

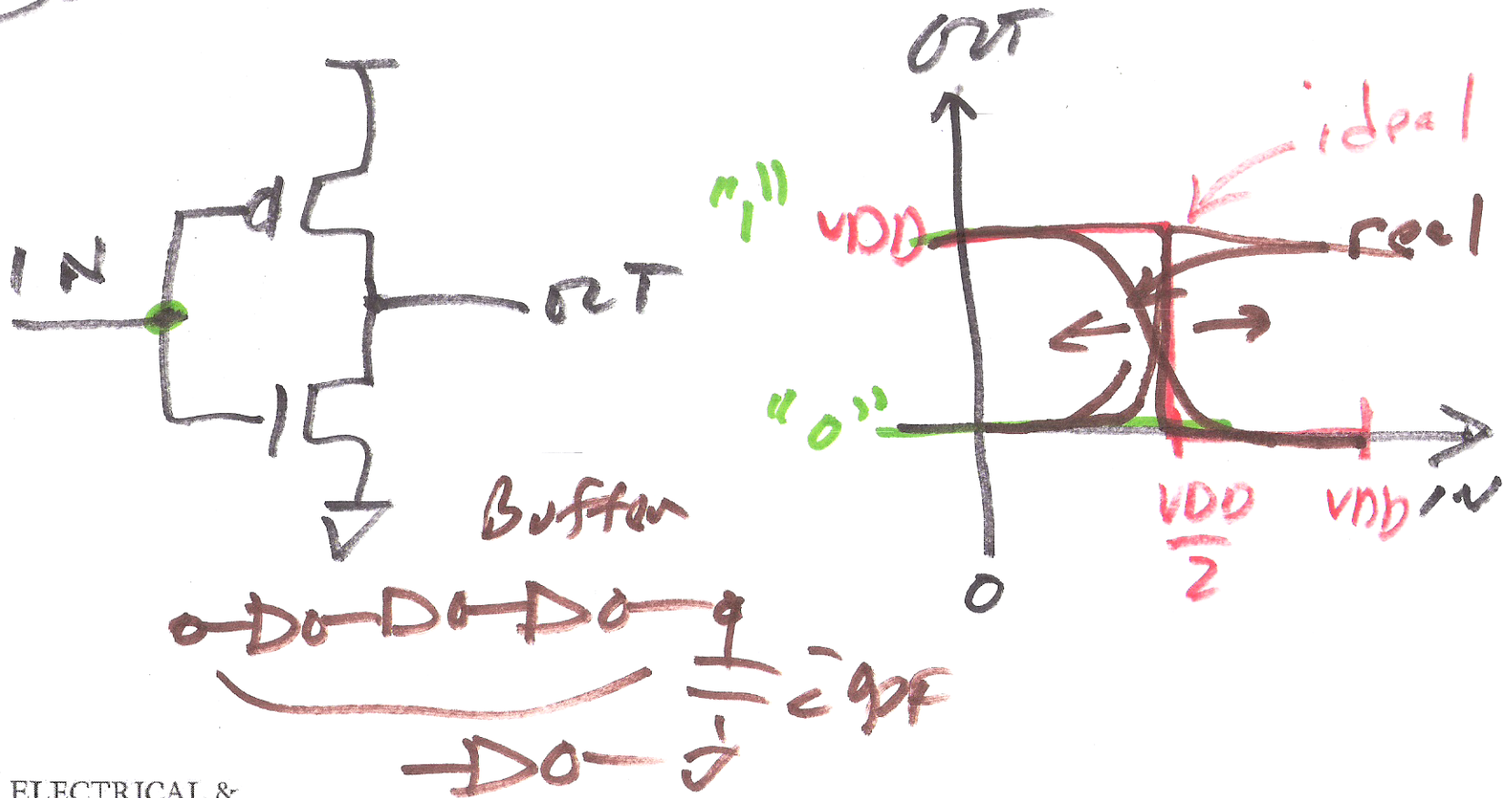
EE 421 / ECE 621

CMOS

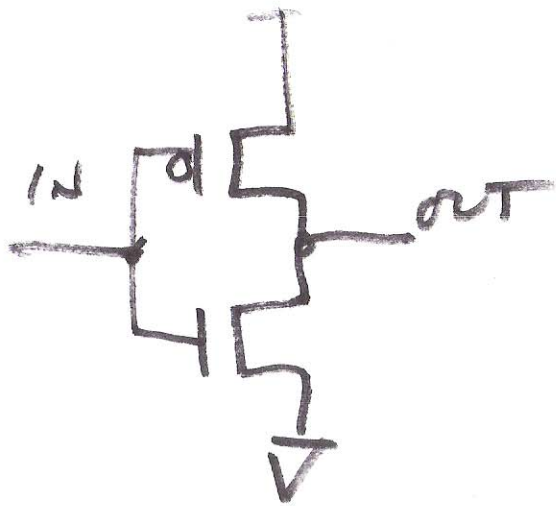
NOV. 5, 2014

DC characteristics of inverters

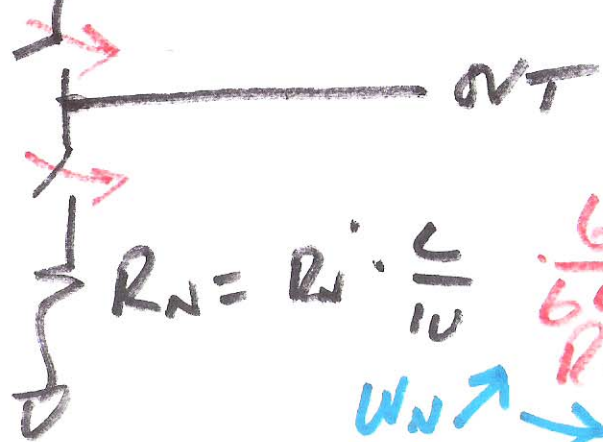
→ DO



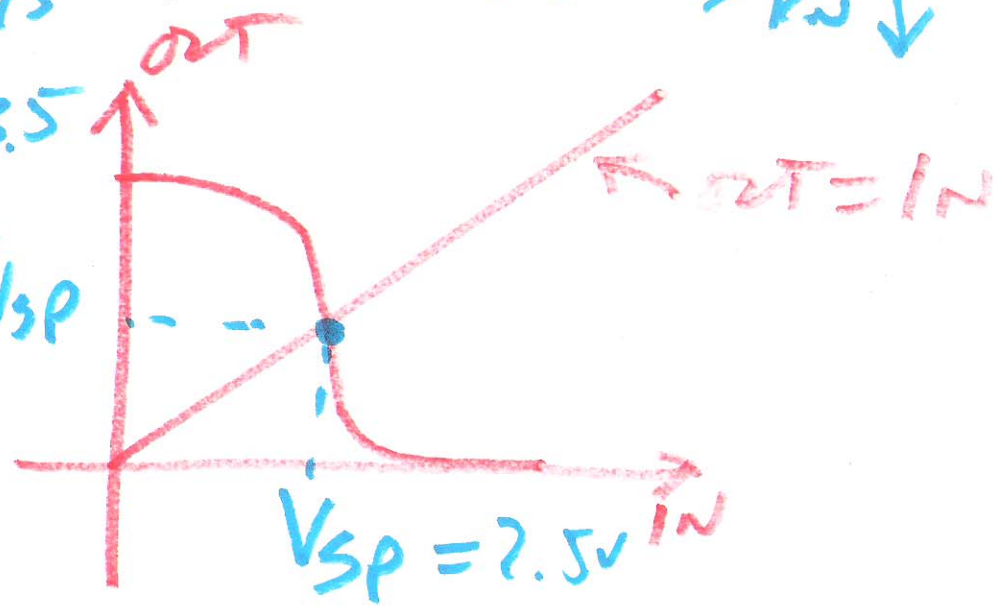
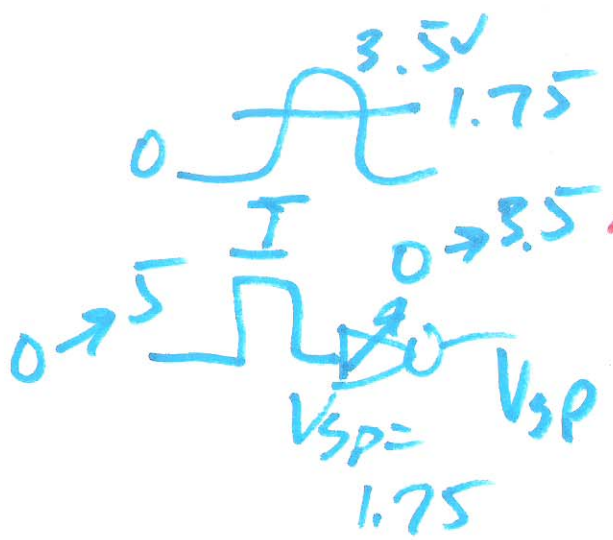
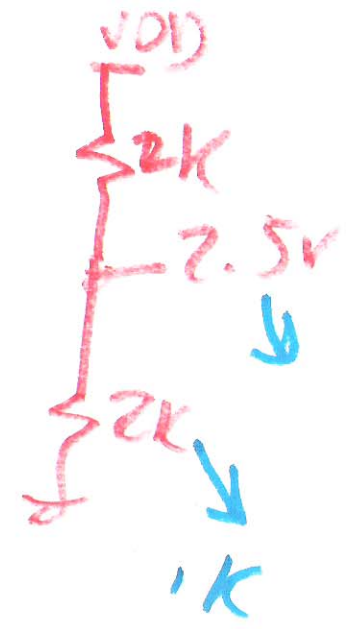
1)



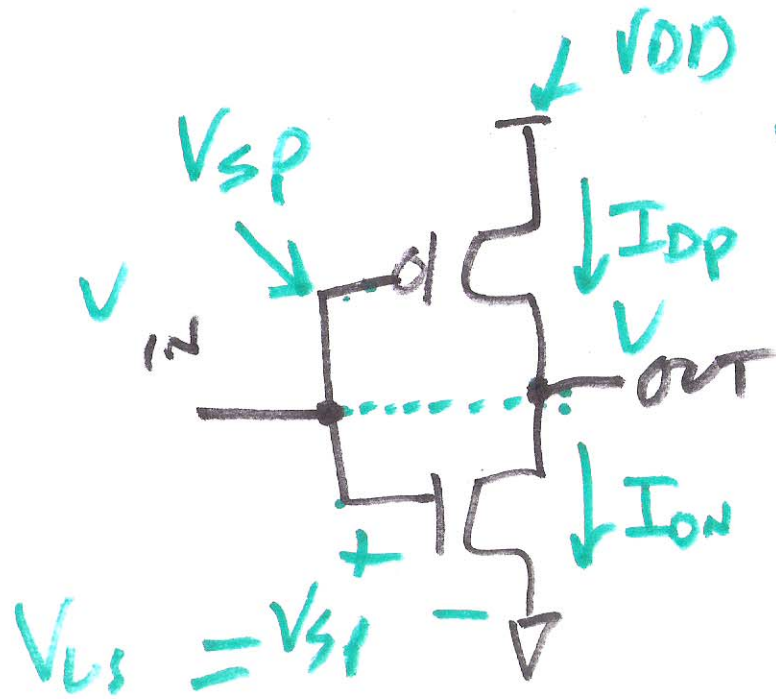
$R_p = R_p' \cdot \frac{W}{L}$
 $\frac{.64}{124} R_p' = 410k \rightarrow 2k$



$R_n = R_n' \cdot \frac{W}{L}$
 $\frac{.64}{641} R_n' = 20k$
 $W_n \uparrow \rightarrow R_n \downarrow$



2)



$$V_{i,n} = V_{out} = V_{sp}$$

$$V_{SG} = V_S - V_G = V_{DD} - V_{SP}$$

$$\frac{\beta_N}{\beta_P} (V_{SP} - V_{THN})^2 =$$

$$\frac{\beta_P}{\beta_N} (V_{DD} - V_{SP} - V_{THP})^2$$

$$V_{DS} \geq V_{GS} - V_{THN}$$

$$V_D - V_S \geq V_G - V_S - V_{THN}$$

$$V_D \geq V_G - V_{THN}$$

$$0 \geq -V_{THN}$$

$$\sqrt{\frac{\beta_N}{\beta_P}} (V_{SP} - V_{THN}) = (V_{DD} - V_{SP} - V_{THP})$$

$$\left(\sqrt{\frac{\beta_N}{\beta_P}} + 1 \right) V_{SP} = V_{DD} - V_{THP} + \sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{THN}$$

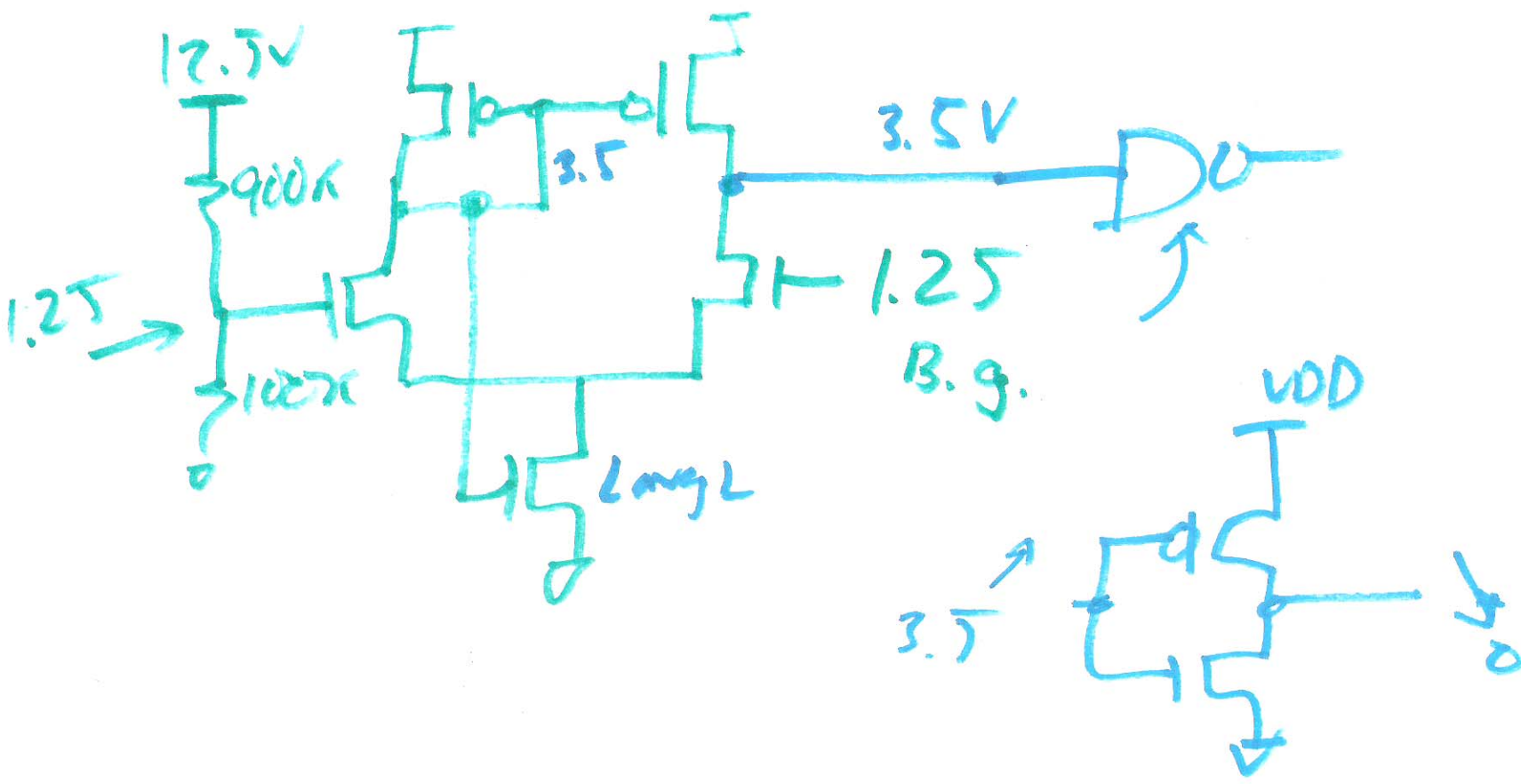
$$V_{SP} = \frac{V_{DD} - V_{THP} + \sqrt{\frac{\beta_N}{\beta_P}} \cdot V_{THN}}{1 + \sqrt{\frac{\beta_N}{\beta_P}}}$$

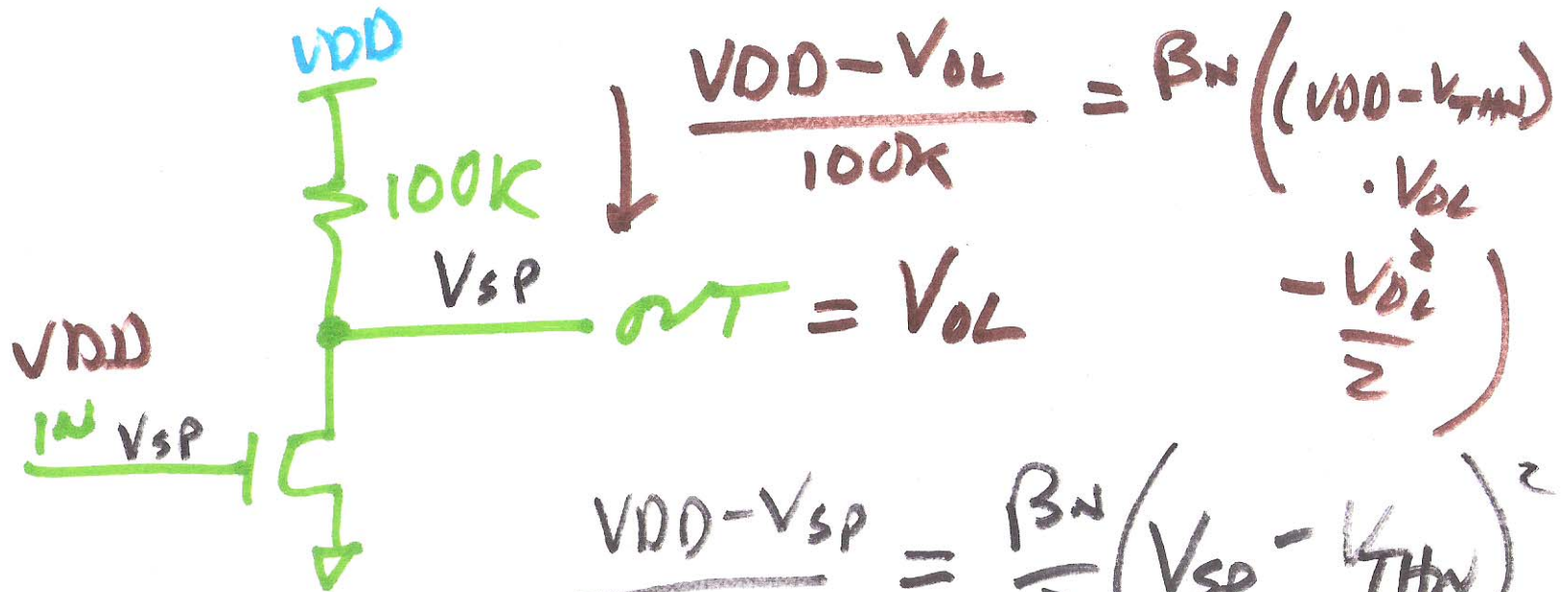
$$\beta_N = \mu_n C_{ox} \cdot \frac{W}{L} = k_{PN} \cdot \frac{W}{L}$$

$$\beta_P = \mu_p C_{ox} \cdot \frac{W}{L} = k_{PP} \cdot \frac{W}{L}$$

$$\beta_N \uparrow \quad \frac{W}{L} \uparrow$$

4)

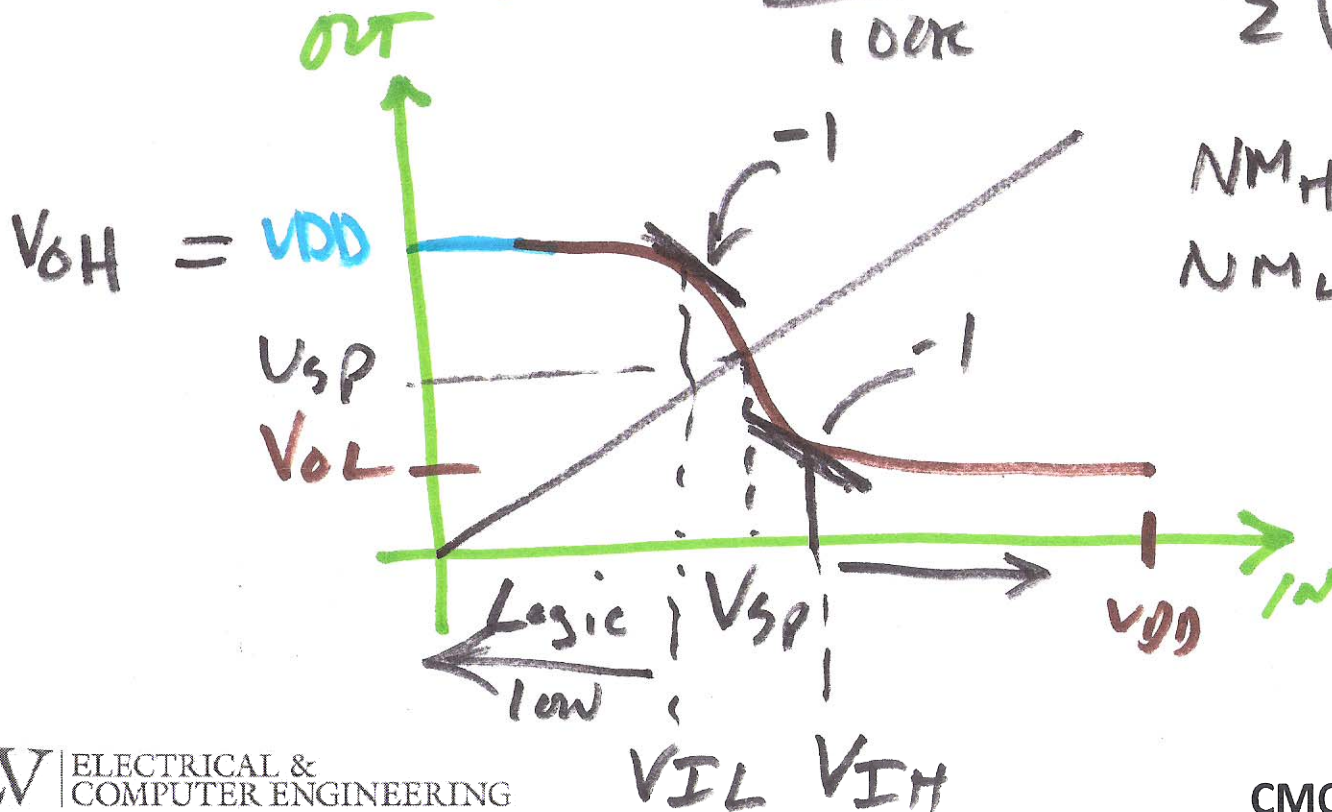




$$\frac{V_{DD} - V_{sp}}{100K} = \frac{\beta_N}{2} (V_{sp} - V_{THN})^2$$

$$NM_H = V_{OH} - V_{IH}$$

$$NM_L = V_{IL} - V_{OL}$$



6)