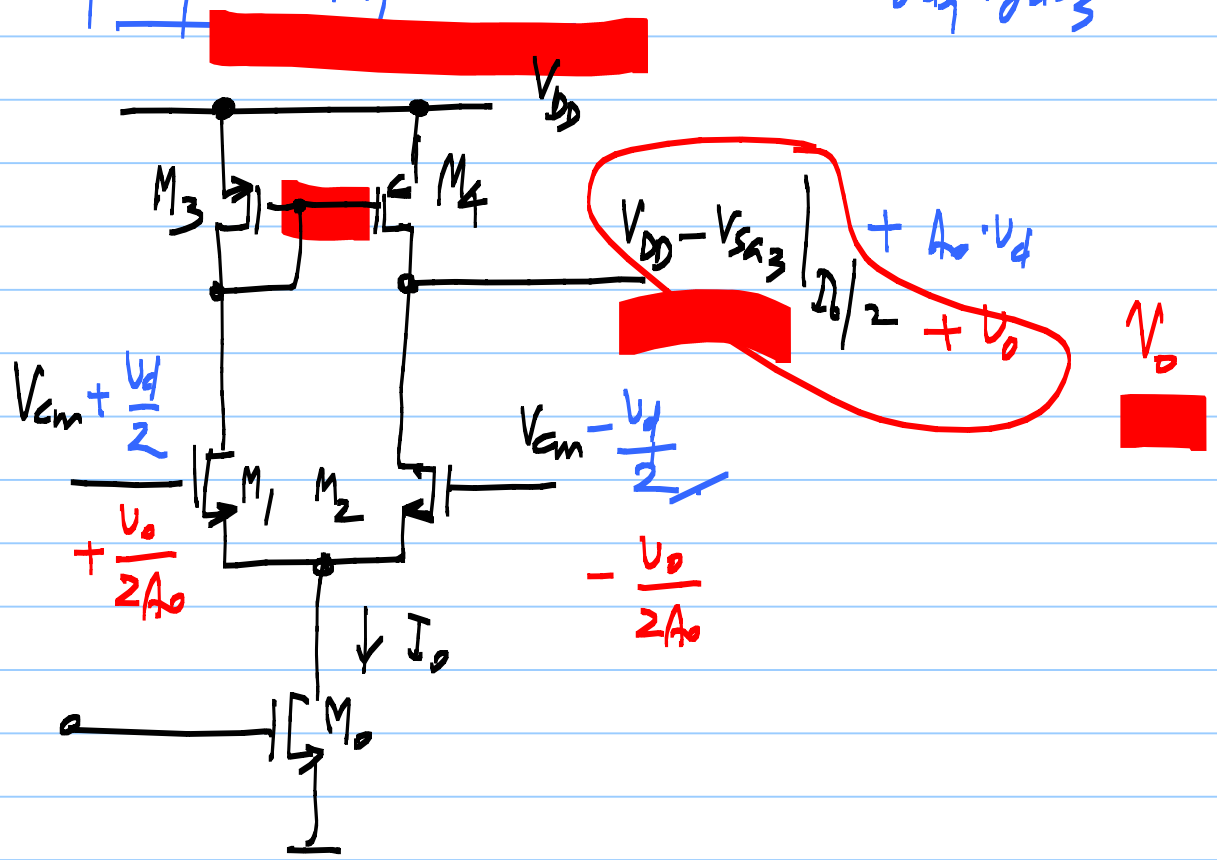
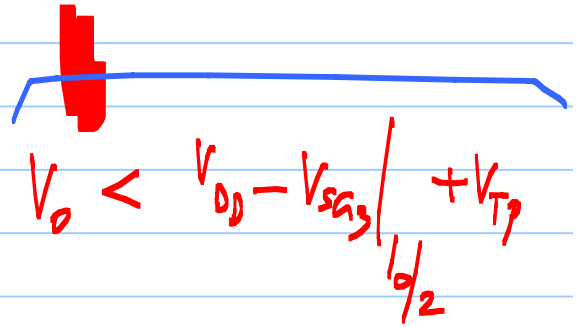
Opamp: Swing limits

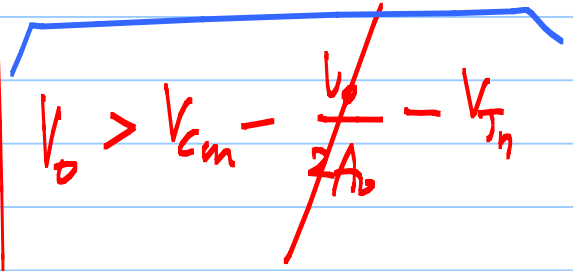
$$A_0 = \frac{g_{m1}}{g_{ds} + g_{ds3}}$$



Upper limit on V_o

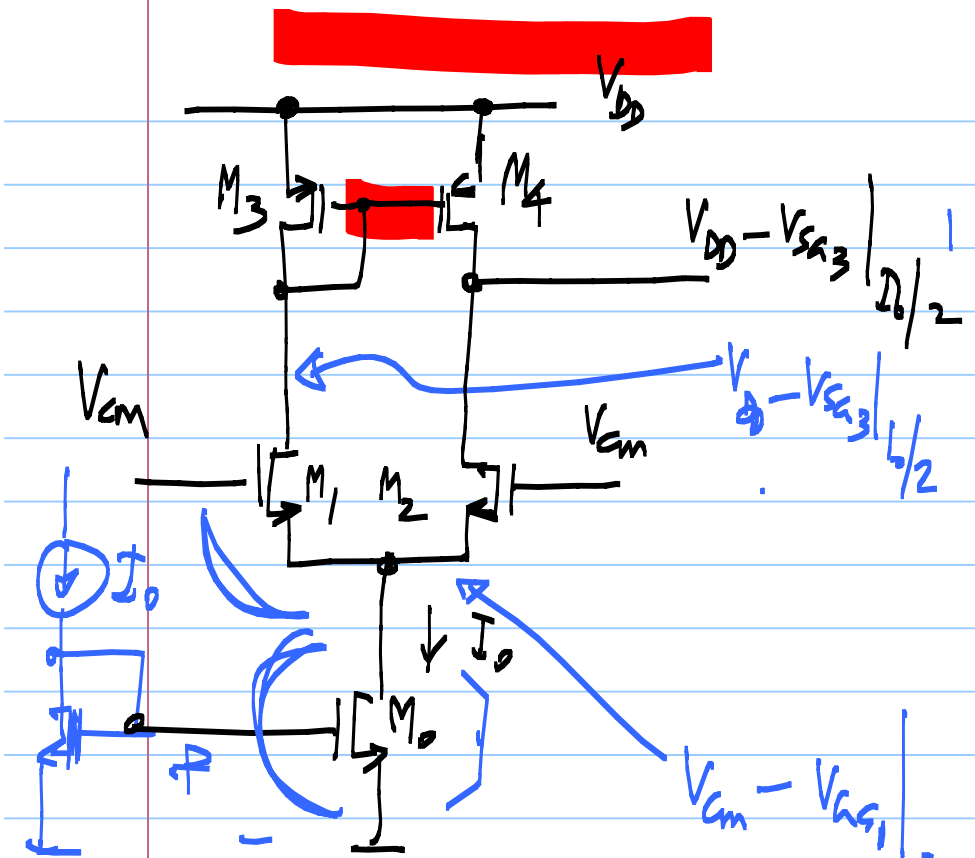


$$V_o < V_{DD} - V_{SG3}\big|_{I_D/2} + V_{Tn}$$



$$V_o > V_{cm} - \frac{v_o}{2A_0} - V_{Tn}$$

$$V_o < V_{DD} - V_{DSAT3}\big|_{I_D/2}$$

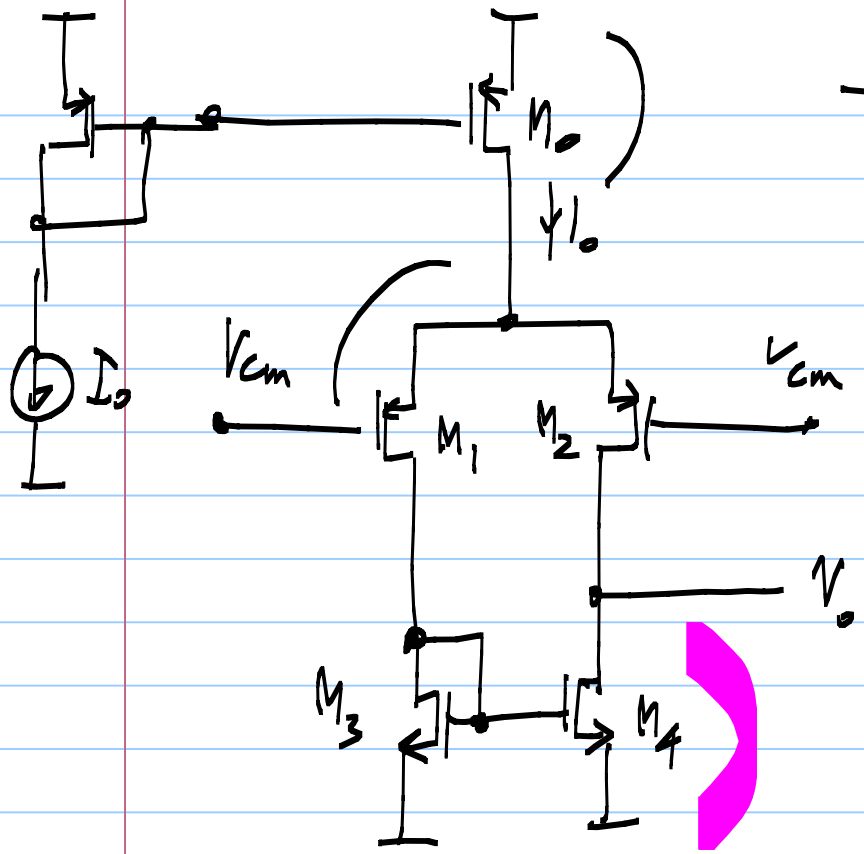


$$V_{CM} - V_{GS_1}\Big|_{\frac{I_0}{2}} > V_{DSAT_0}\Big|_{I_0}$$

$$V_{CM} > V_{TH} + V_{DSAT_1}\Big|_{\frac{I_0}{2}} + V_{DSAT_0}\Big|_{I_0}$$

$$V_{CM} < V_{DD} - V_{TP} - V_{DSAT_3}\Big|_{\frac{I_0}{2}} + V_{TH}$$

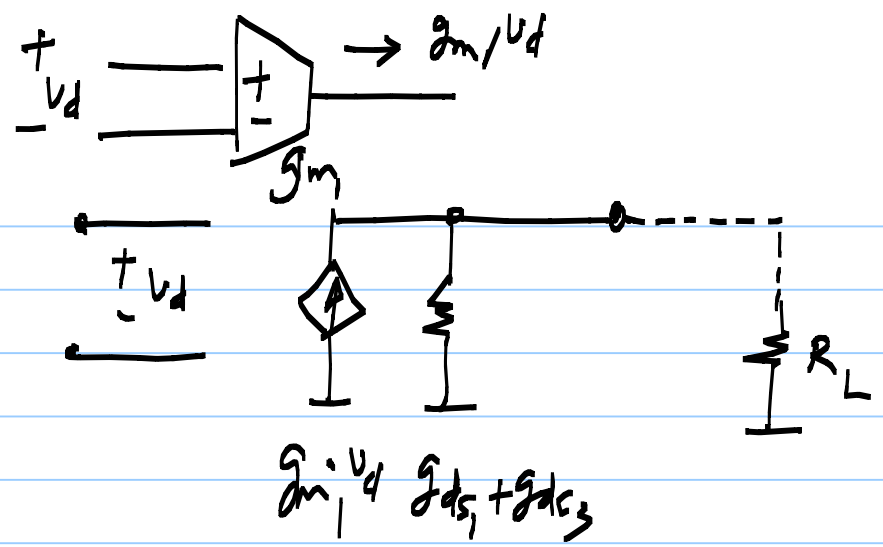
PMOS input pair + nMOS current mirror



$$|V_{DSAT_3}|_{I_0/2} < V_o < V_{cm} + V_{TP}$$

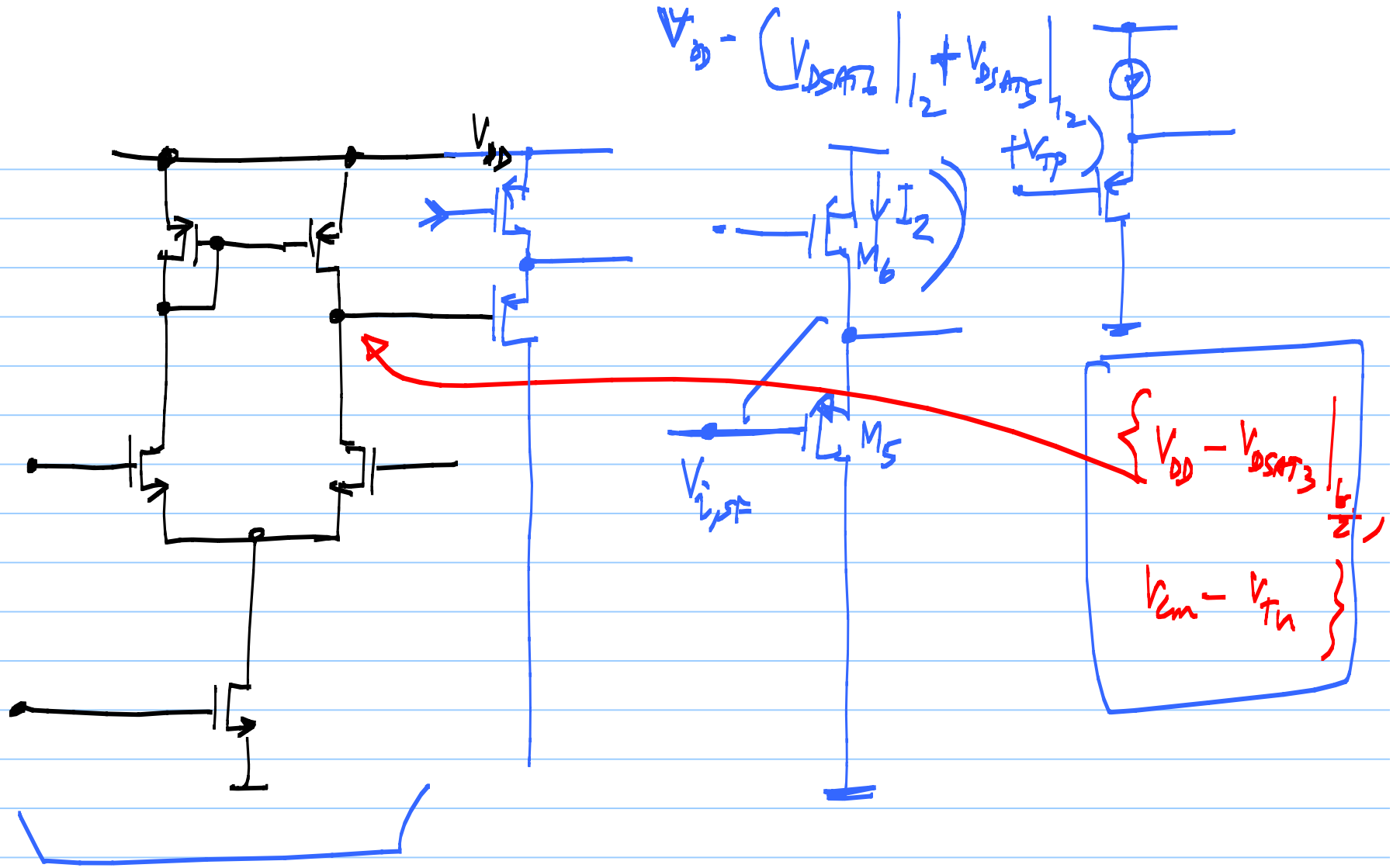
$$|V_{GS3}|_{\frac{I_0}{2}} - V_{TP} < V_{cm} < V_{DD} - \left(|V_{DSAT_0}|_{I_0} + |V_{DSAT_1}|_{\frac{I_0}{2}} + V_{TP}\right)$$

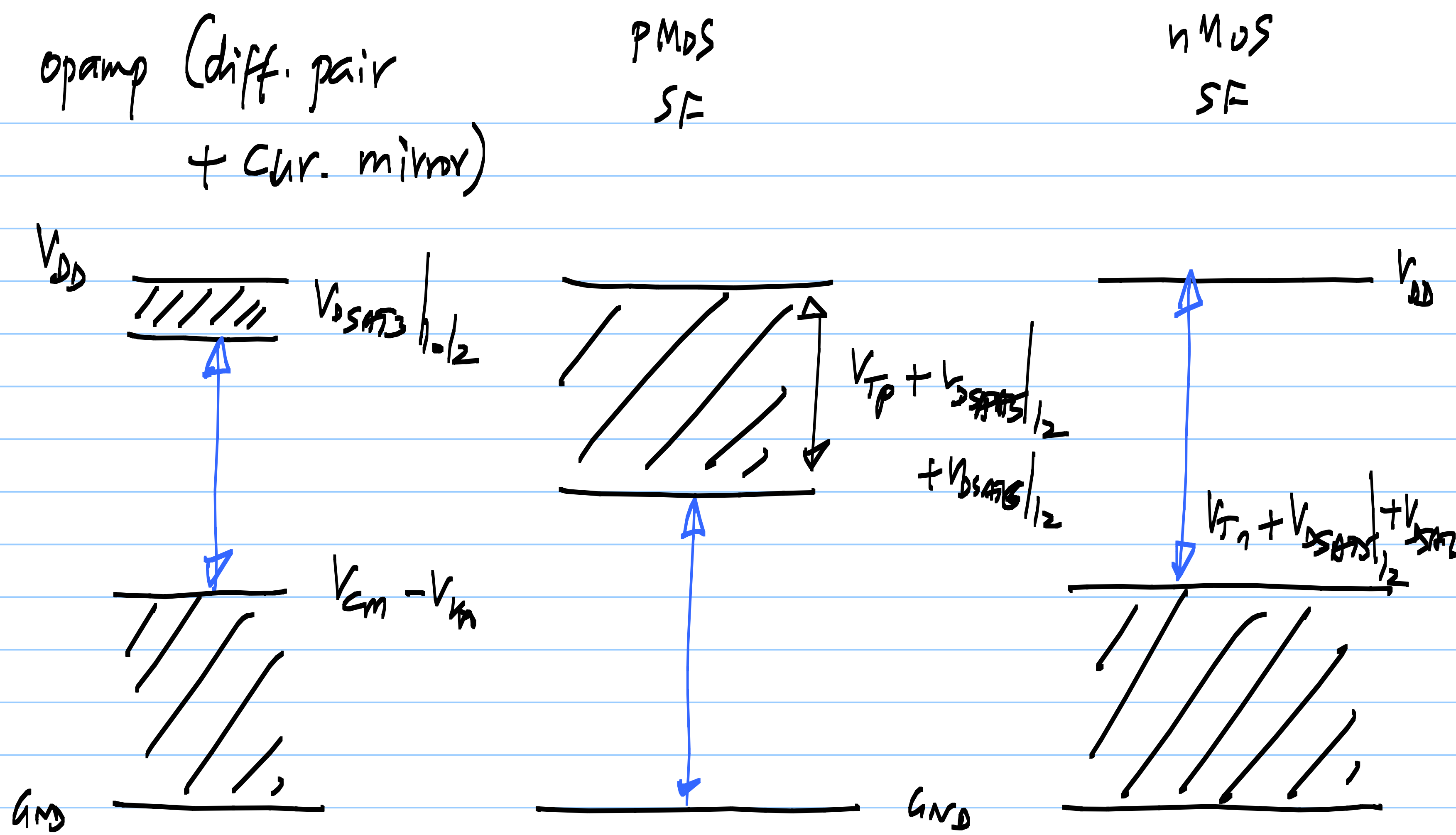
$$|V_{DSAT_3}|_{\frac{I_0}{2}} + V_{Tn} - V_{TP}$$



$$\frac{g_{m_1}}{g_{ds_1} + g_{ds_3} + G_L}$$

Single stage opamp: VCCS : can not be used with resistive loads


$V_{DD} - \left(|V_{DSAT2}|_{I_2} + V_{DSAT5}|_{I_2} + |V_{TP}|\right)$
V_{DD}
I_2
M_6
M_5
V_{in}
$\{V_{DD} - V_{DSAT3}|_{\frac{I_5}{2}}$
$V_{cm} - V_{TN}\}$


opamp (diff. pair
+ cur. mirror)
PMOS
SF
nMOS
SF
VDD
GND
GND
VDD