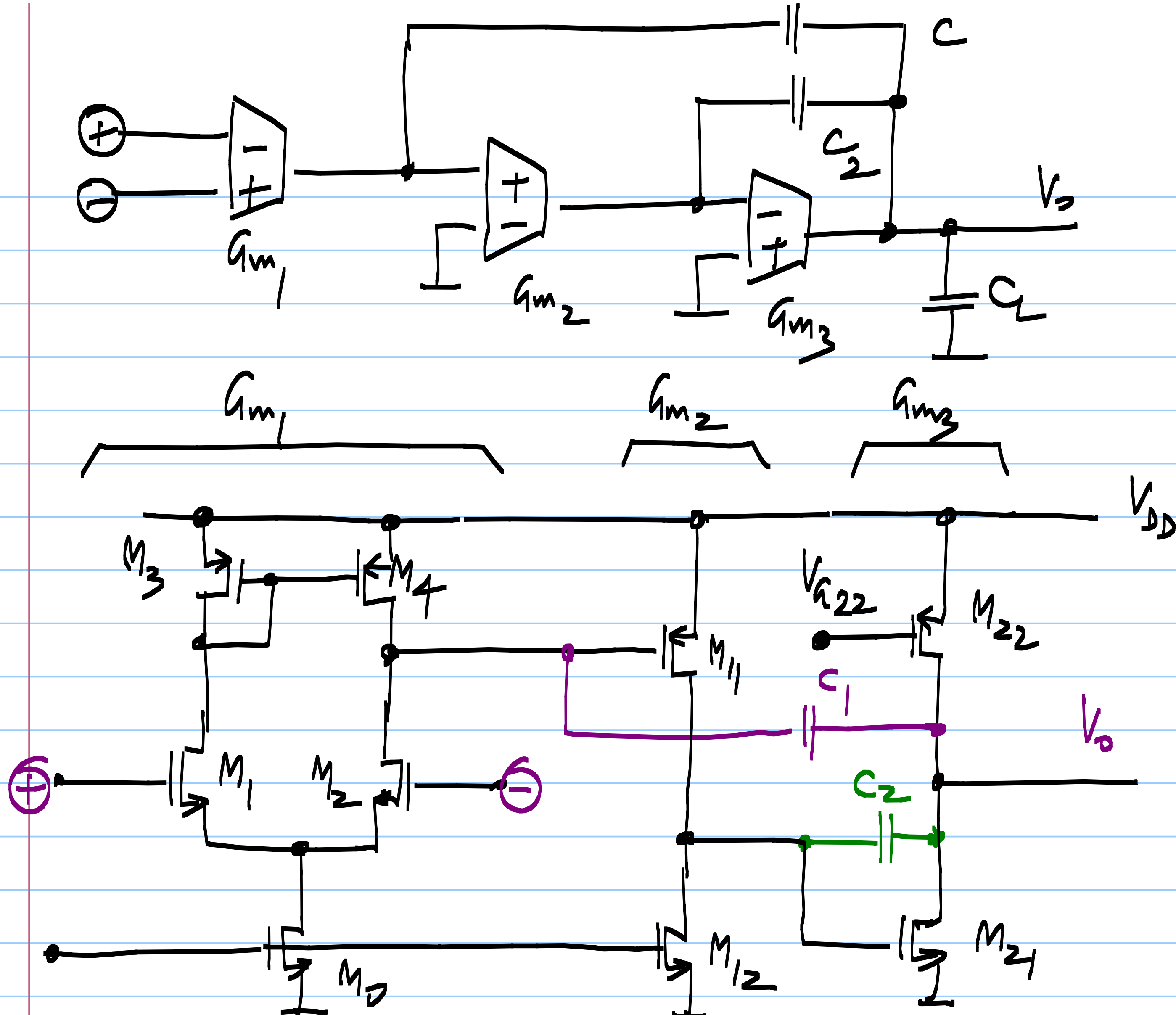
$$\sigma^2_{V_{os}} = \sigma^2_{V_{T12}} + \left(\frac{g_{m3}}{g_{m1}}\right)^2 \sigma^2_{V_{T34}}$$

$$SR_+ = I_0/C$$

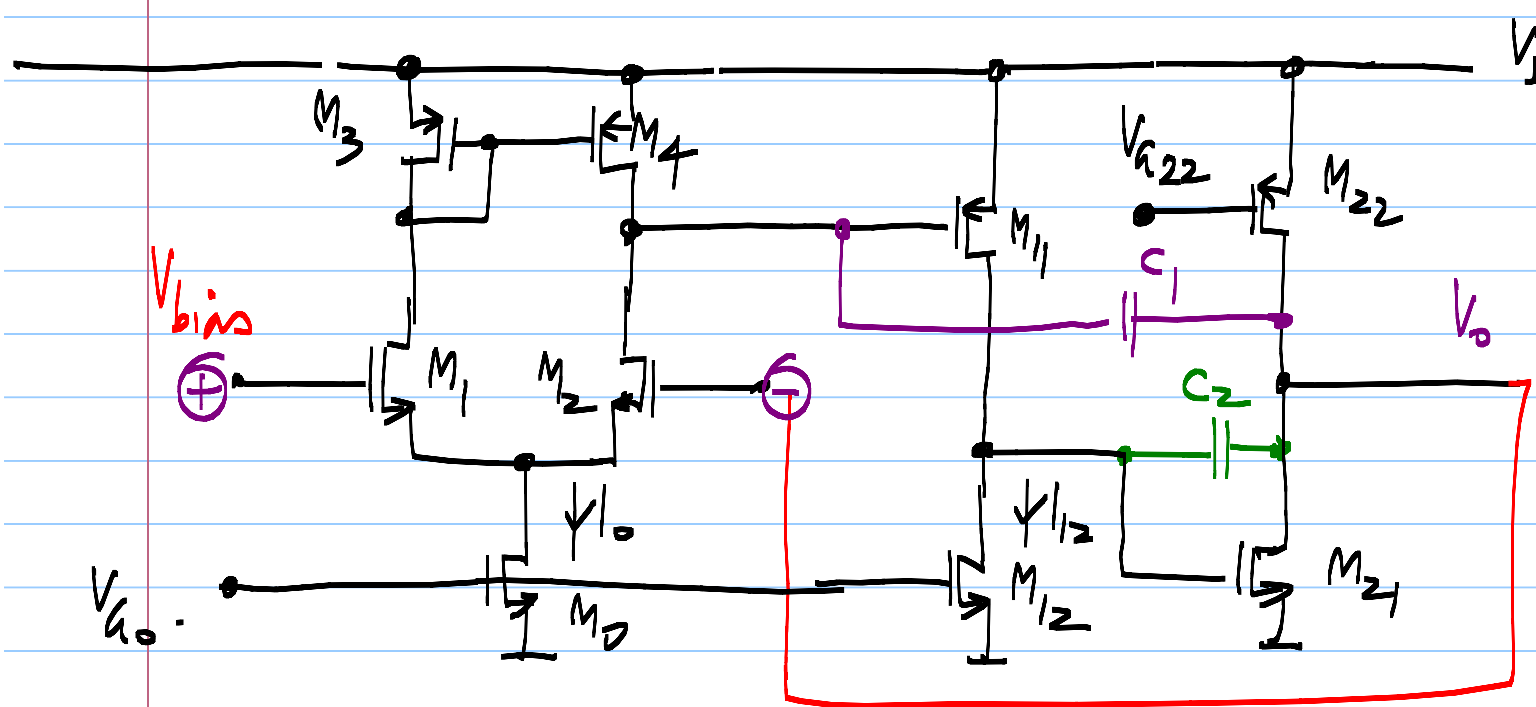
$$SR_- = \min\left(\frac{I_0}{C}, \frac{I_{12}}{C_L + C}\right)$$

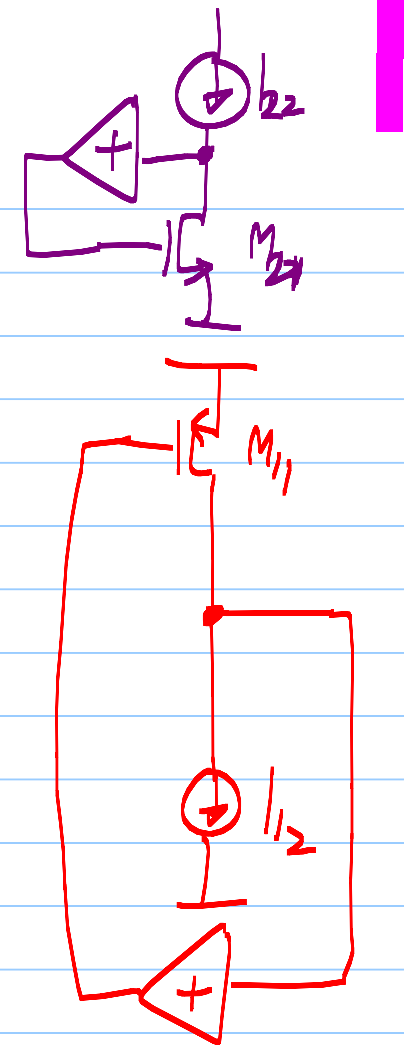
$$V_{T1} + V_{DSAT0} + V_{DSAT1} < V_{bias} < V_{DD} - V_{SG3} + V_{T1}$$

$$V_{DSAT12} < V_{out} < V_{DD} - V_{DSAT11}$$



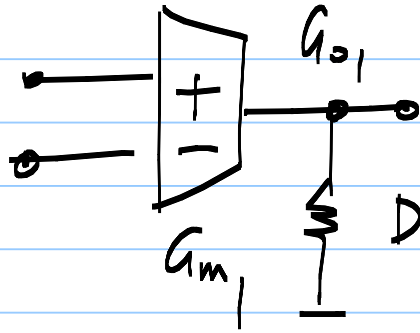
Three stage nested Miller compensated opamp





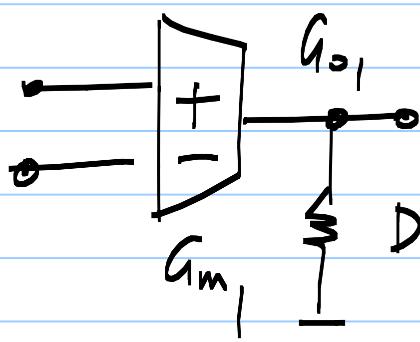
$$\frac{I_0}{W_0} = \frac{I_{12}}{W_{12}} = \frac{I_0'}{W_0'} \; ; \; L_0' = L_0 = L_{12}$$

Single stage opamp



$$A_0 \sim \left(\frac{g_m}{g_{ds}}\right)$$

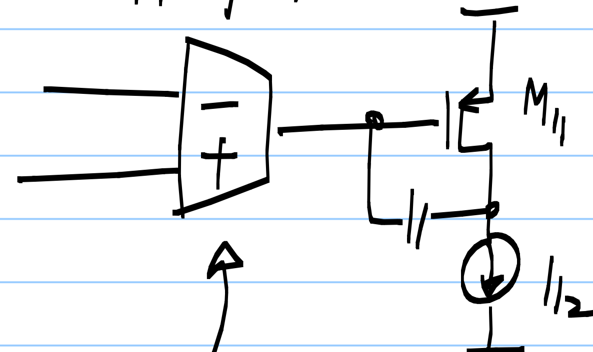
Telescopic/
Folded cascode



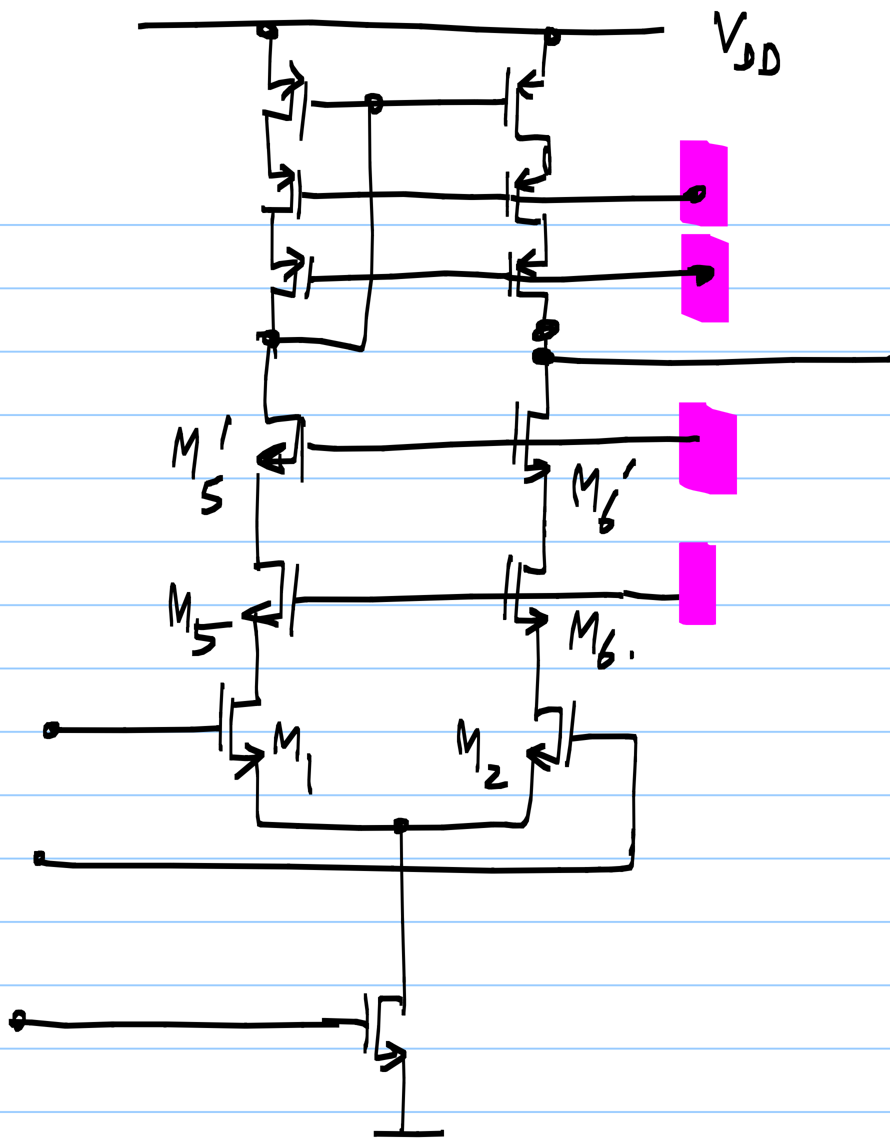
$$A_0 \sim \left(\frac{g_m}{g_{ds}}\right)^2$$

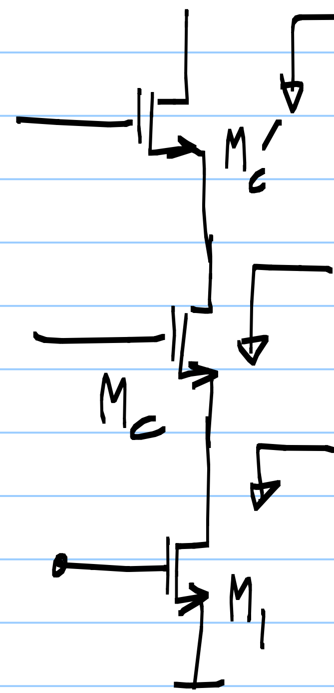
Two stage opamp

Diff. pair



$$\left(\frac{g_m}{g_{ds}}\right)^2 \left(\frac{g_{m11}}{g_{ds11}+g_{ds12}+G_L}\right)$$





$$\left(\frac{g_{mc}'}{g_{dsc}'}\right)\cdot\frac{g_{mc}}{g_{dsc}}\cdot r_{ds1}$$

$$\frac{g_{mc}}{g_{dsc}}\cdot r_{ds1}$$

$$g_{ds1} \quad (r_{ds1})$$