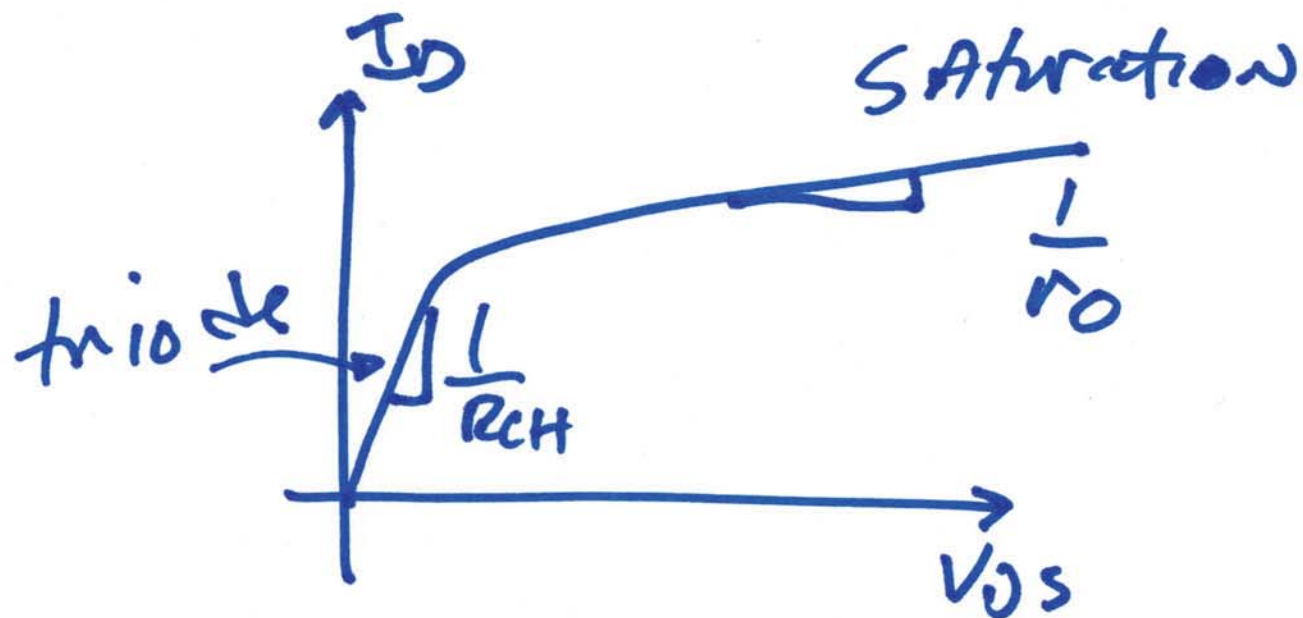
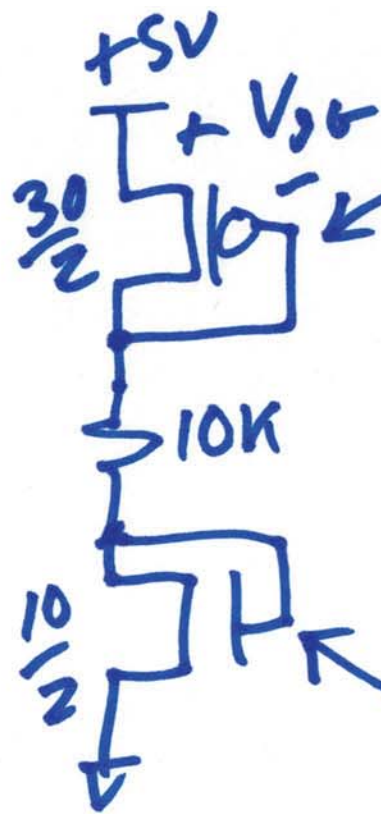


Extra Study Session

MARCH 6, 2016

EE 420 / ECE 620





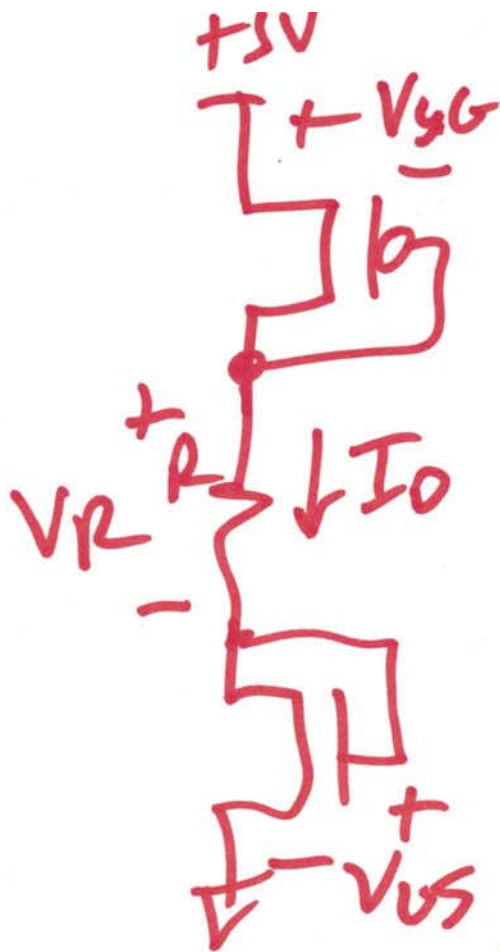
$$5 - V_{SG} = 5 - \sqrt{\frac{2I_D}{40 \mu \cdot \frac{30}{2}}} - .9$$

$$I_D = \frac{5 - \sqrt{\frac{2I_D}{120 \mu \cdot \frac{10}{2}}} - .9 - ()}{10K}$$

$$V_{GS} = \sqrt{\frac{2I_D}{120 \mu \cdot \frac{10}{2}}} + .8$$

$$I_D = \frac{3.3 - 2 \sqrt{\frac{2I_D}{120 \mu \cdot \frac{10}{2}}}}{10K}$$

$$V_{SG} = \sqrt{\frac{2 \cdot I_D}{K_P \cdot W/L}} + .V_{THP}$$



$$5 = V_{sg} + V_R + V_{ds}$$

$$V_R = I_D \cdot R$$

$$V_{sg} = \sqrt{\frac{2I_D}{K_P \cdot \frac{W}{L}}} + V_{THP}$$

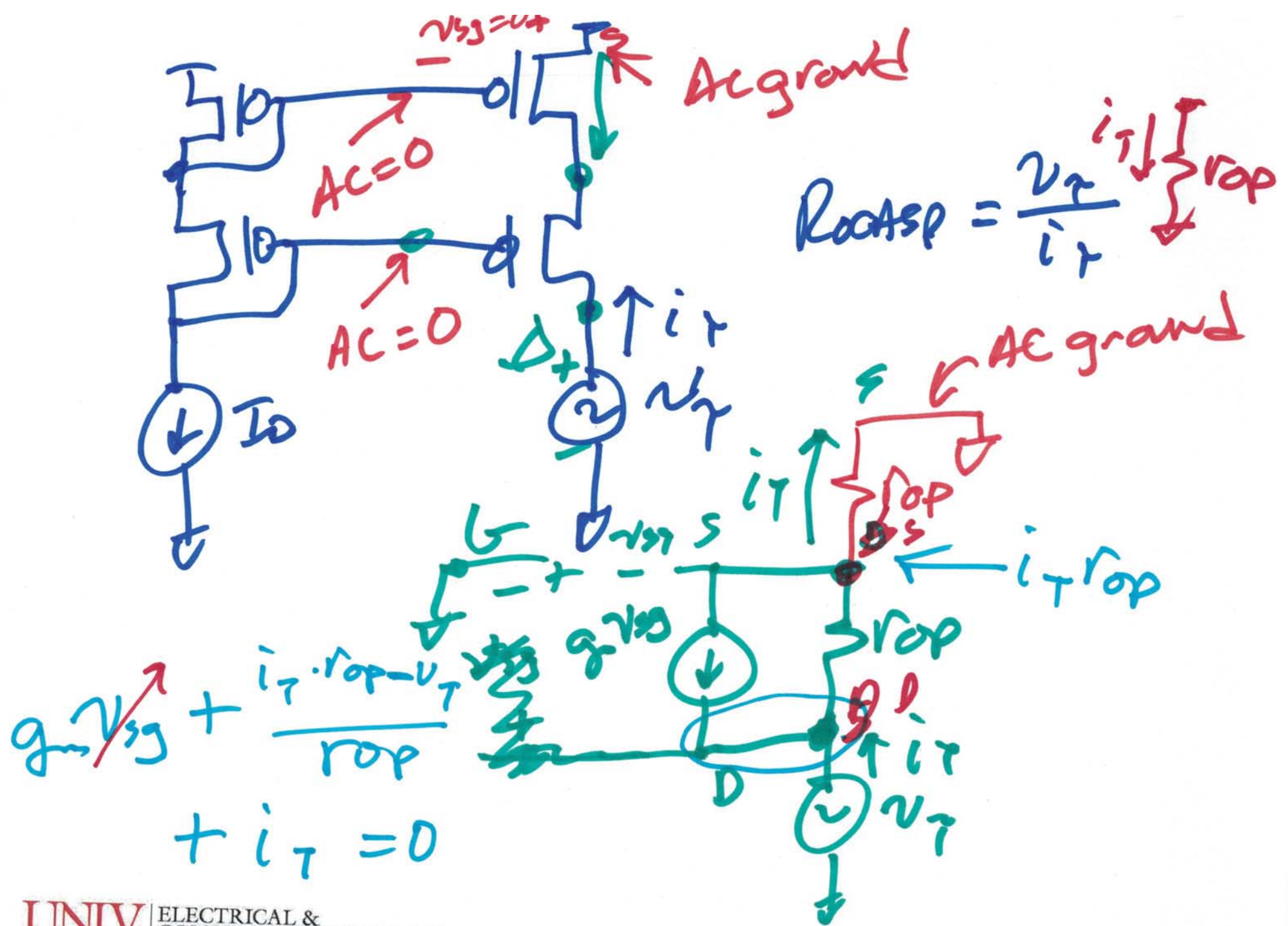
$$V_{ds} = \sqrt{2}$$

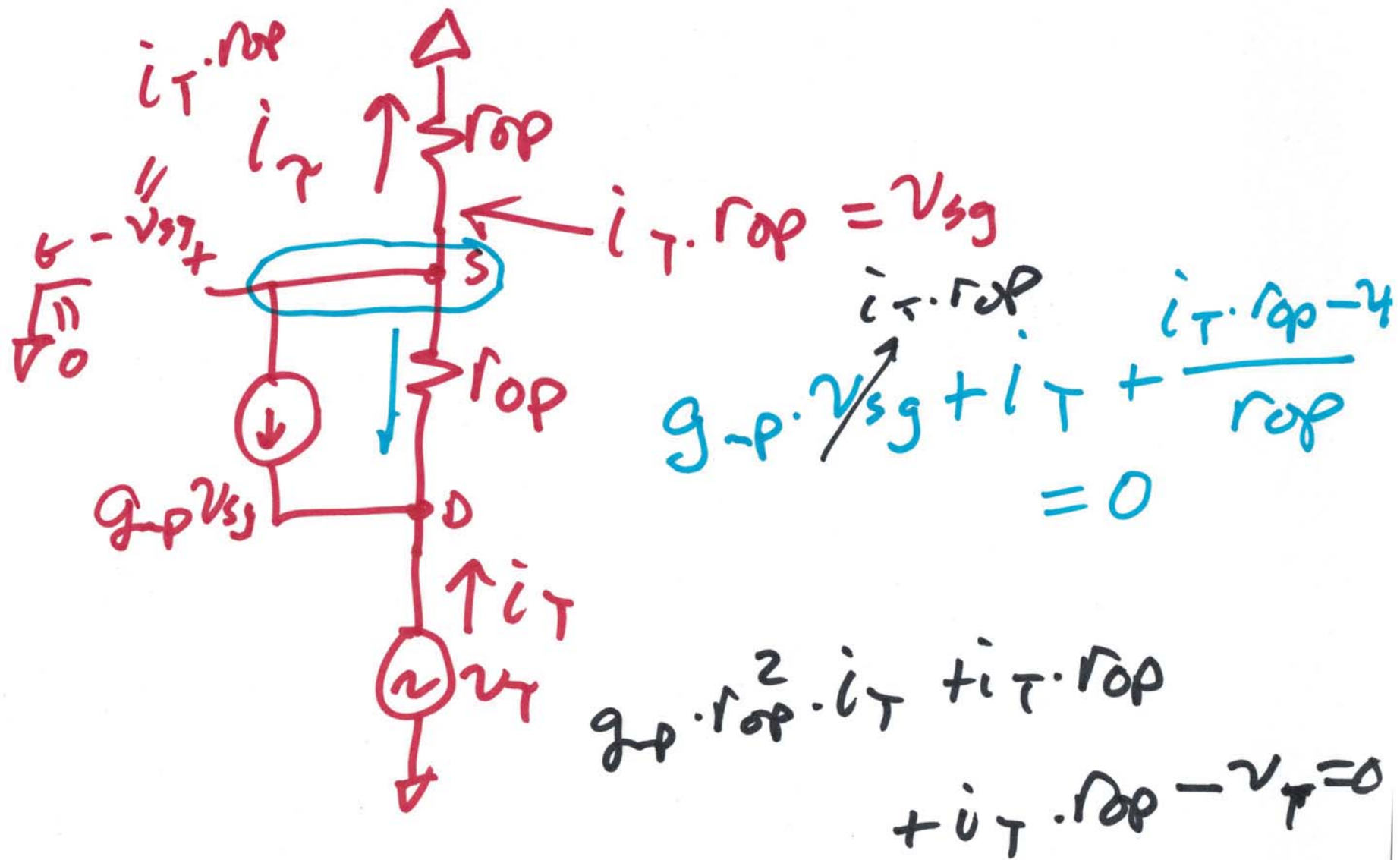
$$V_{ds} = \sqrt{\frac{2I_D}{K_P \cdot \frac{W}{L}}} + V_{THN}$$

$$I_D = (V_{ds} - V_{THN})^2 \cdot \frac{K_P \cdot W}{2L}$$

$$(V_{ds} - V_{THN})^2 = \frac{I_D \cdot 2}{K_P \cdot \frac{W}{L}}$$

$$V_{ds} - V_{THN} = \sqrt{\frac{I_D \cdot 2}{K_P \cdot \frac{W}{L}}}$$





$$R_{outsp} = \frac{v_T}{i_T} = \boxed{g_m r_{op}^2 + 2r_{op}}$$

$$I_D = \frac{K_P}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2$$

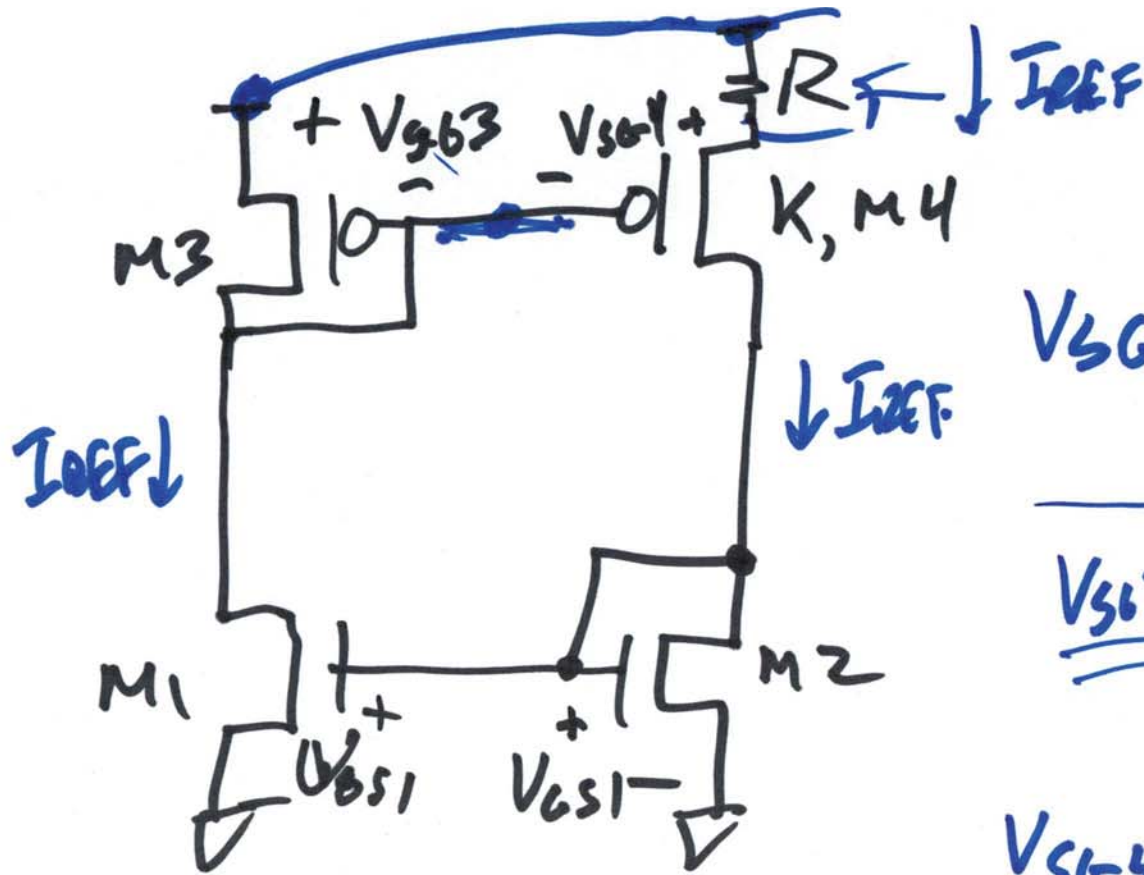
$$I_D = \frac{K_P}{2} \cdot \frac{W}{4L} (V_{GSMWS} - V_{THN})^2$$

$$V_{GSMWS} = V_{GS} + V_{OS, SAT}$$

$$I_D = \frac{K_P}{2} \frac{W}{L \cdot 4} (V_{GS} - V_{THN} + V_{OS, SAT})^2$$

$$I_D = \frac{K_P}{2} \frac{W}{L \cdot 4} (2(V_{GS} - V_{THN}))^2$$

$$V_{OS, SAT} = V_{GS} - V_{THN}$$



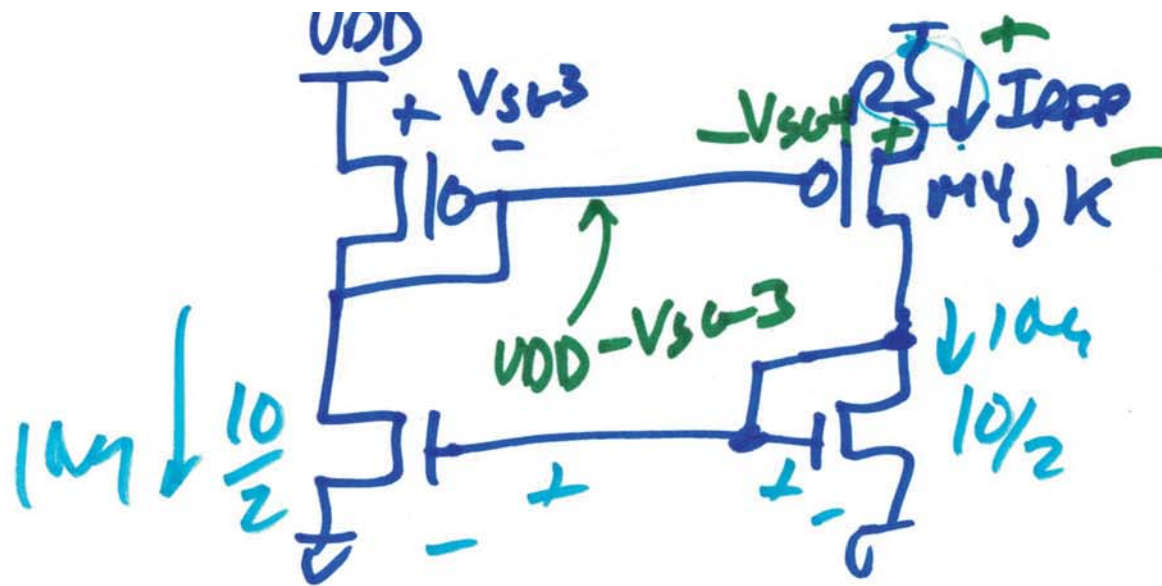
$$V_{GS3} = I_{REF} \cdot R$$

$$\underline{V_{GS3}} = \sqrt{\frac{2I_{REF}}{K_P \cdot \frac{W}{L}}} + V_{THP}$$

$$\underline{V_{GS4}} = \sqrt{\frac{2I_{REF}}{K_P \cdot K \cdot \frac{W}{L}}} + V_{THP}$$

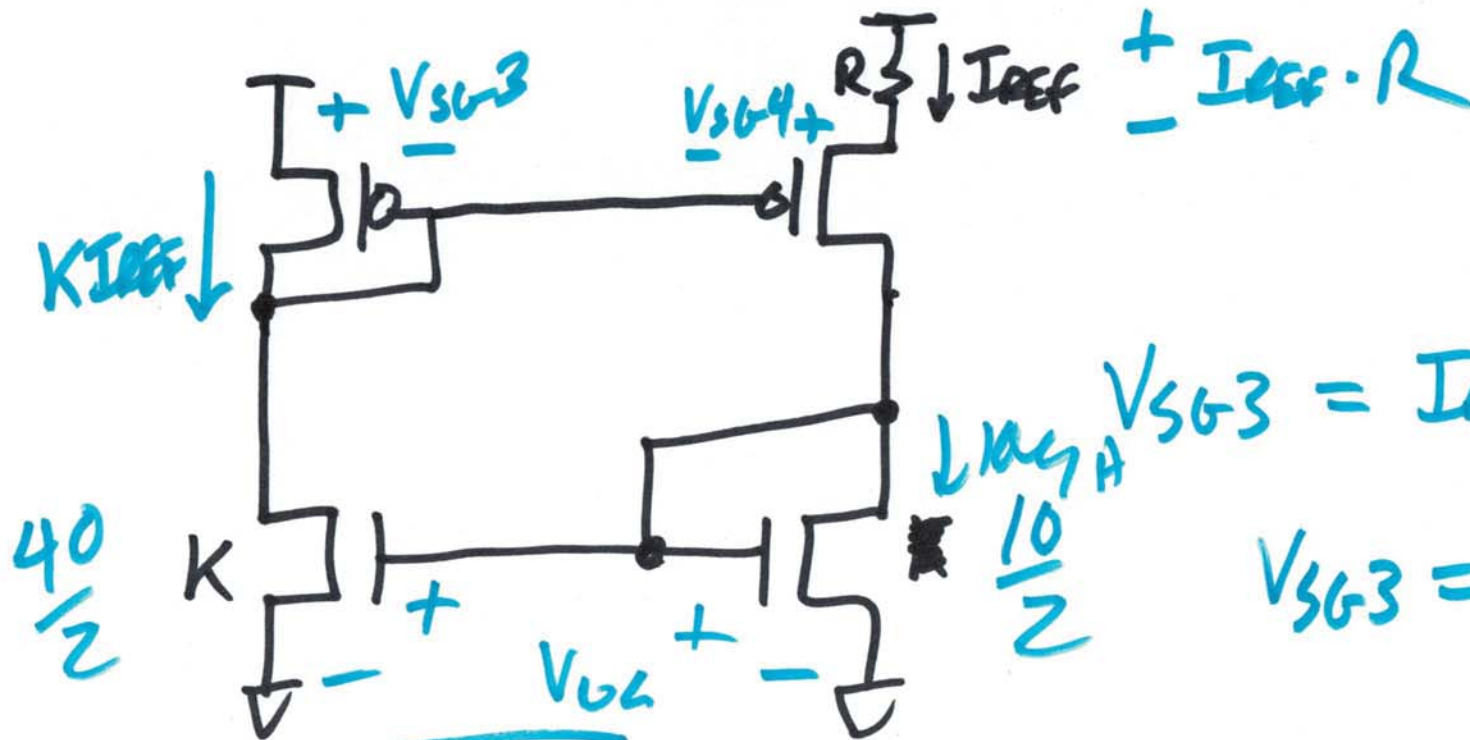
$$\sqrt{\frac{2I_{REF}}{K^2 K_P \cdot \frac{W}{L}}} \cdot \left(1 - \frac{1}{\sqrt{K}}\right) = I_{REF} \cdot R$$

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



$$VDD - I_{REF} \cdot R - V_{SG4} = VDD - V_{SG3}$$

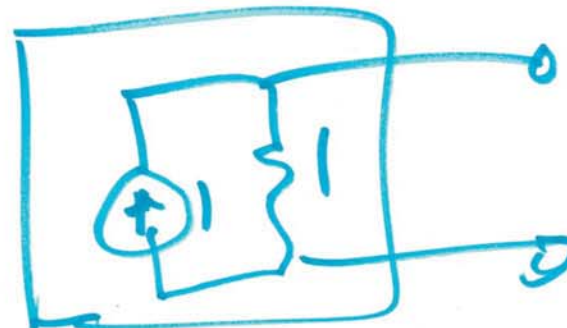
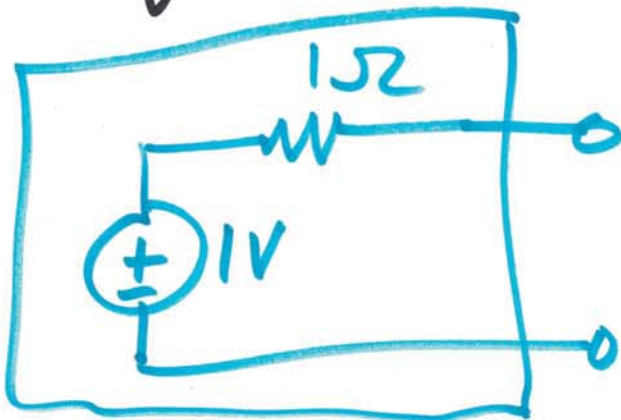
$$V_{SG4} + I_{REF} \cdot R = V_{SG3}$$



$$V_{SG3} = I_{REF} \cdot R + V_{SG4}$$

$$V_{SG3} = \sqrt{\frac{2K I_{REF}}{K_P \cdot \frac{W}{L}}} + V_{THP}$$

$$V_{SG4} = \sqrt{\frac{2 I_{REF}}{K_P \cdot \frac{W}{L}}} + V_{THP}$$



Chs. Ex. EOC
9 & 20 H.W. Quiz 22/23

