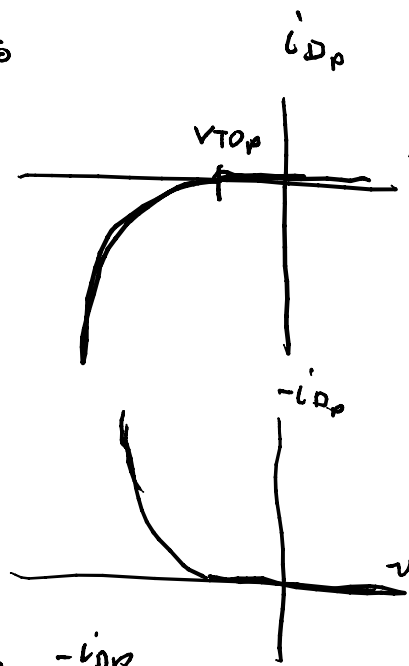
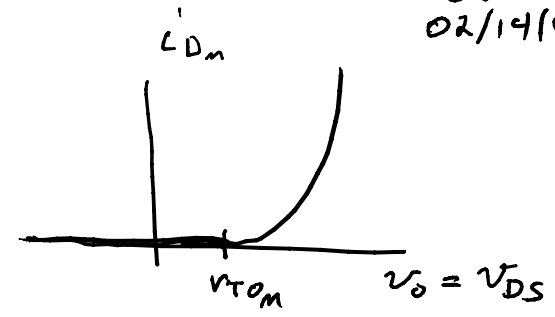
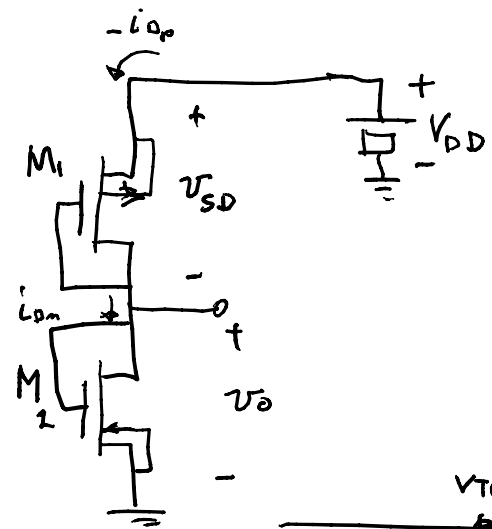
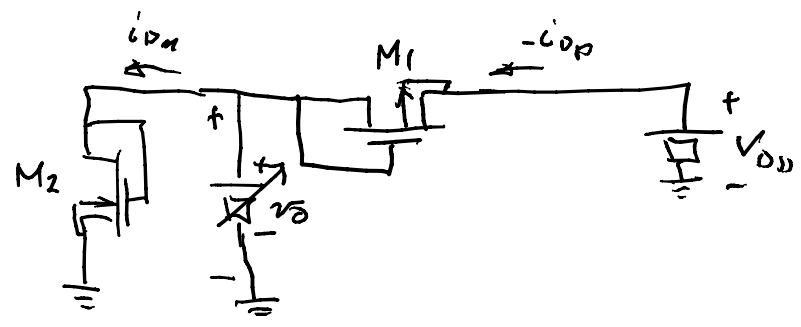
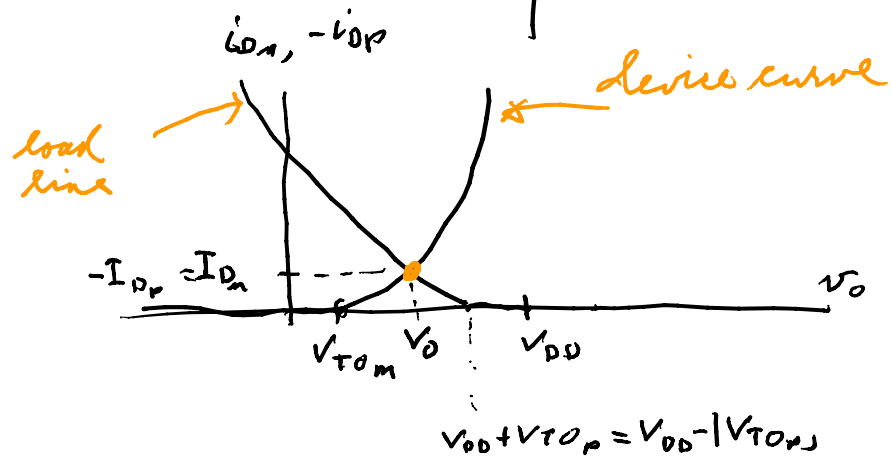
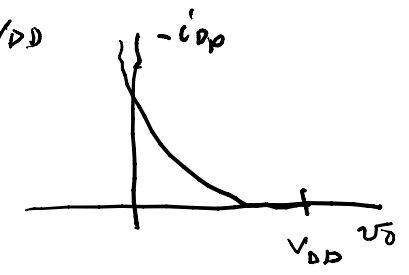


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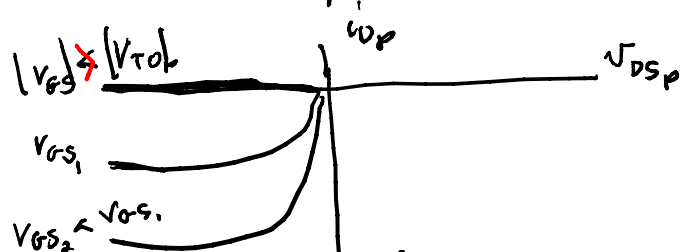
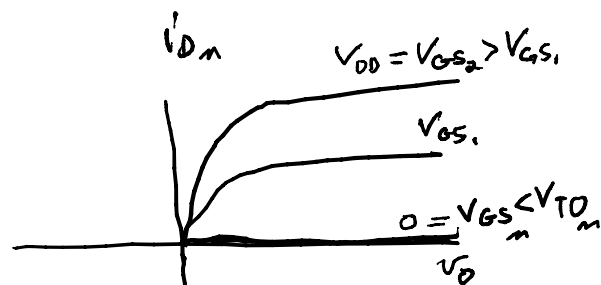
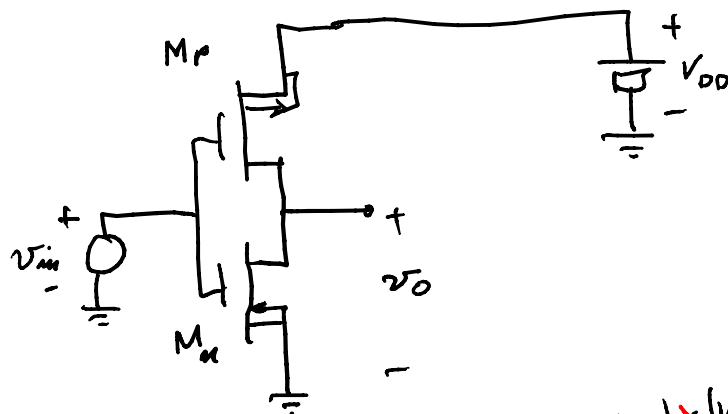


for M_1 : $v_{DS,p} = -v_{SD,p}$
 $0 = v_o - V_{DD} + v_{SD,p}$
 $v_o = V_{DD} - v_{SD,p} = V_{DD} + v_{DS,p}$
 $v_{DS,p} = v_o - V_{DD}$

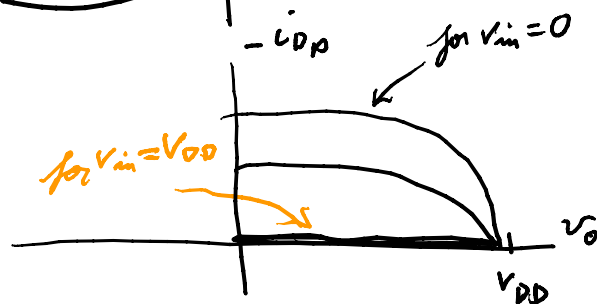
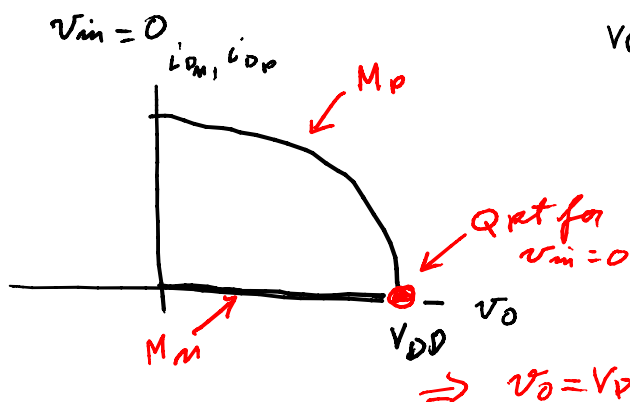


where $-i_{Op} = i_{Dn}$ is the Q point

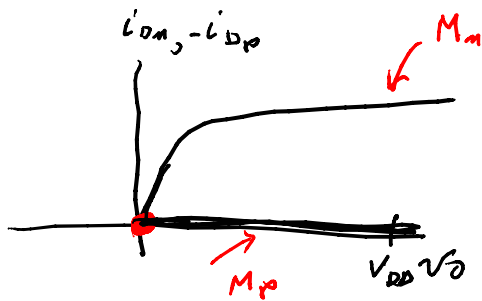
Move to using these devices as an inverter



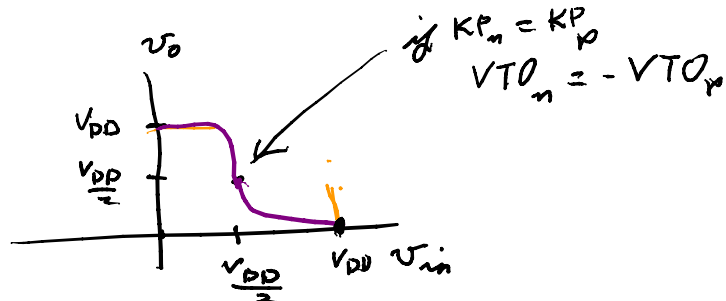
use "0" as ground



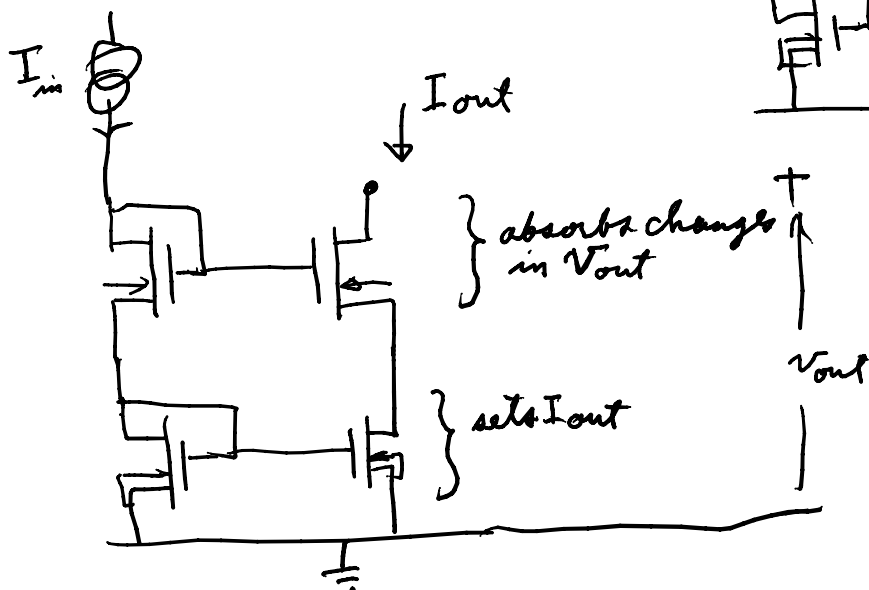
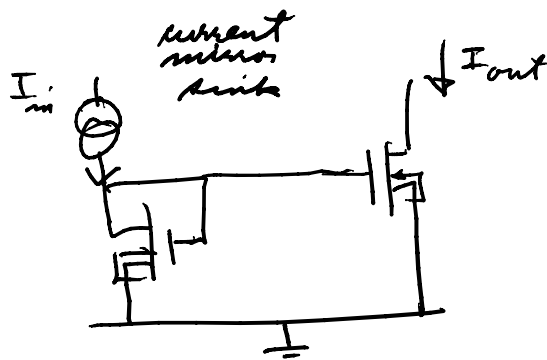
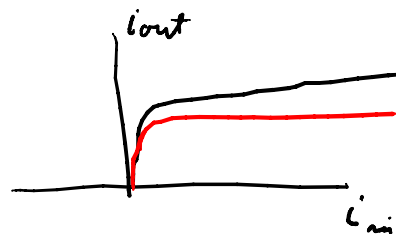
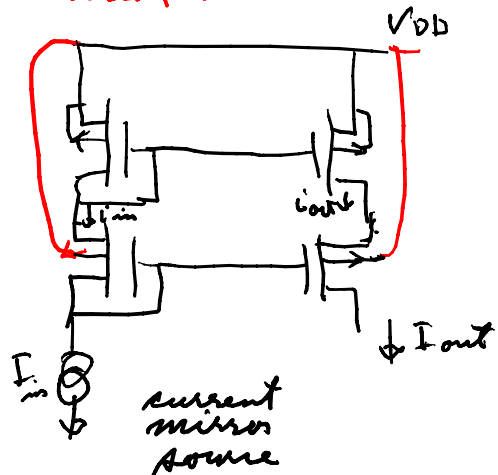
$V_{in} = V_{DD} \Rightarrow$ binary 1



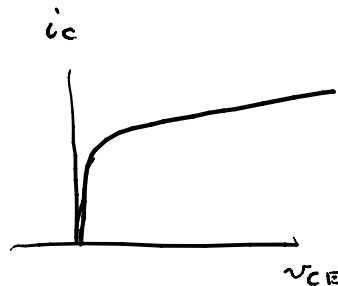
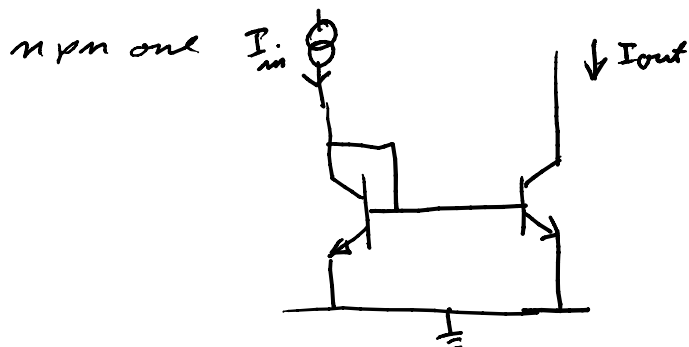
$\Rightarrow v_O = 0$ when $V_{in} = V_{DD}$



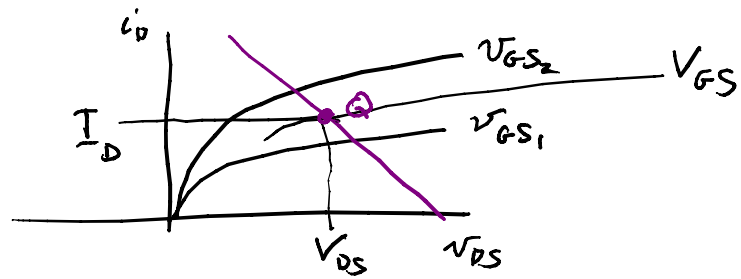
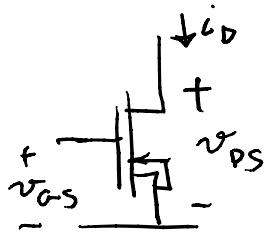
cascode current mirrors



cascode sink current mirrors



small signal behavior $\Rightarrow$ use Taylor series



$$i_D = f(v_{GS}, v_{DS}) = f(\underset{I_D}{v_{GS}}, v_{DS}) + \left. \frac{\partial f}{\partial v_{GS}} \right|_{\substack{v_{GS} \\ v_{DS}}} (v_{GS} - V_{GS})$$

$$+ \left. \frac{\partial f}{\partial v_{DS}} \right|_Q (v_{DS} - V_{DS}) + \partial^2$$