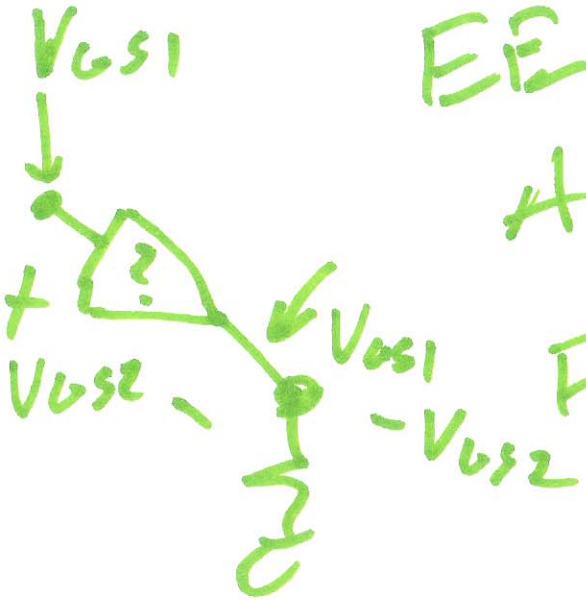
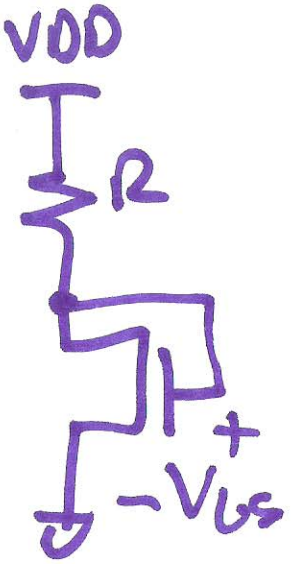
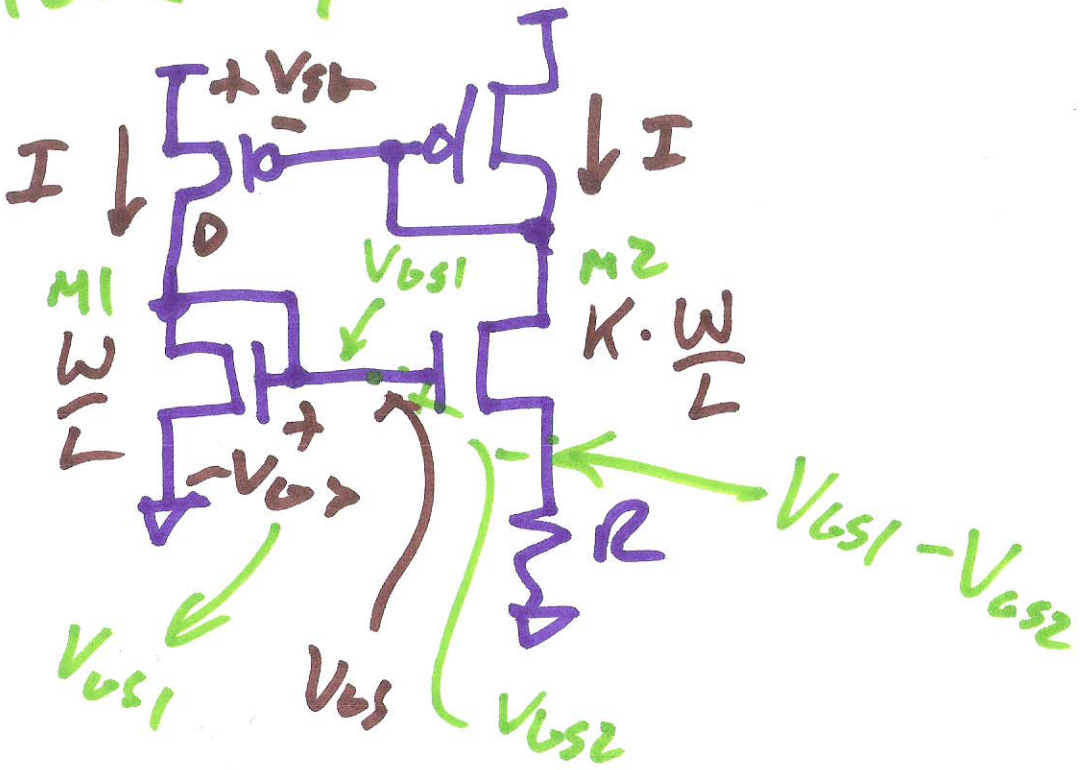
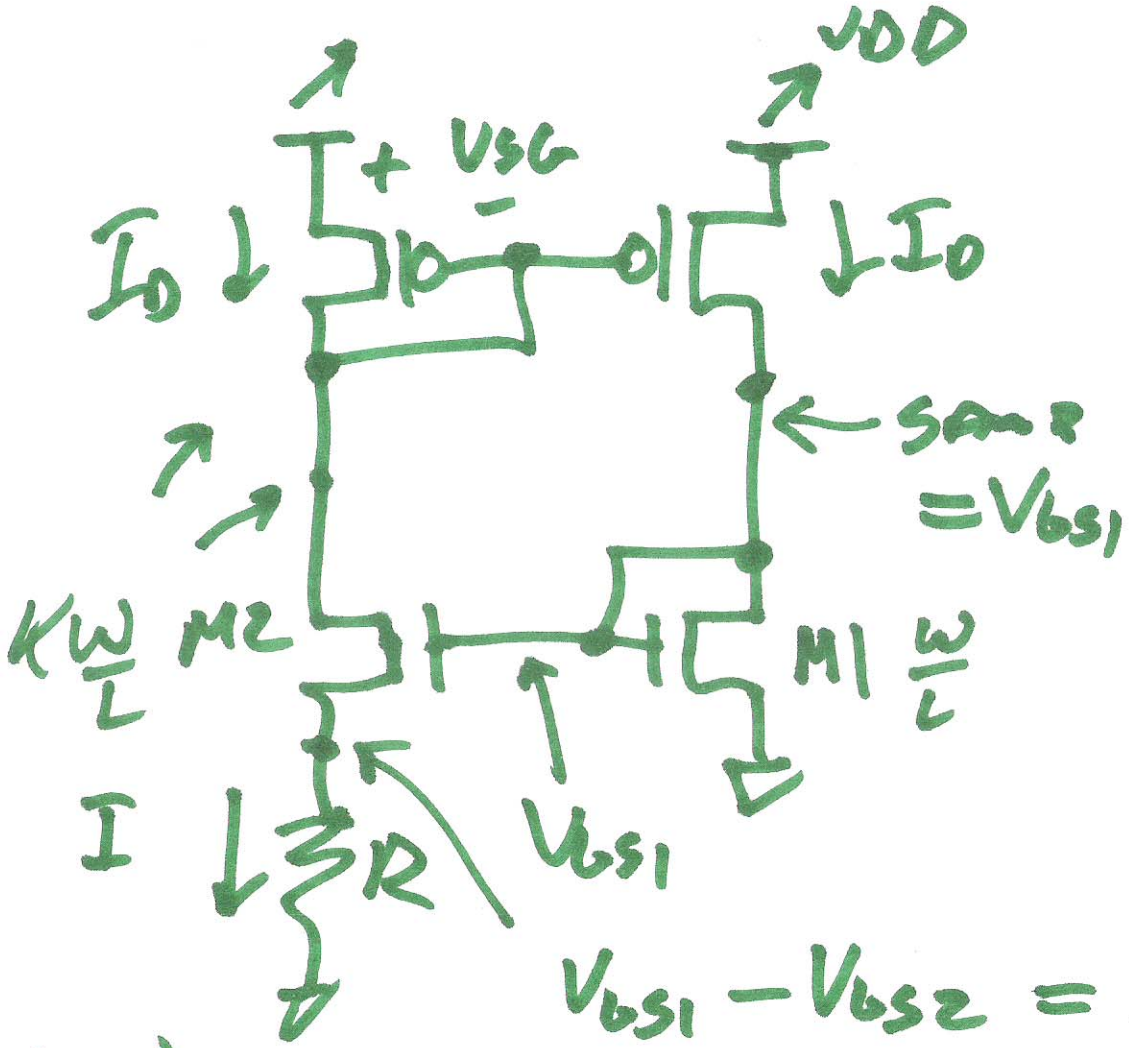
EE 420/ECG 620
Analog IC Design
Feb. 11, 2015
Lecture 9









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

$$V_{GS1} - V_{GS2} = I \cdot R$$

$$\sqrt{\frac{2I}{KP \cdot \frac{W}{L}}}\left(1 - \frac{1}{\sqrt{K}}\right) = \sqrt{\frac{2I}{KP \cdot \frac{W}{L}}} + V_{THN} - \sqrt{\frac{2I}{KP \cdot K \cdot \frac{W}{L}}} - V_{THN} = IR$$

$$\sqrt{\frac{2I}{K_P \cdot \frac{W}{L}}}\left(1-\frac{1}{\sqrt{K}}\right)=IR$$

$$\frac{2I}{K_P \cdot \frac{W}{L}}\left(1-\frac{1}{\sqrt{K}}\right)^2=I^2 \cdot R^2$$

$$I=\frac{1}{R^2 \cdot K_P \cdot \frac{W}{L}}\left(1-\frac{1}{\sqrt{K}}\right)^2$$

if $K=4$

$$I=\frac{1}{2R^2 \cdot K_P \cdot \frac{W}{L}}, \quad 2I \cdot K_P \cdot \frac{W}{L}=\frac{1}{R^2}$$

$$g_m=\sqrt{2I \cdot K_P \frac{W}{L}}=\frac{1}{R}$$

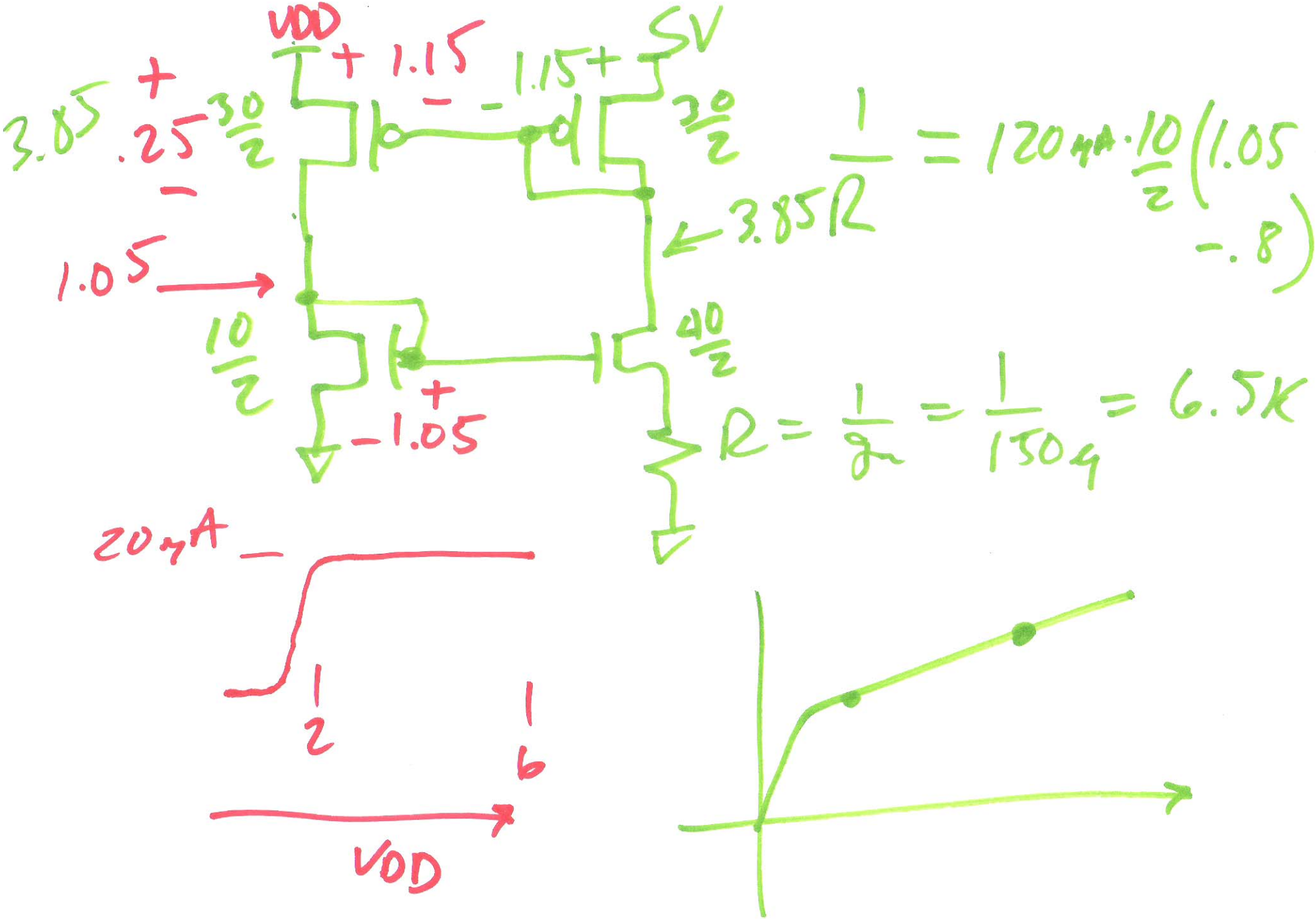
$$I = \frac{1}{R^2 \cdot \frac{KP}{2} \cdot \frac{W}{L}} \left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$$\frac{KP}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2 = \frac{1}{R^2 \frac{KP}{2} \cdot \frac{W}{L}} \left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$$\frac{R}{2} \cdot KP \cdot \frac{W}{L} (V_{GS} - V_{THN})^2 = \left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$K = 4$

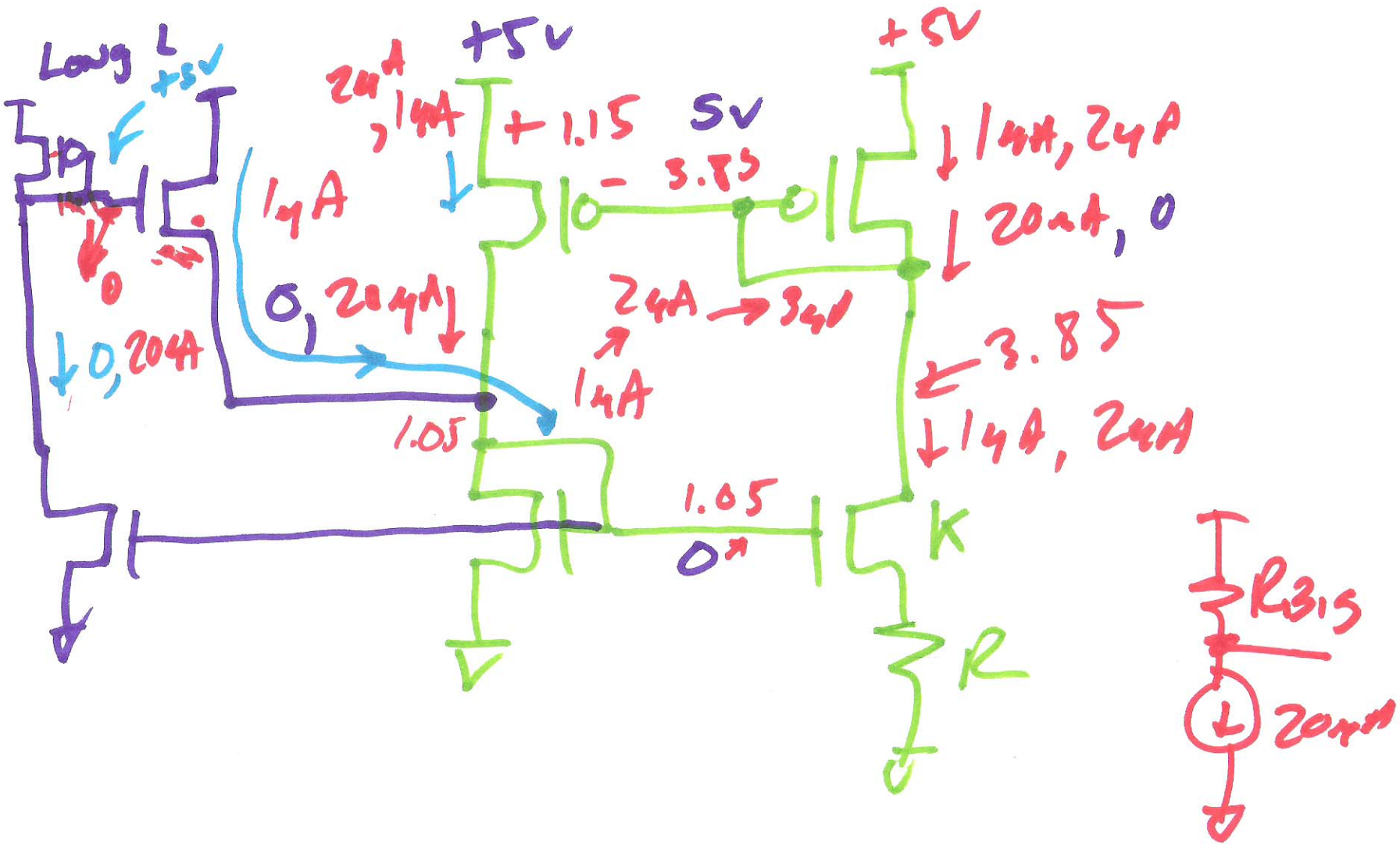
$$g_m = KP \cdot \frac{W}{L} \underbrace{(V_{GS} - V_{THN})}_{V_{OVN} = V_{DS,SAT}} = \frac{1}{R}$$



$$\frac{1}{R} = 120\mu A \cdot \frac{10}{2}(1.05 - .8)$$

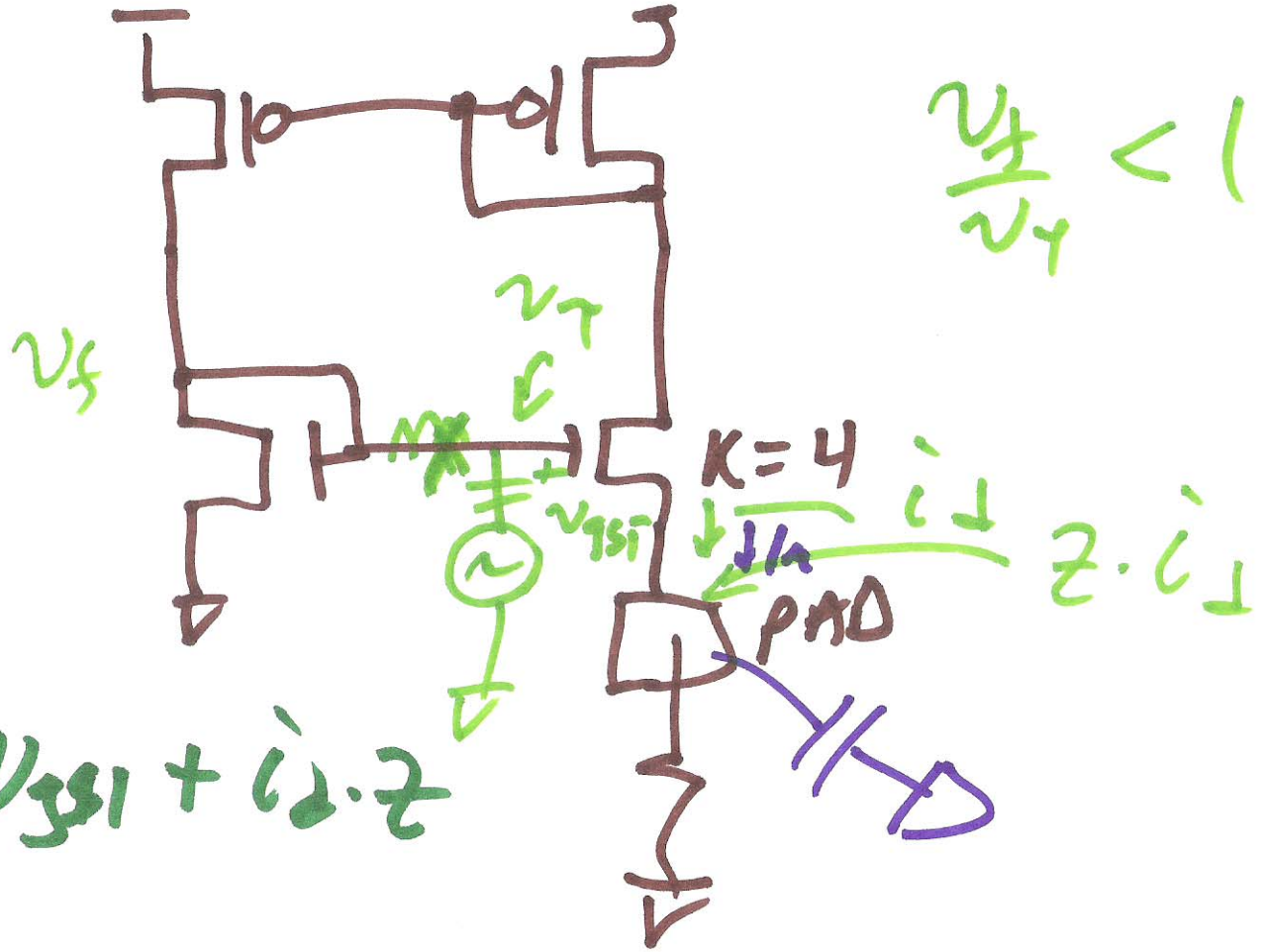
$$R = \frac{1}{g_m} = \frac{1}{150\mu} = 6.5K$$

Beta-multiplier-reference



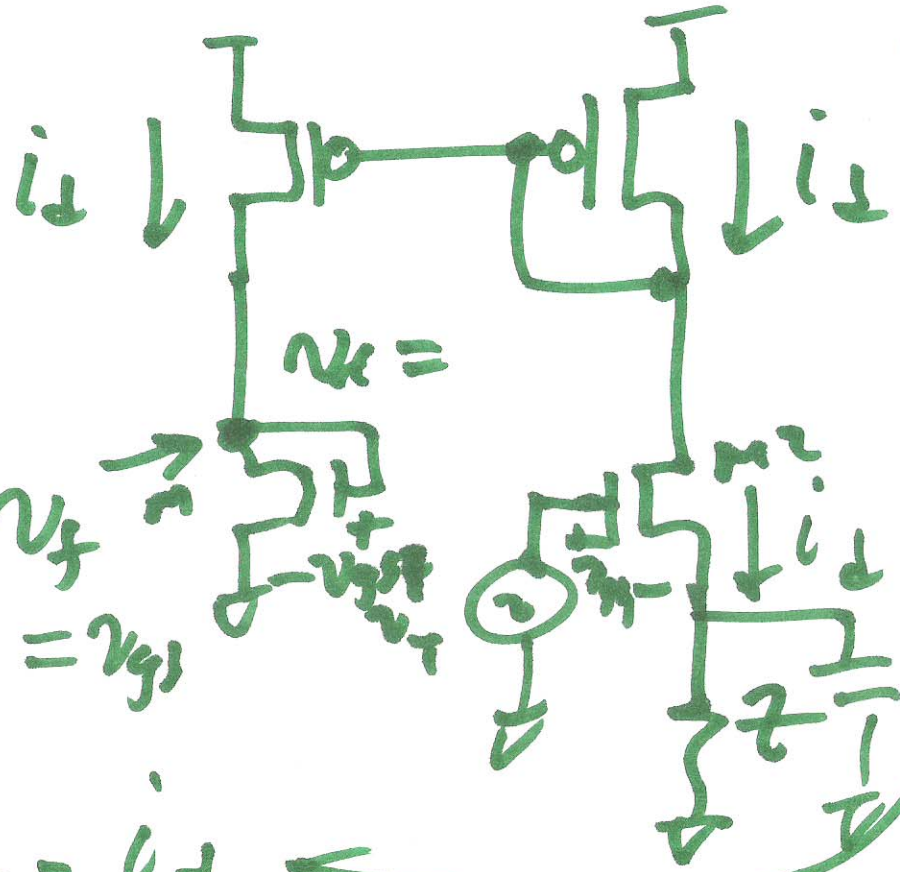
UNLV | ELECTRICAL & COMPUTER ENGINEERING

CMOSedu.com



$$\frac{v_f}{v_T} < 1$$

$$v_T = v_{gs1} + i_1 \cdot 2$$



$$v_T = v_{gs2} + i_d \cdot Z$$

$$= i_d \left(\frac{1}{g_{m2}} + Z\right)$$

$$g_{m1} = \sqrt{2I \cdot K_P \cdot \frac{W}{L}}$$

$$g_{m2} = \sqrt{2I \cdot K_P \cdot \frac{W}{L} \cdot K}$$

$$v_{gs} = \frac{i_d}{g_{m1}}$$

$$\sqrt{K}\, g_{m1} = g_{m2}$$

$$v_f = \frac{v_T}{\frac{1}{g_{m2}} + Z} \cdot \frac{1}{g_{m1}} \Rightarrow \frac{v_f}{v_T} = \frac{1}{\frac{1}{\sqrt{K}} + Z \cdot g_{m1}}$$