

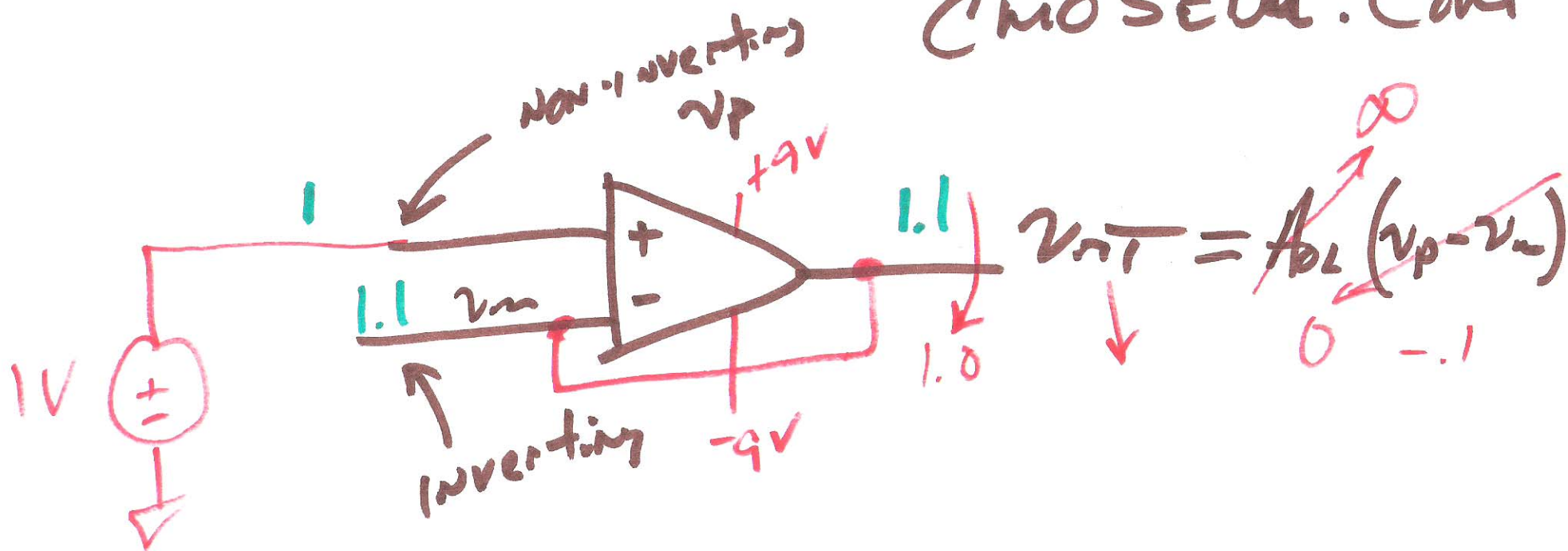
GONZAGA IEEE

Lecture on
Analog Design

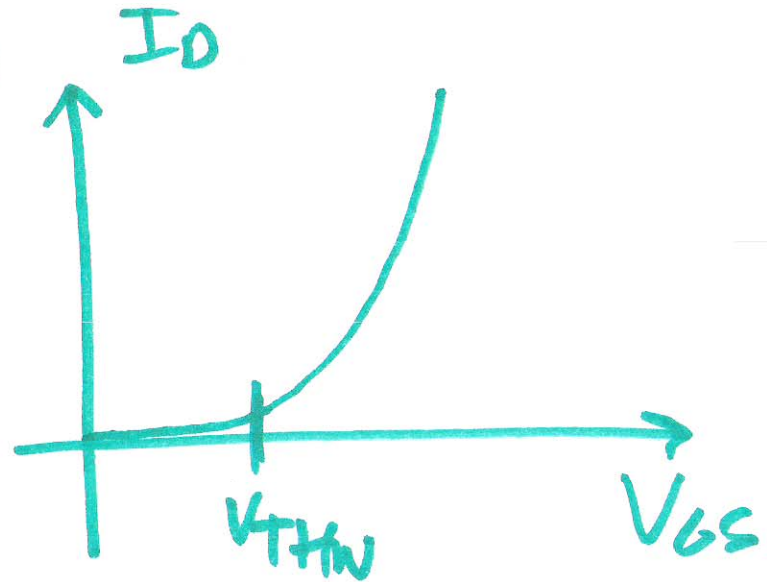
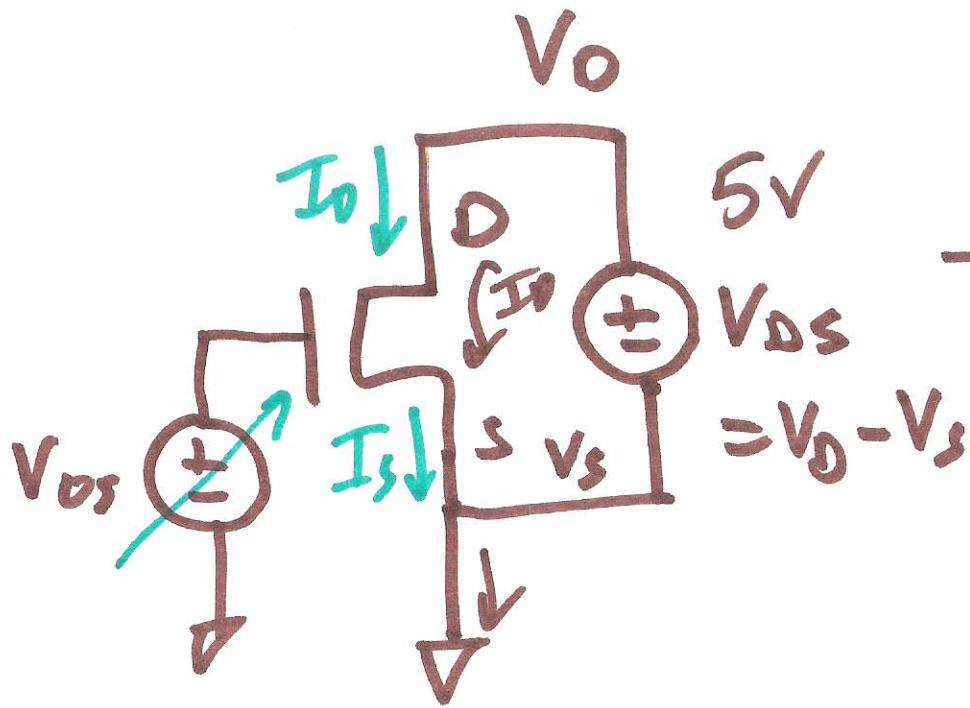
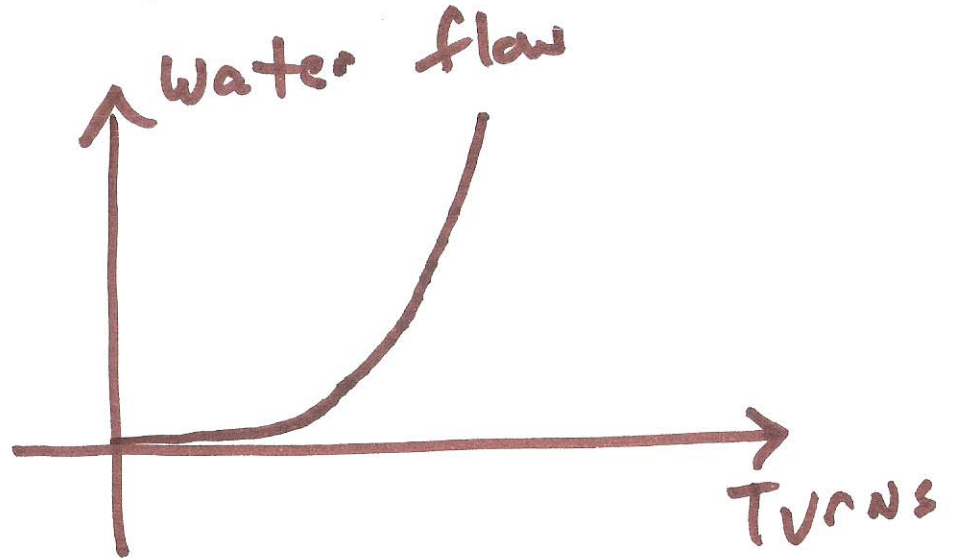
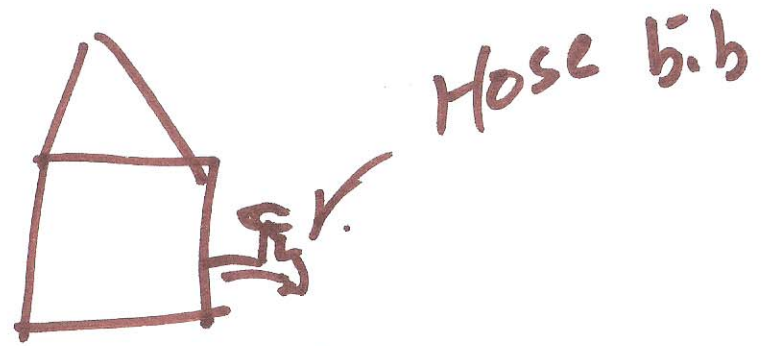
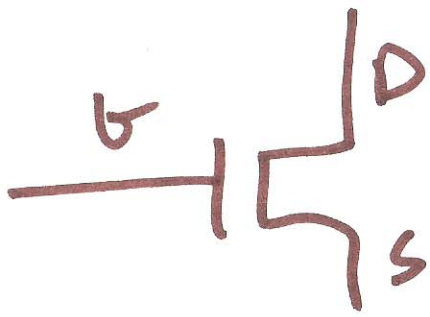
April 9, 2015

Jake Baker

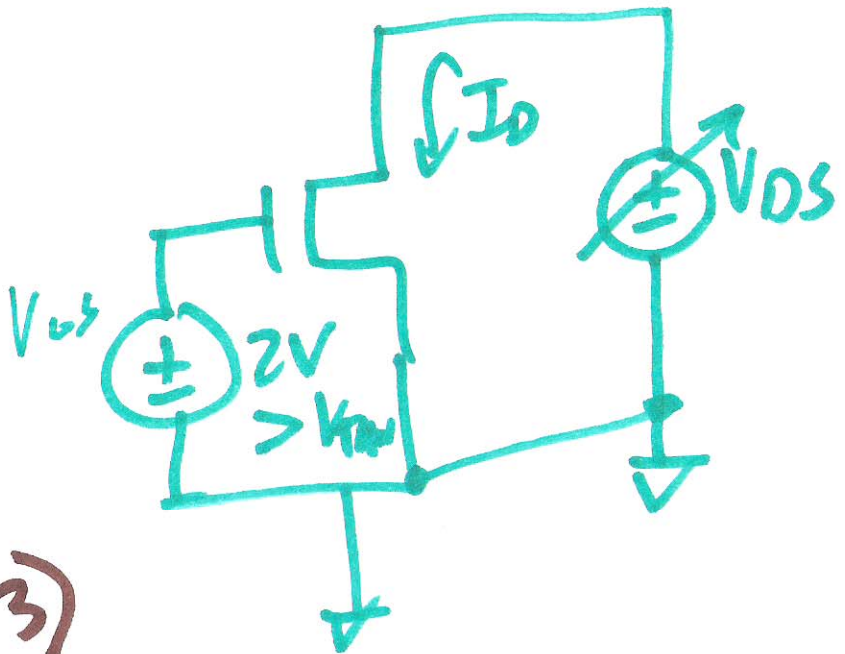
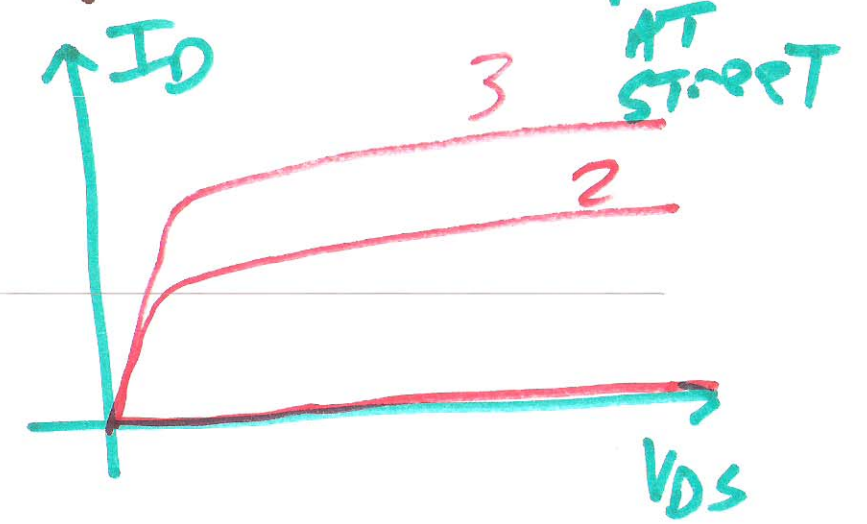
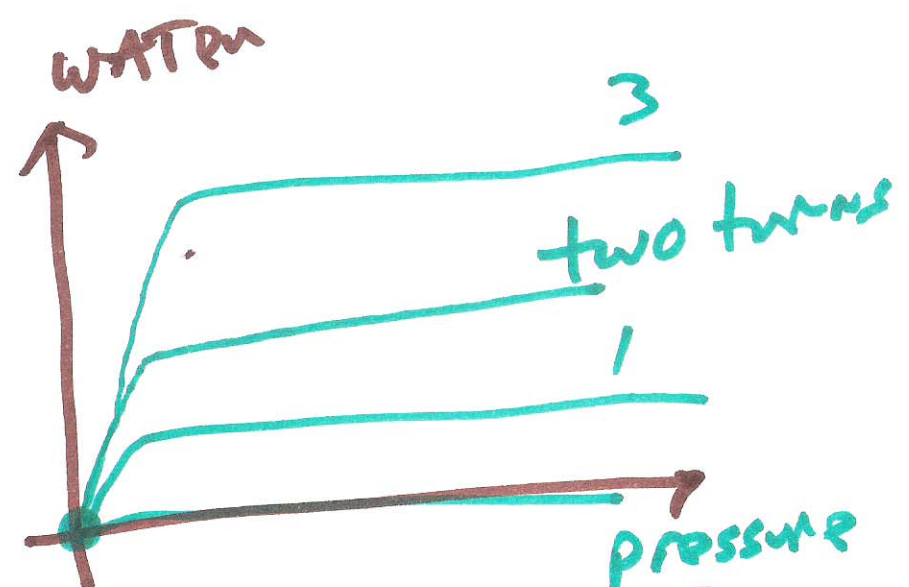
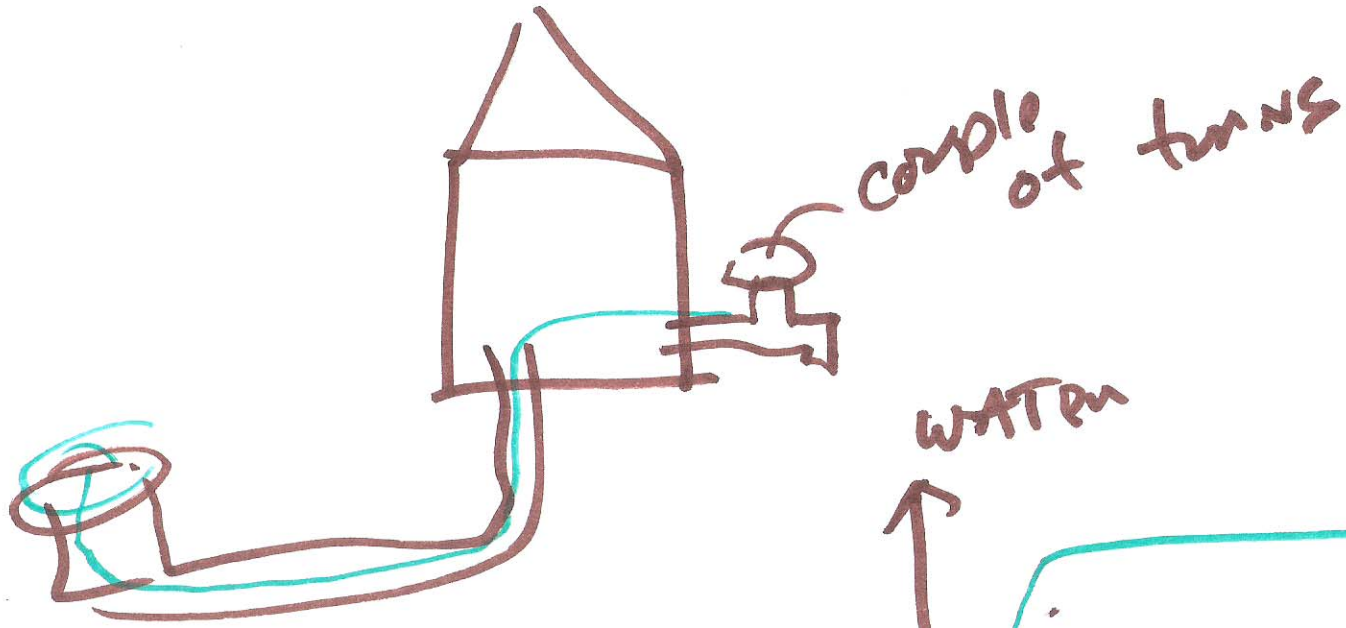
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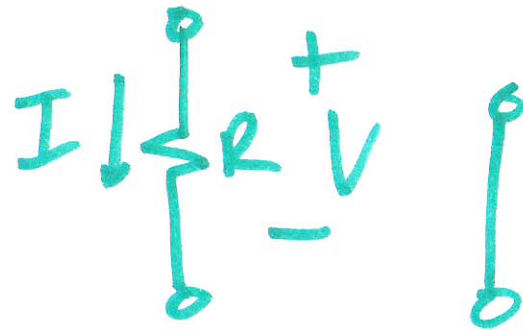
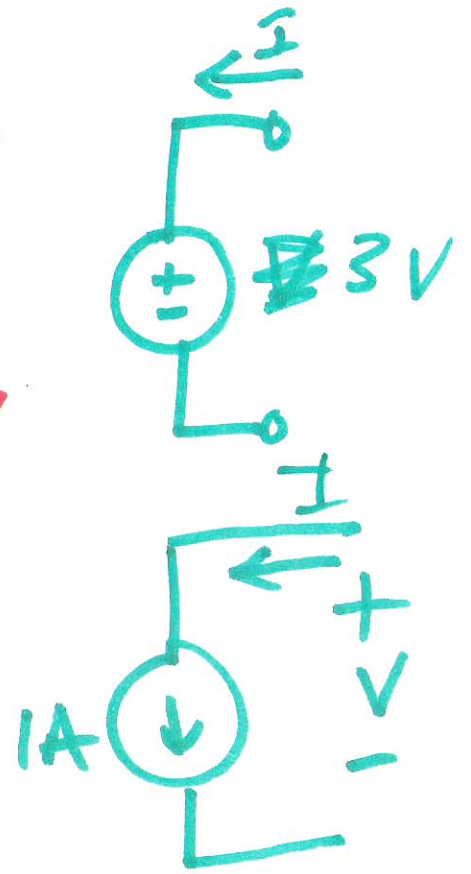
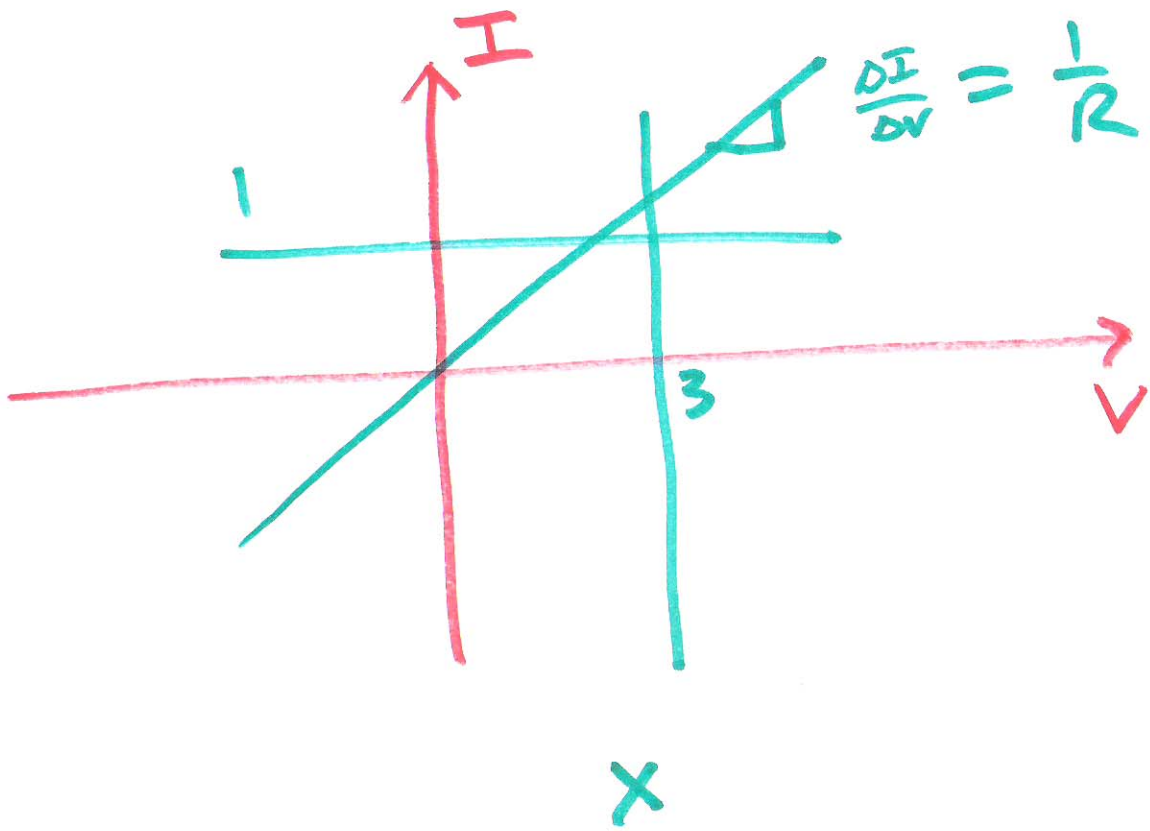


1)

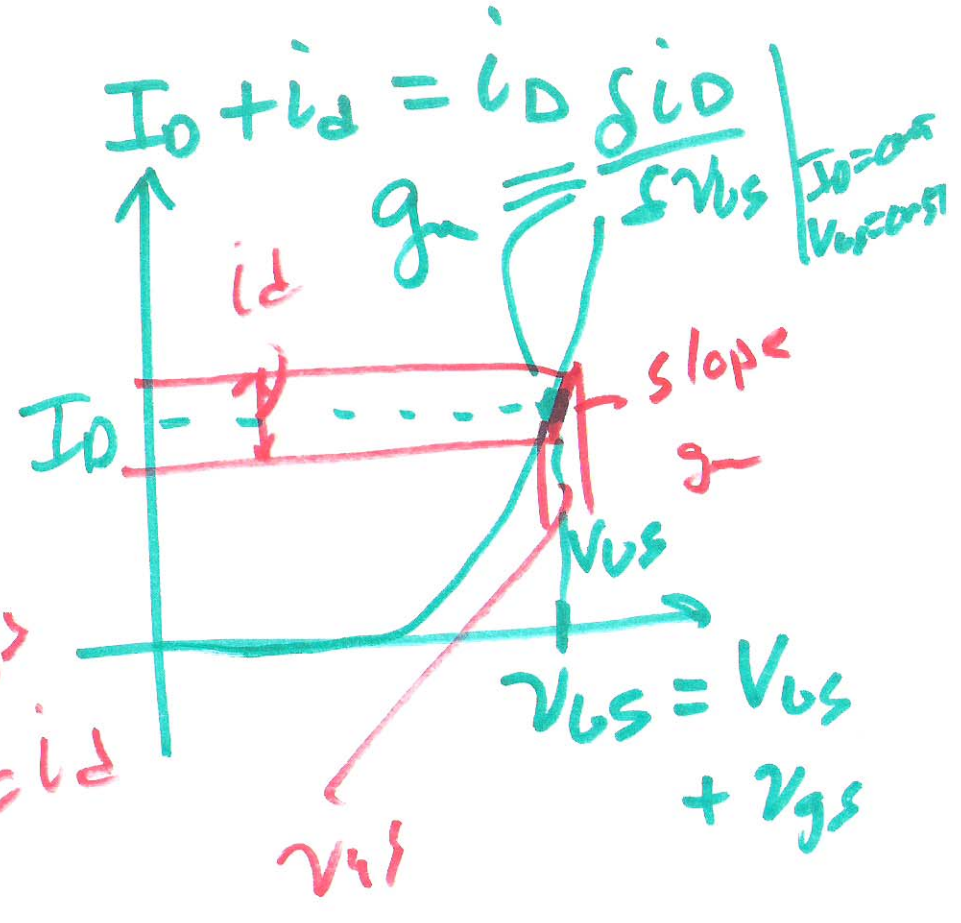
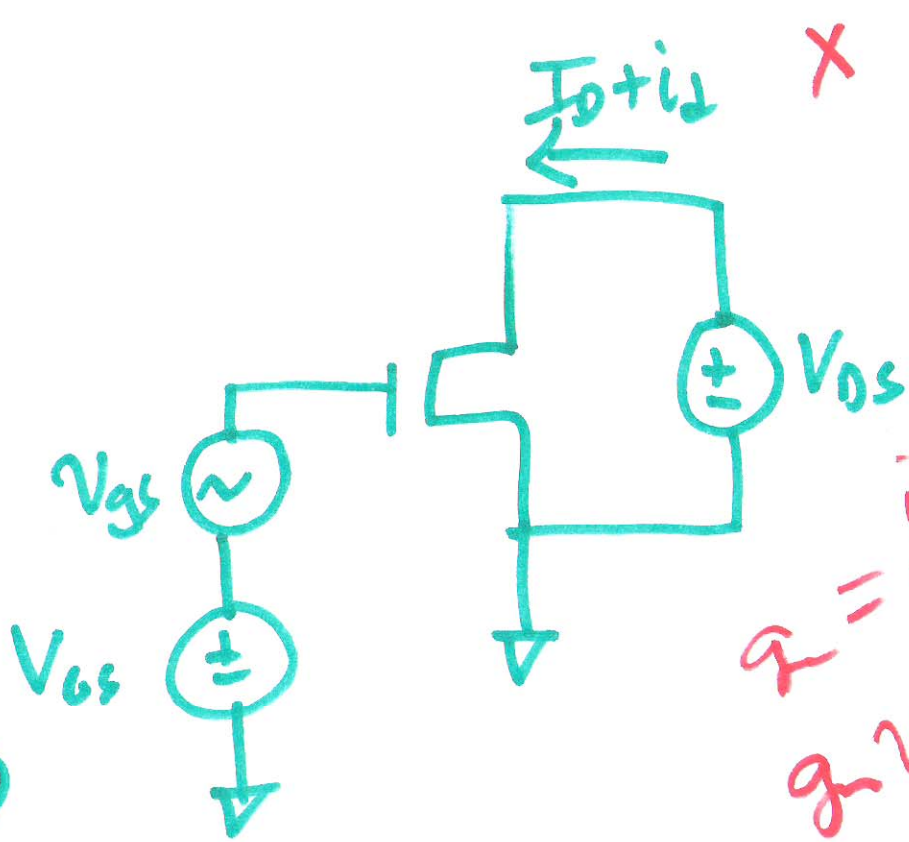
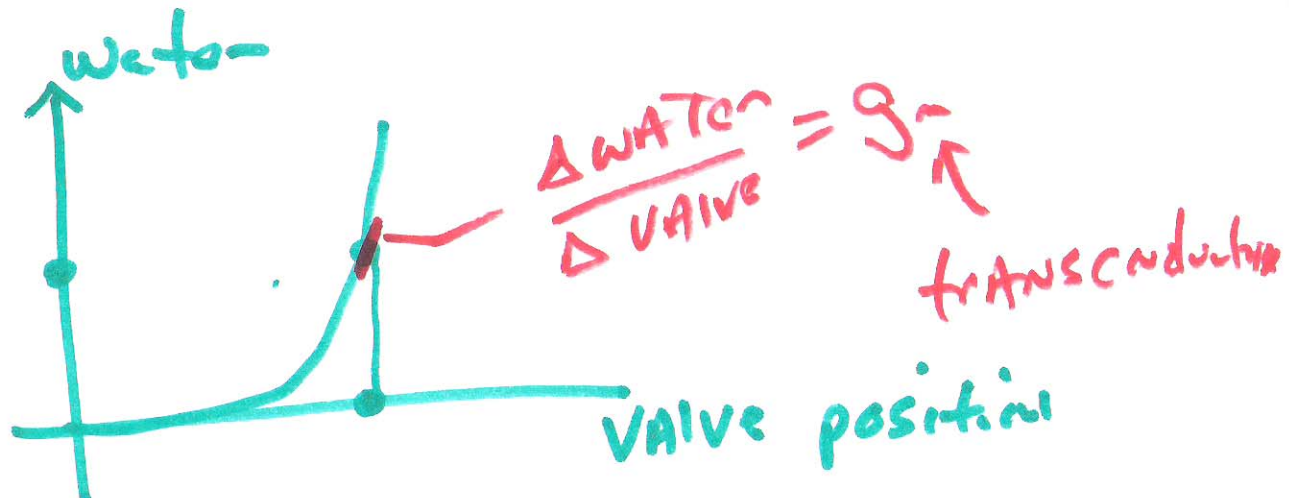
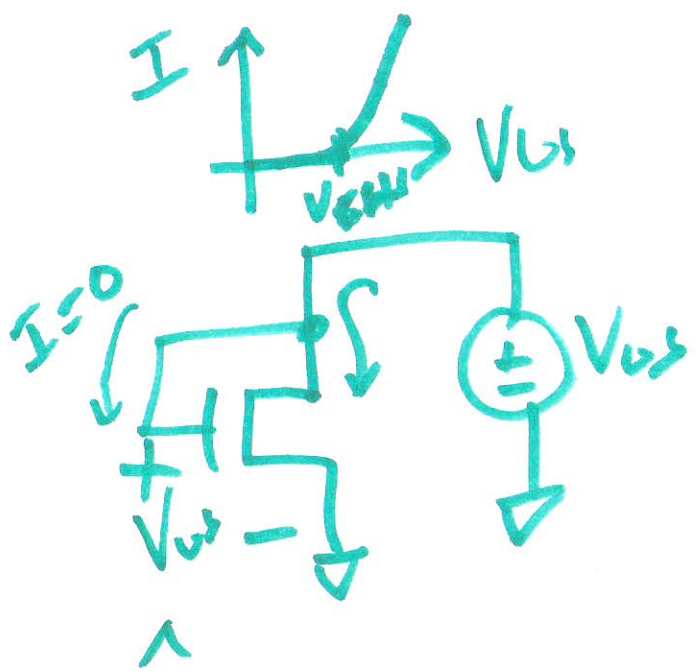


2)





4)



5)

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

$$i_D + I_0 = \frac{K_P \cdot W}{2} \frac{L}{L} (V_{GS} + v_{gs} - V_{THN})^2$$

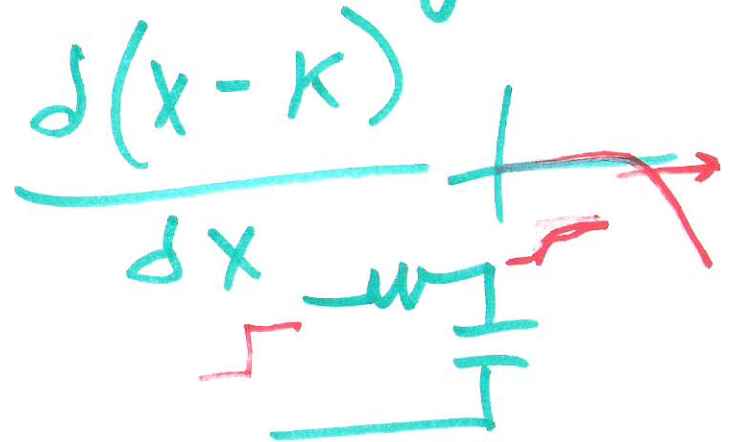
$$g_m = \frac{\delta i_D + \delta I_0}{\delta V_{GS}} = \frac{K_P \cdot W}{L} (V_{GS} + v_{gs} - V_{THN}) \frac{\delta (V_{GS} + v_{gs})}{\delta V_{GS}}$$

$V_{GS} \gg v_{gs}$
 small-signal
 $I_0 = \text{const}$
 $V_{GS} = \text{const}$

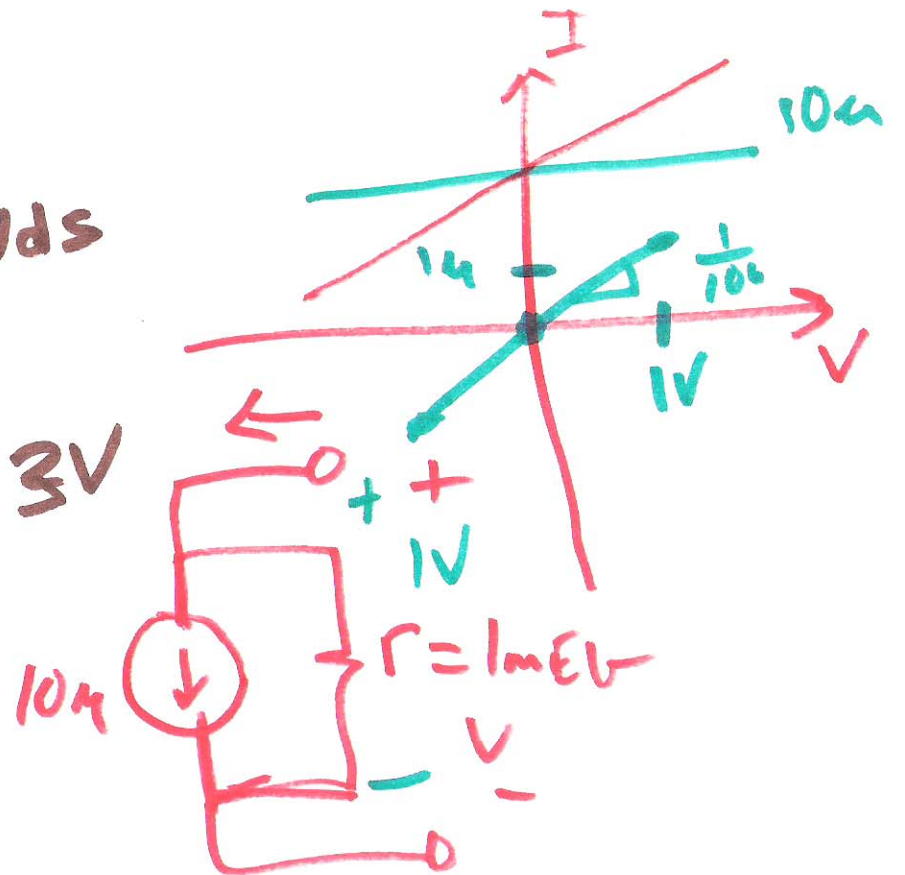
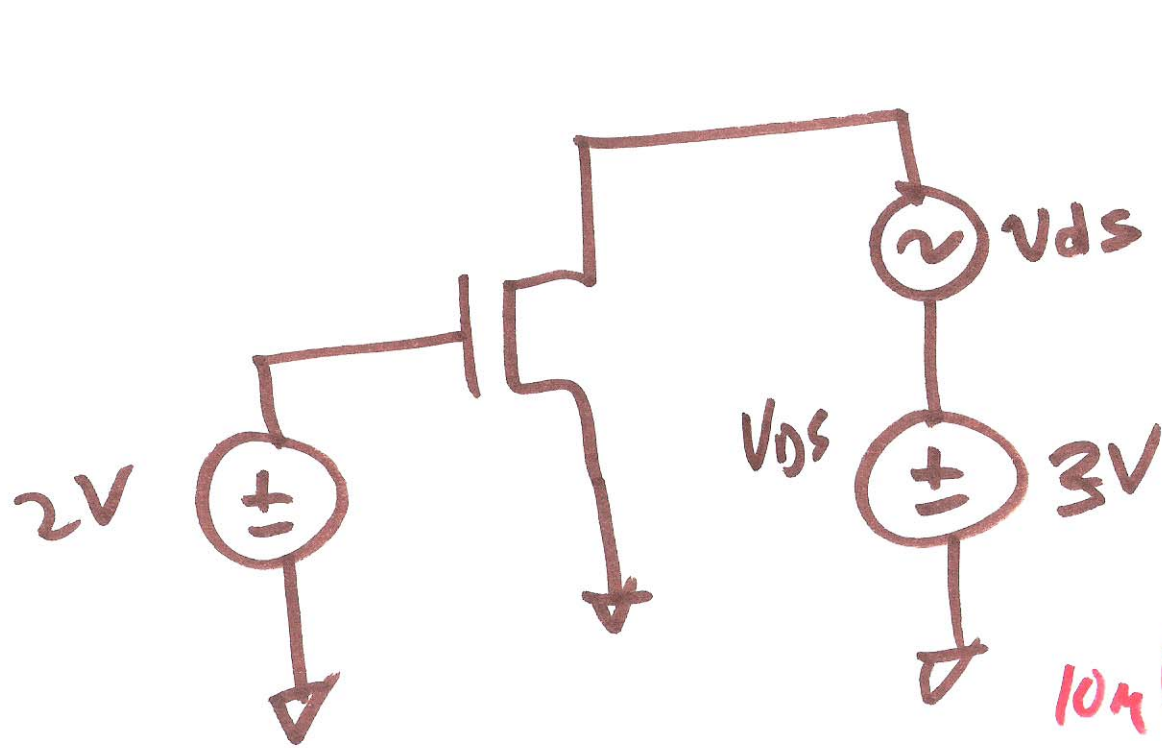
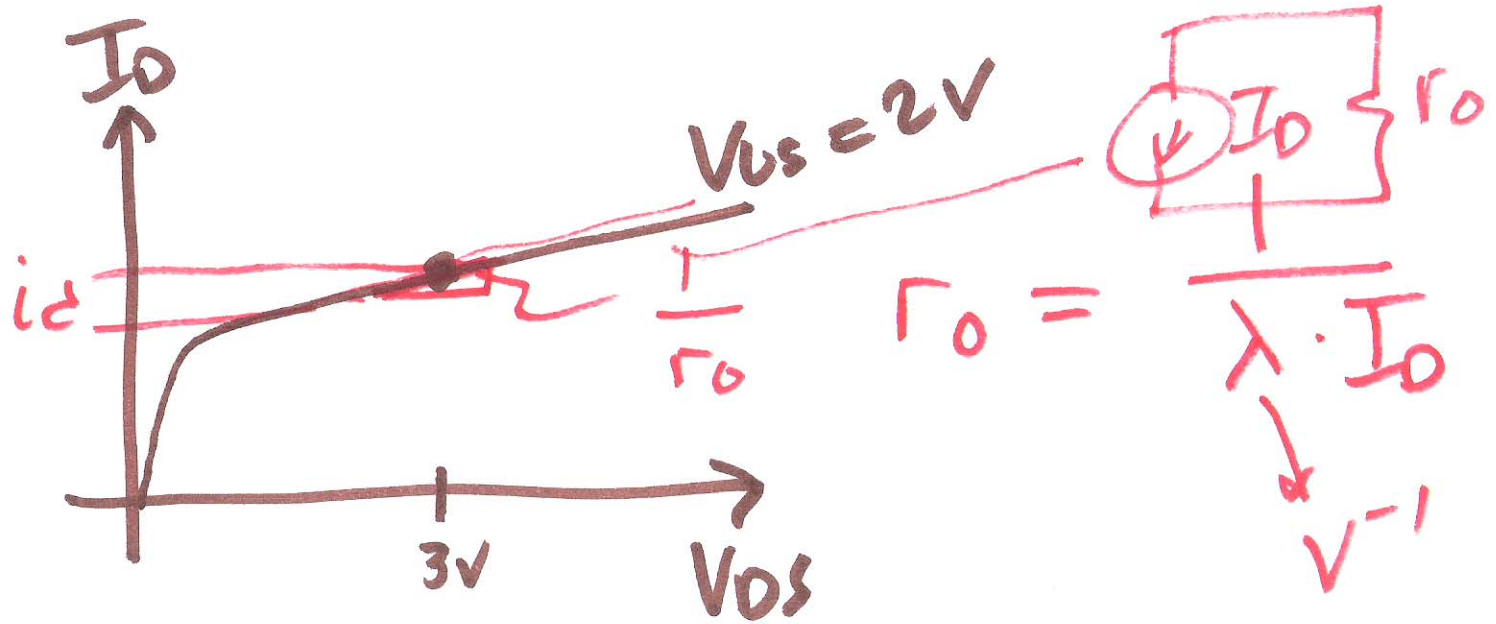
$V_{GS} \uparrow \rightarrow g_m \uparrow$
 $\rightarrow \text{speed} \uparrow$
 $\rightarrow \text{gain} \downarrow$

$$g_m = \frac{K_P \cdot W}{L} (V_{GS} + v_{gs} - V_{THN})$$

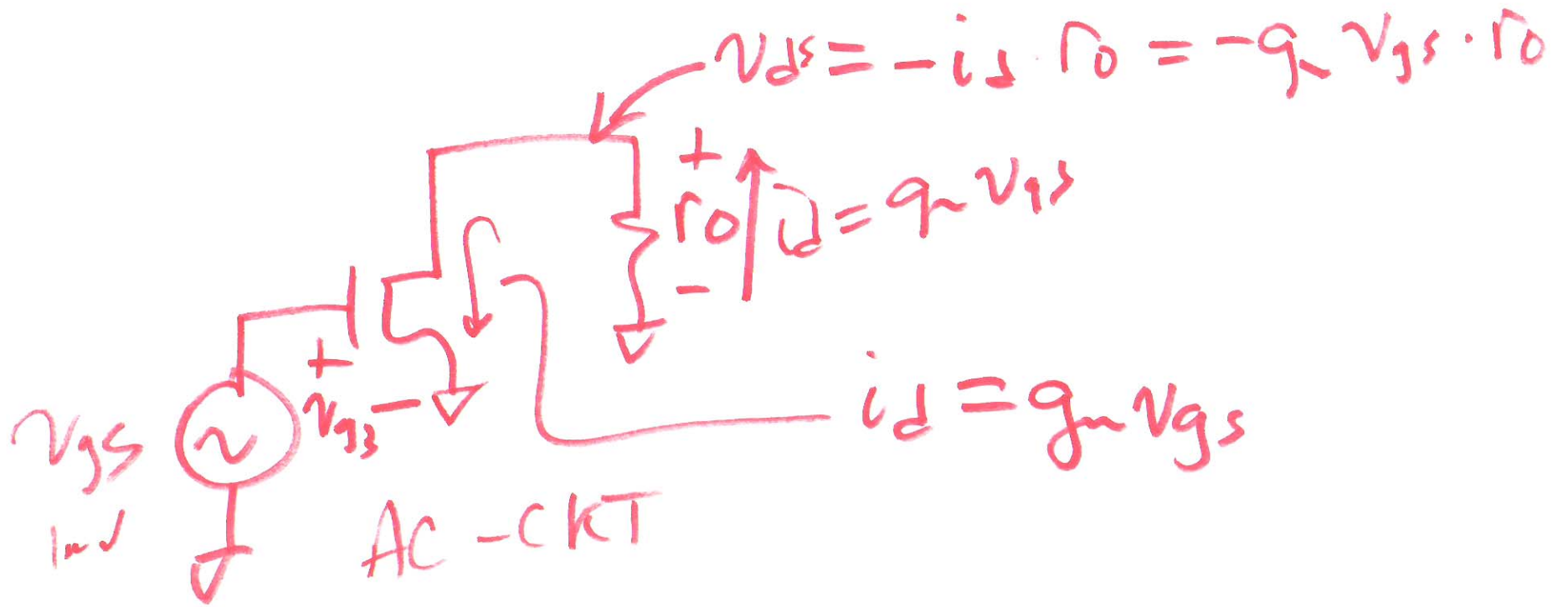
$$g_m = \sqrt{\frac{2I_0}{K_P \cdot W/L}}$$



b)



\Rightarrow



$$\begin{aligned}
 \frac{v_{ds}}{v_{gs}} &= -g_m r_o \\
 &\quad \uparrow \\
 &\quad \text{open-circuit} \\
 &= \frac{\sqrt{\frac{2I_D}{\mu_p \cdot \frac{W}{L}}}}{\lambda I_D} \propto \frac{1}{\sqrt{I_D}}
 \end{aligned}$$

8)