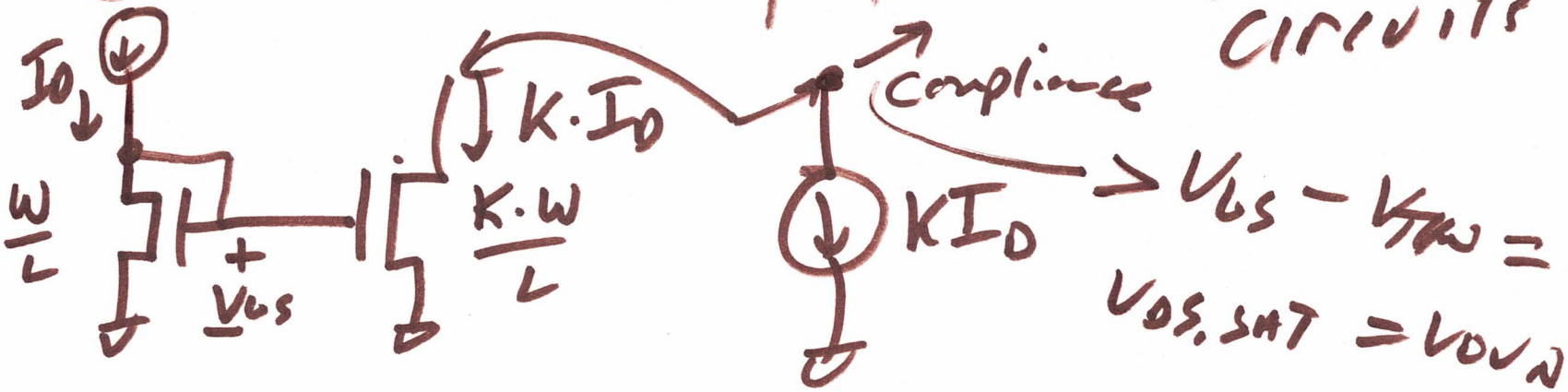
EE 420/ELEC 620
Analog IC Design

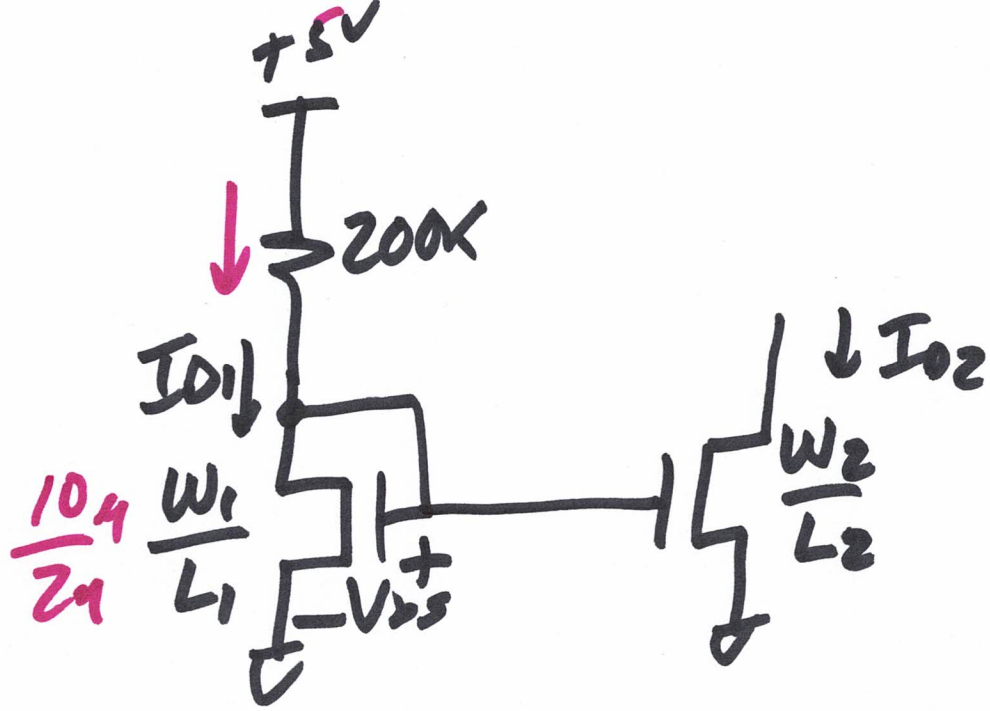
Feb. 12, 2020

Lecture 7

CURRENT MIRRORS

Ch. 20





$$\frac{5 - V_{DS}}{200K} = \frac{120\mu}{2}\cdot\frac{10}{2}\cdot (V_{GS} - 0.8)^2$$

$$\frac{I_{D1}}{I_{D2}} = \frac{\cancel{\frac{K'_P}{2}\frac{W_1}{L_1}(V_{GS} - V_{THN})^2}}{\cancel{\frac{K'_P}{2}\frac{W_2}{L_2}(V_{GS} - V_{THN})^2}}$$

$$= \frac{W_1/L_1}{W_2/L_2}, \; L_1 = L_2 \rightarrow \frac{W_1}{W_2}$$

$$\frac{5 - V_{GS}}{200k} = 30u\,(V_{GS} - 0.8)^2$$

$$0.2 \cdot 10^6$$

$$5 - V_{GS} = 60\left(V_{GS}^2 - 1.6V_{GS} + .64\right)$$

$$5 - V_{GS} = 60V_{GS}^2 - 96V_{GS} + 38.4$$

$$0 = 60V_{GS}^2 - 95V_{GS} + 33.4$$

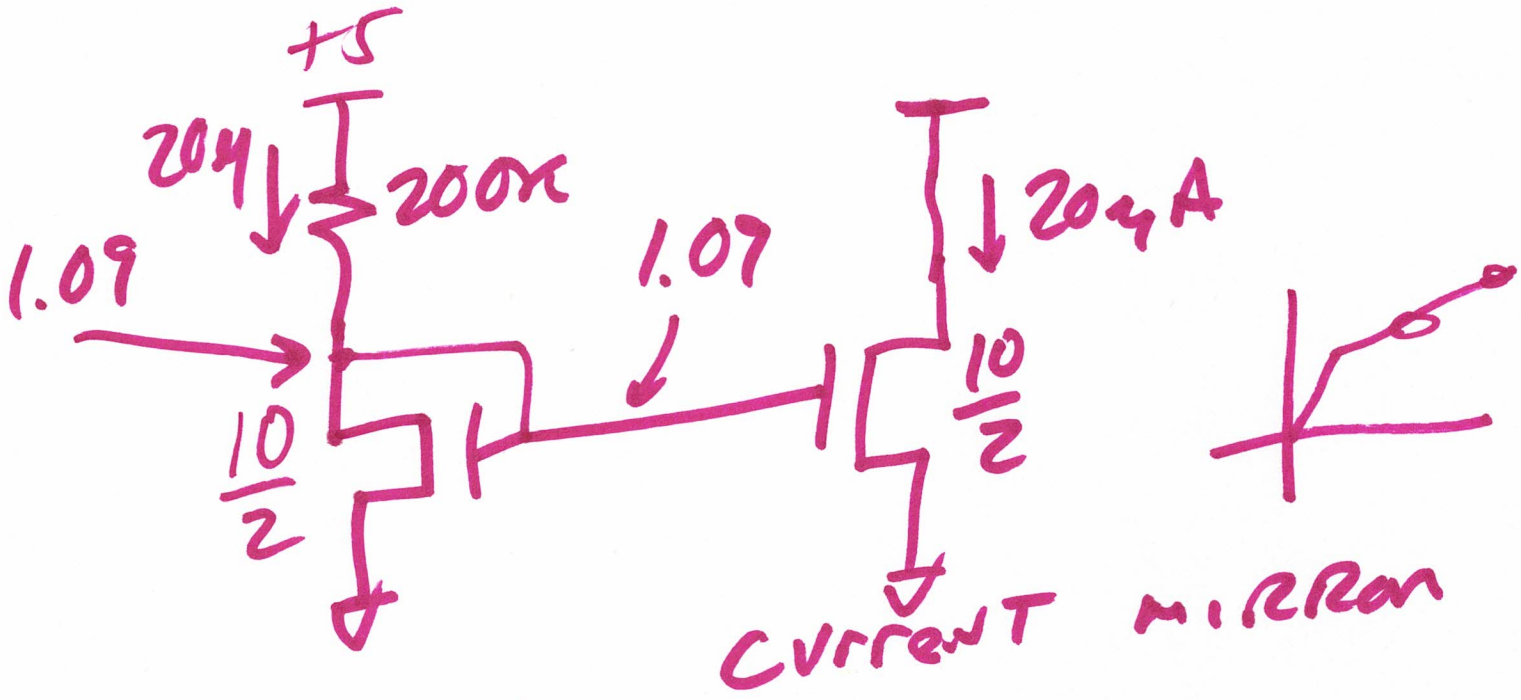
$$V_{GS} = V_{GS}^2 - 1.58V_{GS} + .56$$

NO < V_{THN} 0.6

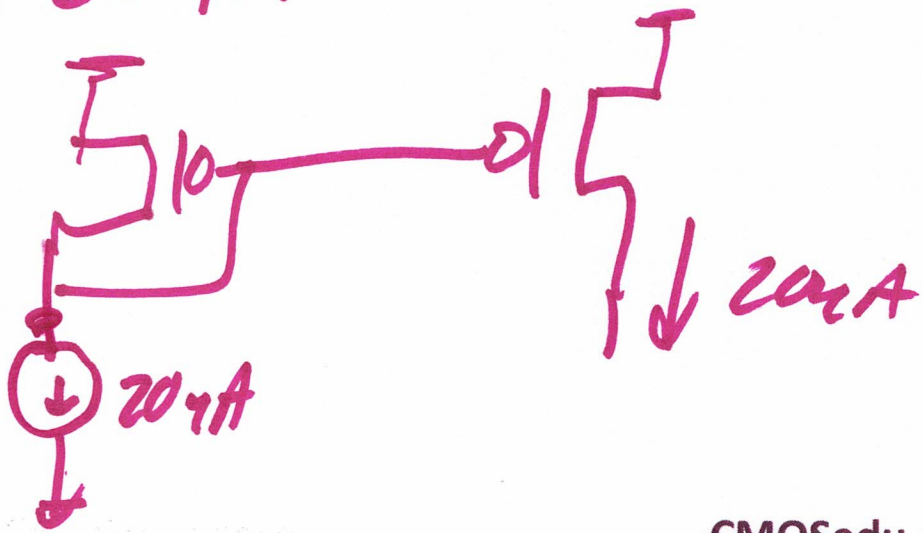
$$V_{GS} = \frac{1.58 \pm \sqrt{2.5 - 2.24}}{2}$$

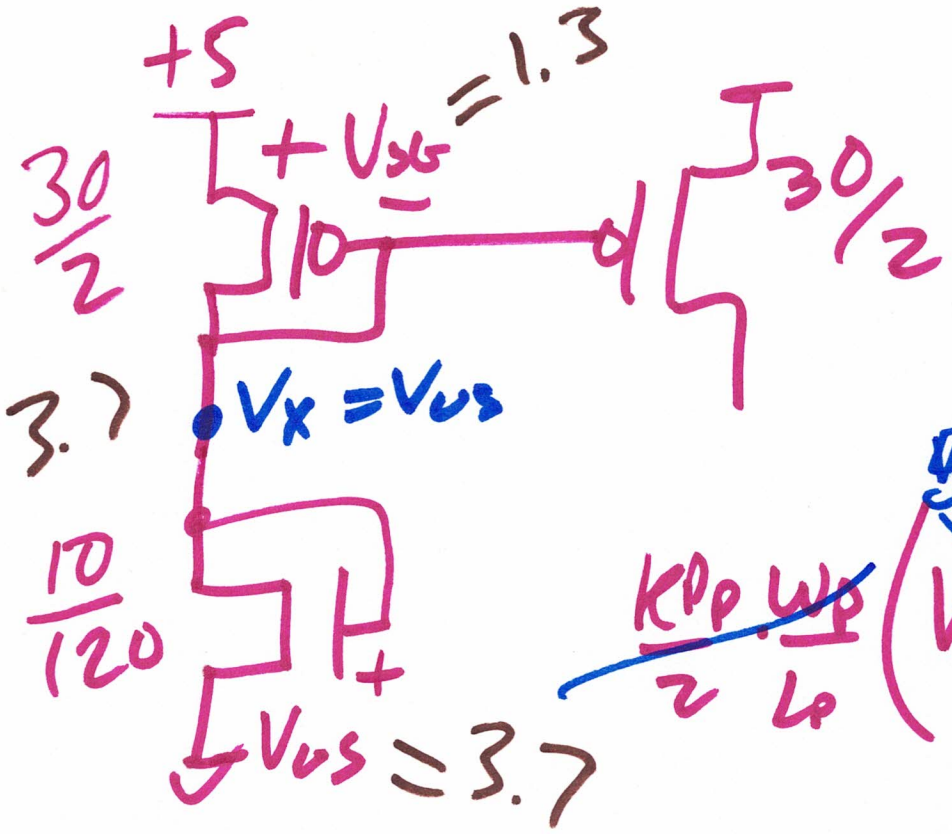
1.09, .49

3)



$$\frac{5-1.0}{200K} \simeq 20\mu A$$





$$5 = V_{SG} + V_{DS}$$

$$\sqrt{\frac{2I_D}{K_{PP}\frac{W_P}{L_P}}} + .9 + \sqrt{\frac{2I_D}{K_{PN}\frac{W_N}{L_N}}} + .5$$

$$\frac{K_{PP}}{2}\frac{W_P}{L_P}\left(5 - V_X - V_{THP}\right)^2 =$$

$$\frac{K_{PN}}{2}\frac{W_N}{L_N}\left(V_X - V_{THN}\right)^2$$

$$I_D = \frac{120\mu/V^2}{2}\frac{10}{120}\left(3.7 - .8\right)^2$$

$$= \boxed{42\mu A = I_D}$$

5)

$$\frac{40\mu A/V^2}{2} \cdot .15\left(5 - V_x - 0.9\right)^2$$

$$\frac{120\mu}{2} \cdot \frac{10}{120}\left(V_x - .8\right)^2$$

$$\frac{300\mu A}{V^2}\left(4.1 - V_x\right)^2 = \frac{5\mu A}{V^2}\left(V_x - .8\right)^2$$

$$60\left(4.1 - V_x\right)^2 = \left(V_x - .8\right)^2$$

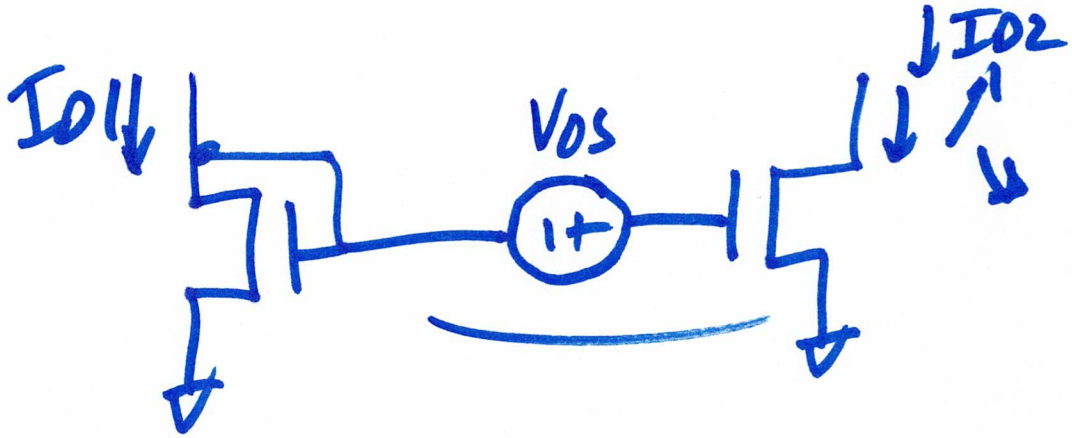
$$7.7\left(4.1 - V_x\right) = V_x - .8$$

$$31.76 - 7.7V_x = V_x - .8$$

$$V_x = 3.7V$$

6)

Threshold voltage mismatch



$$\frac{I_{D2}}{I_{D1}} =$$