22-2-2013

Lec 25

5) Input referred noise voltage

$$\frac{\overline{v_{n,in}^2}}{\Delta f} = \frac{16}{3} kT \cdot \frac{(g_{m1} + g_{m3})}{g_{m1}^2}$$

$$\simeq \frac{16kT}{3} \cdot \frac{1}{g_{m1}} \left[1 + \frac{g_{m3}}{g_{m1}} \right]$$

6) Input referred offset voltage.

(HW)

$$V_{os} = \Delta V_{T1,2} + \left(\frac{g_{m3}}{g_{m1}} \right) \Delta V_{T3,4}$$

$$\sigma_{OS,in}^2 = \sigma_{V_{T,12}}^2 + \left(\frac{g_{m3}}{g_{m1}} \right)^2 \sigma_{V_{T3,4}}^2$$

7) Input CM voltage range

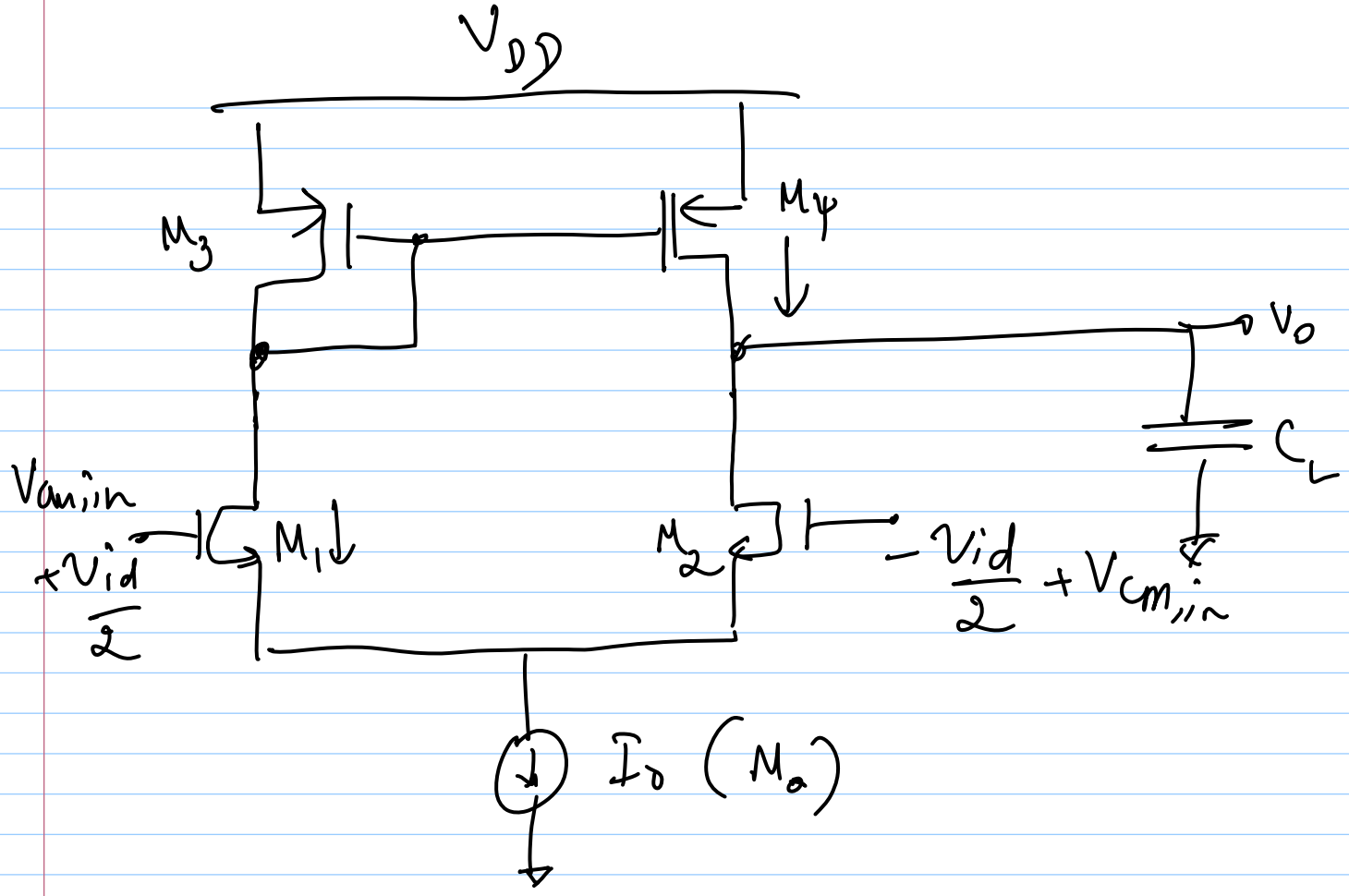
$$V_{in,max} = V_{DD} - V_{SG_3} + V_{T_1}$$

$$V_{in,min.} = V_{DSAT_0} + V_{GS_1}$$

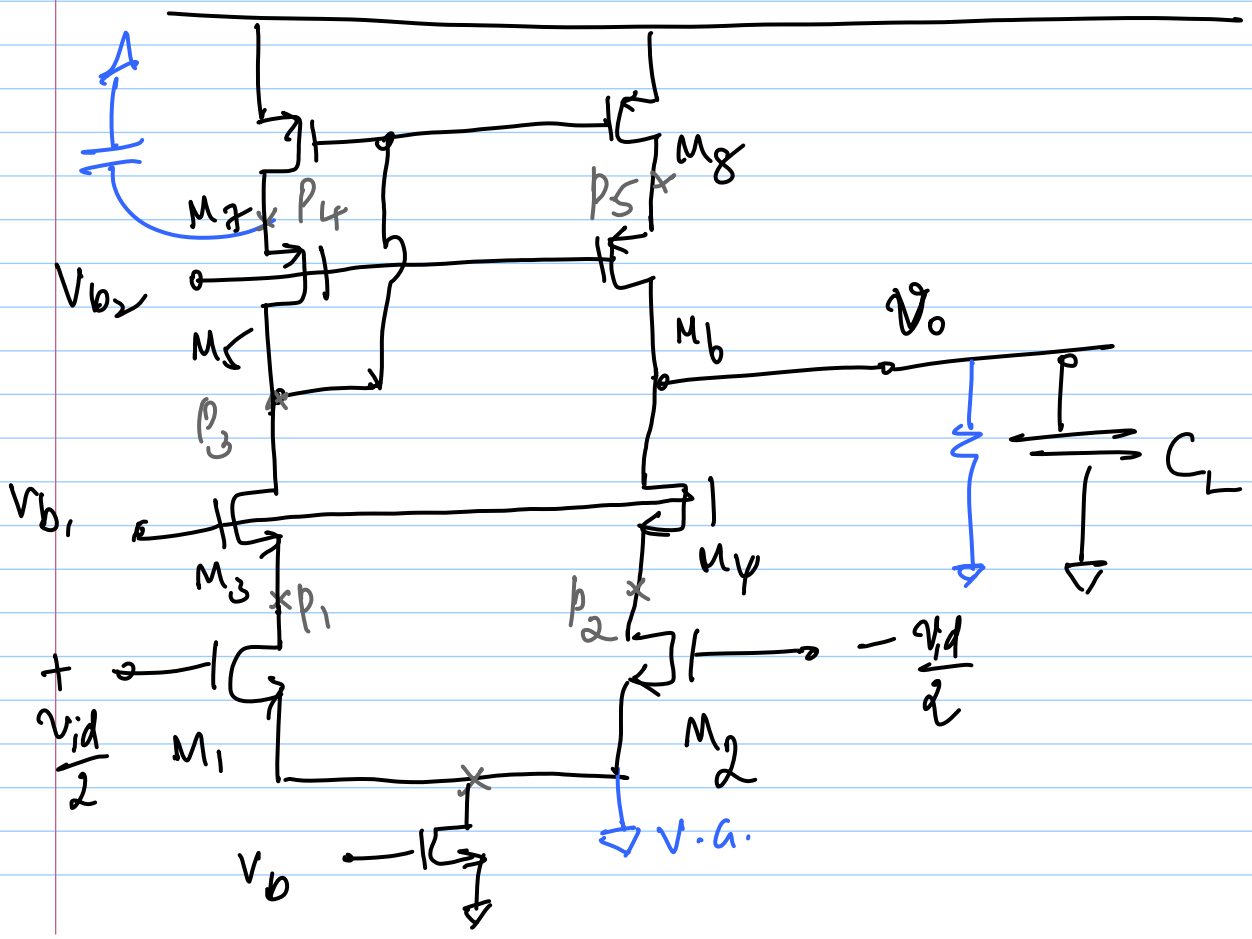
8) Output swing limits

$$V_{out,max.} = V_{DD} - V_{DSAT_4}$$

$$V_{out,min.} = V_{CM,in} - V_{T_2}$$



Telescopic Opamp



1) DC gain = $G_m \times R_o$ $\left(\text{or } \frac{G_m}{G_o}\right)$

$G_m = g_{m_1}$ → simple 1-stage

$R_o = \left(g_{m4} \cdot r_{ds4}\right) \cdot r_{ds2} \parallel \left(g_{m5} r_{ds5}\right) r_{ds7}$

2) $\omega_u = \frac{G_m}{C_L} = \frac{g_{m1}}{C_L}$ = same as simple 1-stage

pole = $\frac{G_o}{C_L}$ < simple 1-stage opamp

3) Non-dominant poles & zeroes

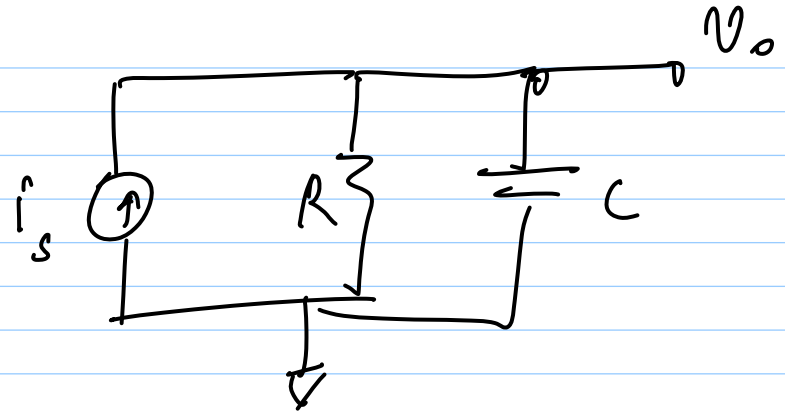
$p_1 - p_5$ – ND poles (LHP)

Zeroes

$$A_v = (\quad)\left[(\quad)\frac{v_{id}}{2} + (g_{m_1})\frac{-v_{id}}{2}\right]$$

$$\frac{g_{m_3} \cdot g_{m_1}}{g_{m_3} + sC_1}$$

(W_z)



$$\frac{v_o}{i_s} = \frac{1}{g + sC} \rightarrow w_p = \frac{g}{C}$$