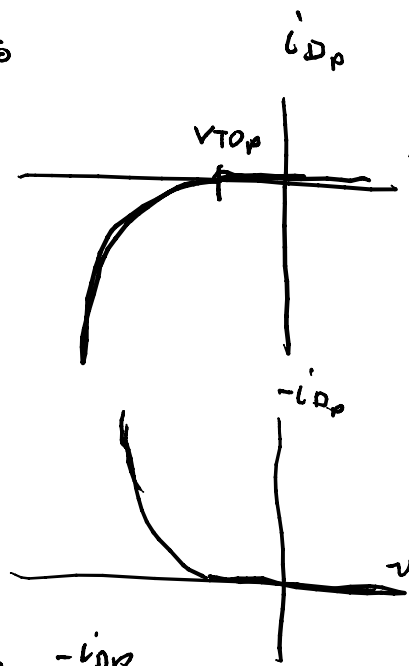
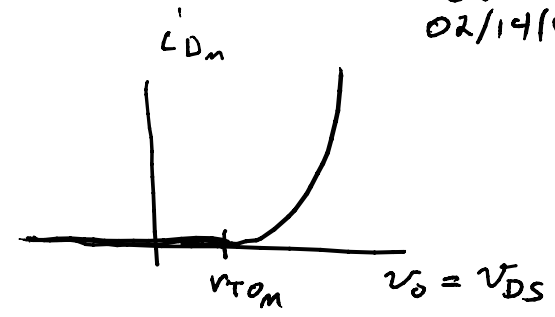
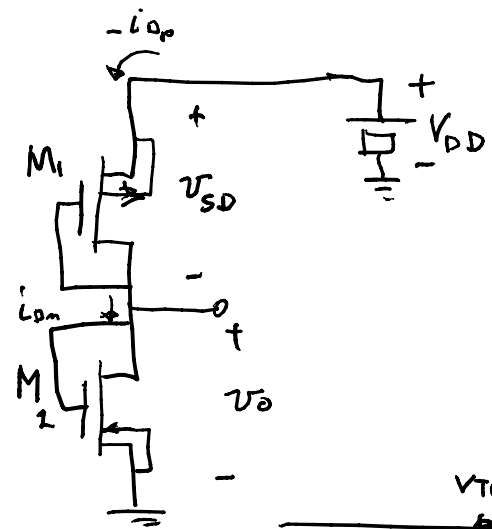


EE303
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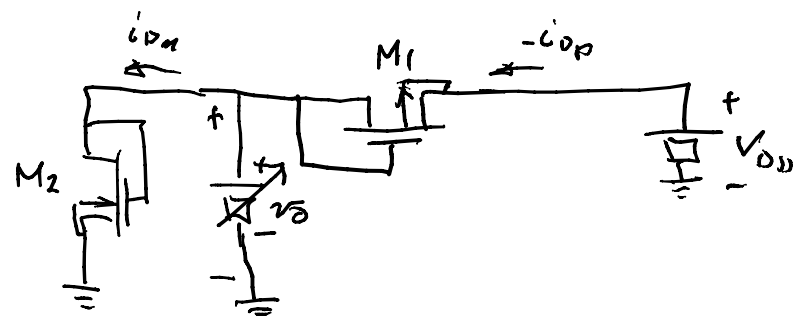
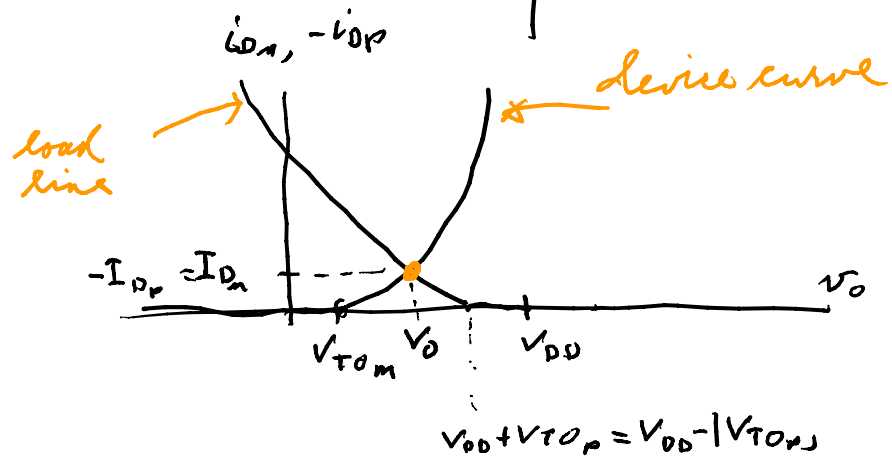
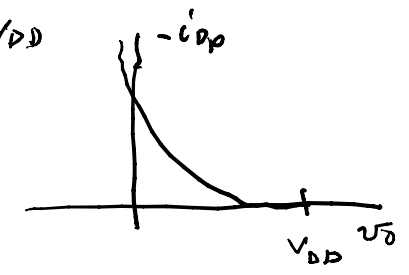


for M_1 : $v_{DS,p} = -v_{SD,p}$

$$0 = v_o - V_{DD} + v_{SD,p}$$

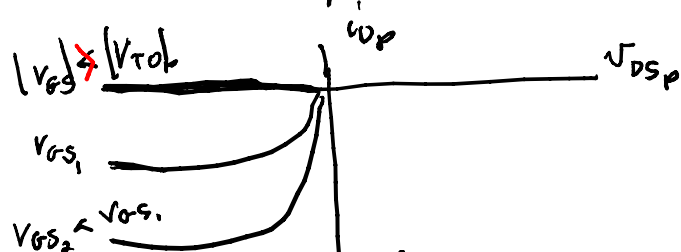
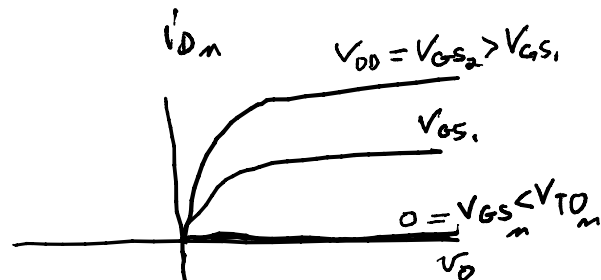
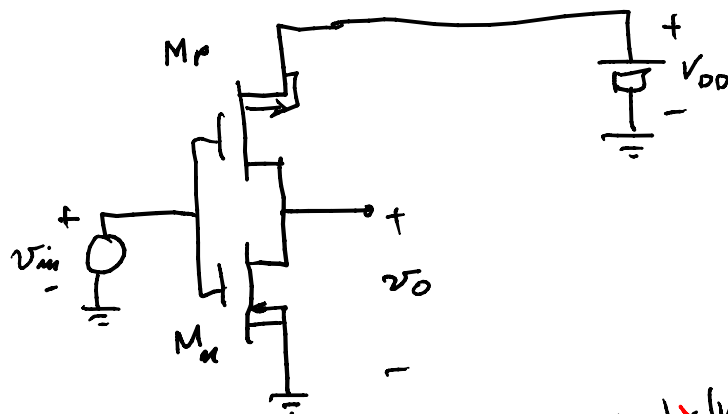
$$v_o = V_{DD} - v_{SD,p} = V_{DD} + v_{DS,p}$$

$$v_{DS,p} = v_o - V_{DD}$$

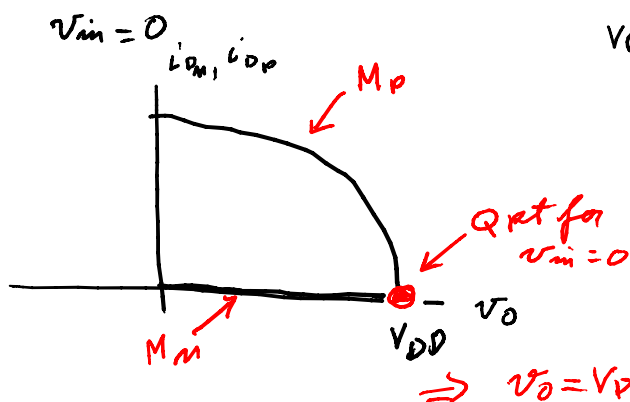


where $-i_{o,p} = i_{D,n}$ is the Q point

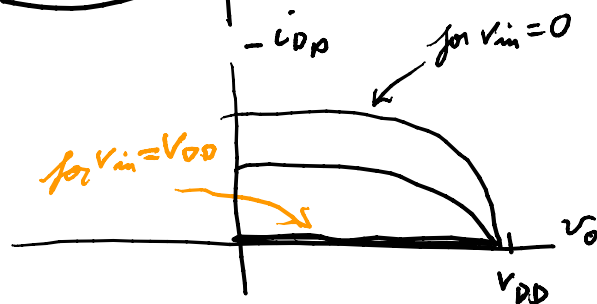
Move to using these devices as an inverter



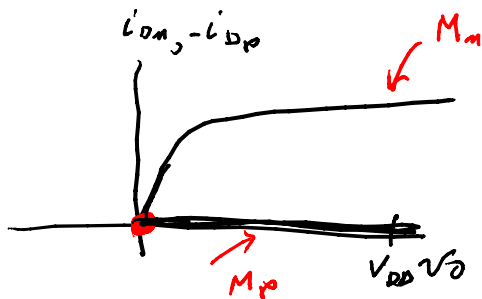
use "0" as ground



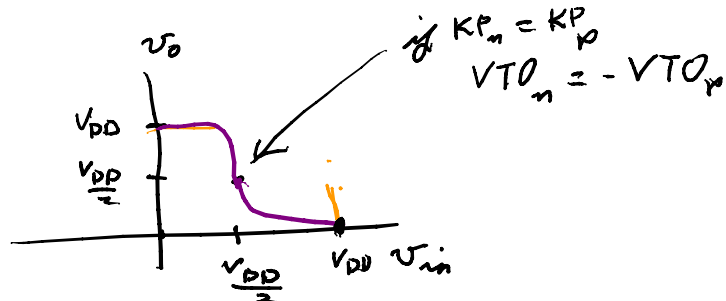
$\Rightarrow v_o = V_{DD}$ when $v_{in} = 0$



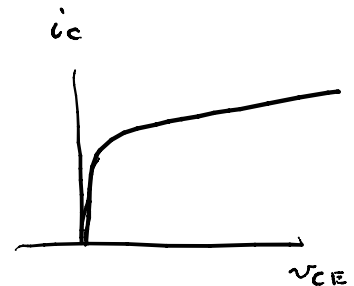
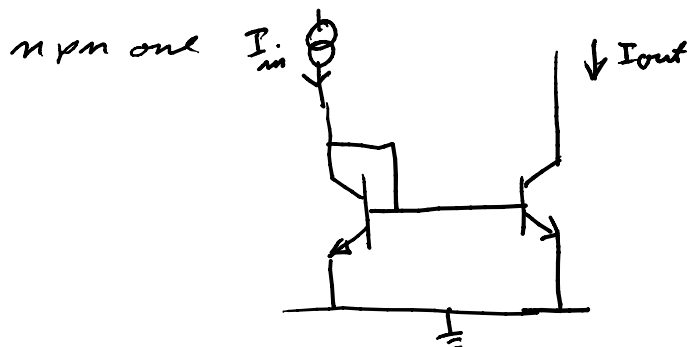
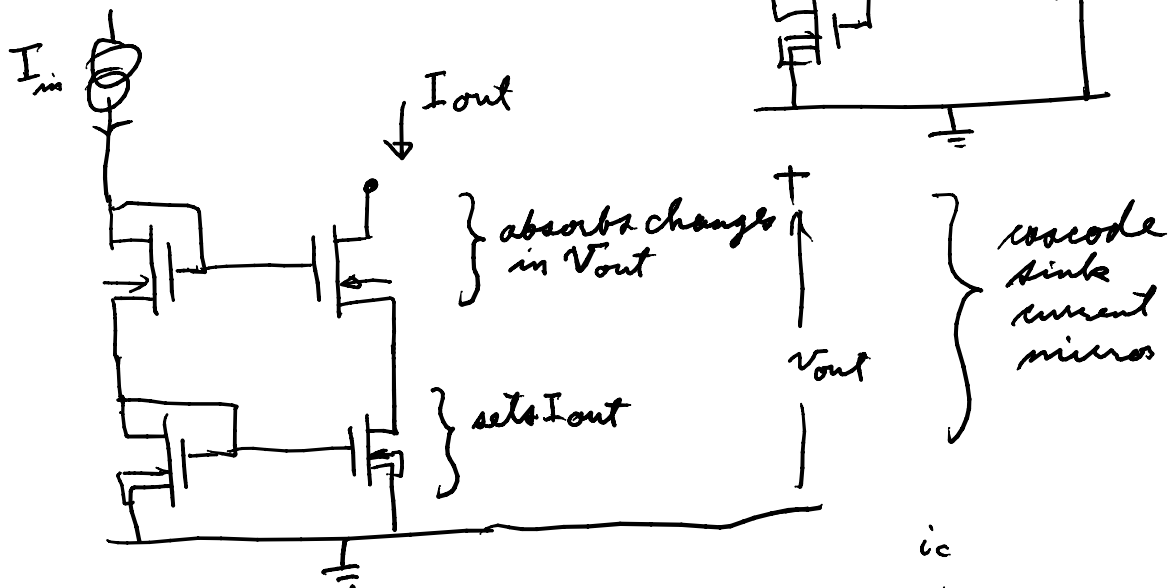
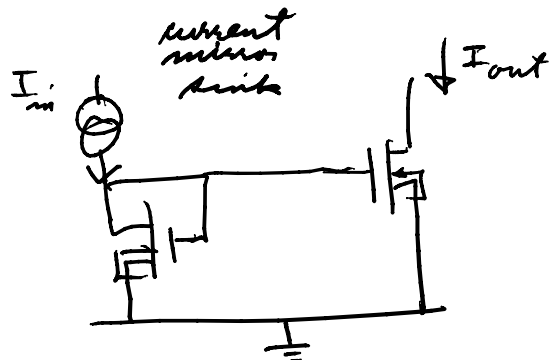
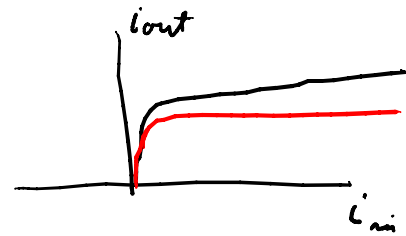
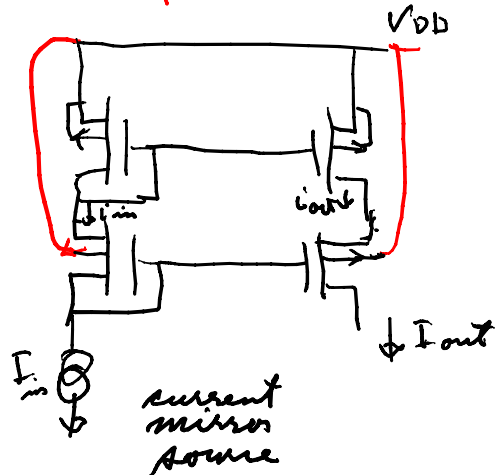
$v_{in} = V_{DD} \Rightarrow$ binary 1



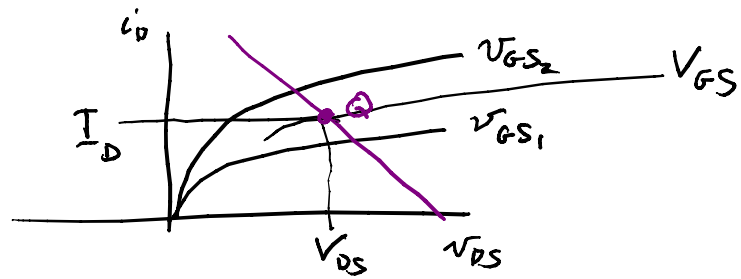
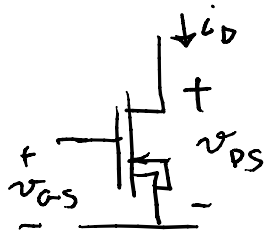
$\Rightarrow v_o = 0$ when $v_{in} = V_{DD}$



cascode current mirrors



small signal behavior $\Rightarrow$ use Taylor series



$$\begin{aligned}
 i_D = f(v_{GS}, v_{DS}) &= f(\underset{\substack{\text{"} \\ I_D}}{v_{GS}}, \underset{\substack{\text{"} \\ V_{DS}}}{v_{DS}}) + \left. \frac{\partial f}{\partial v_{GS}} \right|_{\substack{v_{GS} \\ v_{DS}}} (v_{GS} - V_{GS}) \\
 &+ \left. \frac{\partial f}{\partial v_{DS}} \right|_Q (v_{DS} - V_{DS}) + \partial^2
 \end{aligned}$$