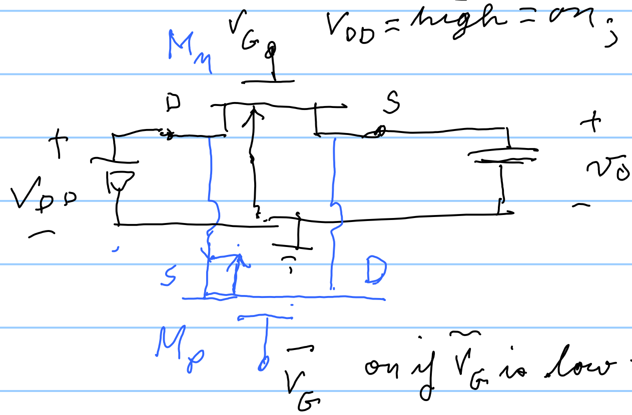
Note Title

EE303H

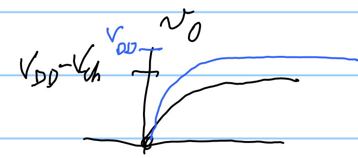
10/20/15

10/20/2015

V_{DD} = high = on; gnd = low = off



on if $\tilde{V}_G$ is low ⇒ V_G = high



here M_p remains on when $v_O = V_{DD}-V_{th}$

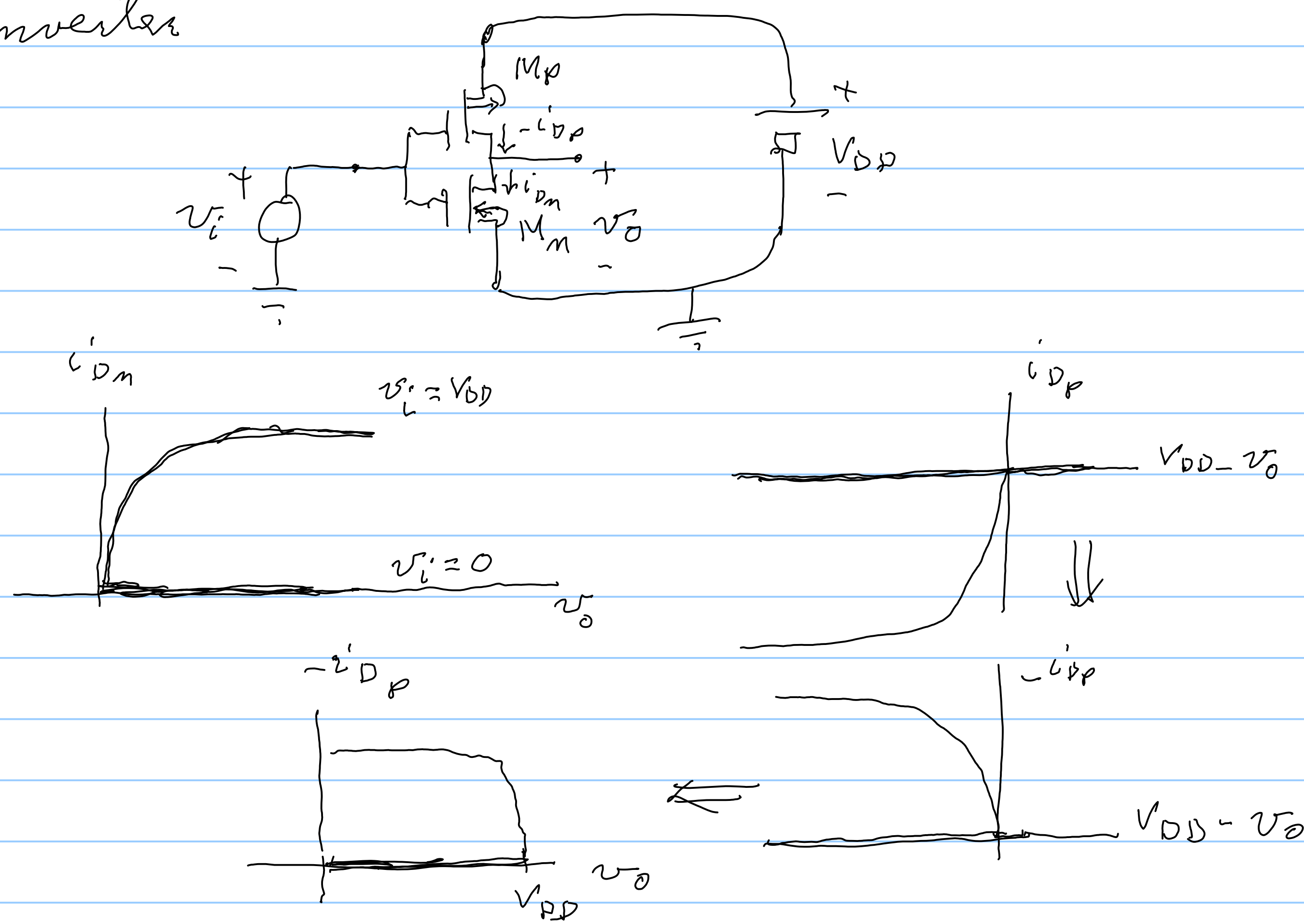
⇒ a CMOS pass "transistor" = CMOS transmission gate

suffer from gate capacitance holding charge after chang V_G

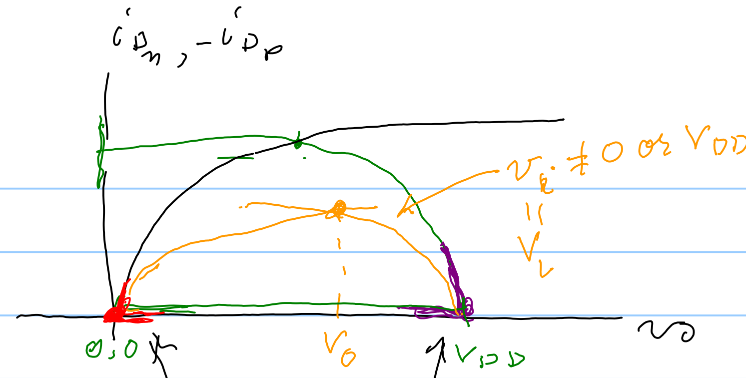
also need a switch to discharge load C when $V_G = 0$ ⇒ gnd or open as desire to transfer a zero

∴ connect a pass transistor to ground but make it close when signal transistor is open ⇒ use $\bar{V}_G$ on its gate if NMOS

Inverter



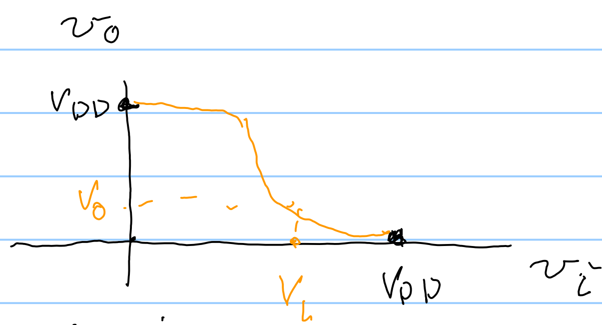
Mp
-iDp
iDn
Mn
vi
+
-
vo
VDD
iDn
vi = VDD
vi = 0
vo
iDp
VDD - vo
-iDp
VDD - vo
-iDp
VDD
vo



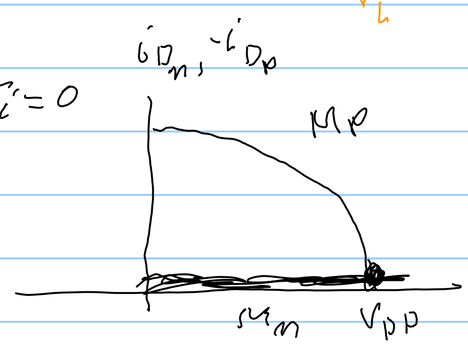
shows that if $v_i = 0$ the load line (of M_p) intersects the M_n curve at $v_O = V_{DD}$

for $v_i = V_{DD}$

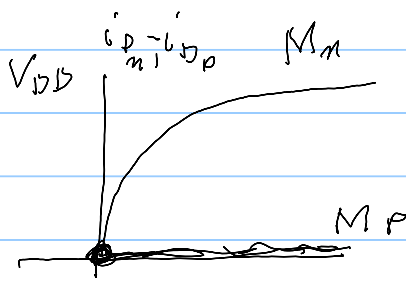
for $v_i = 0$, M_p on all the way, M_n = off

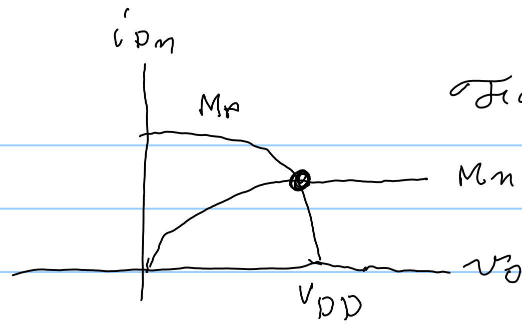


For $v_i = 0$



For $v_i = V_{DD}$

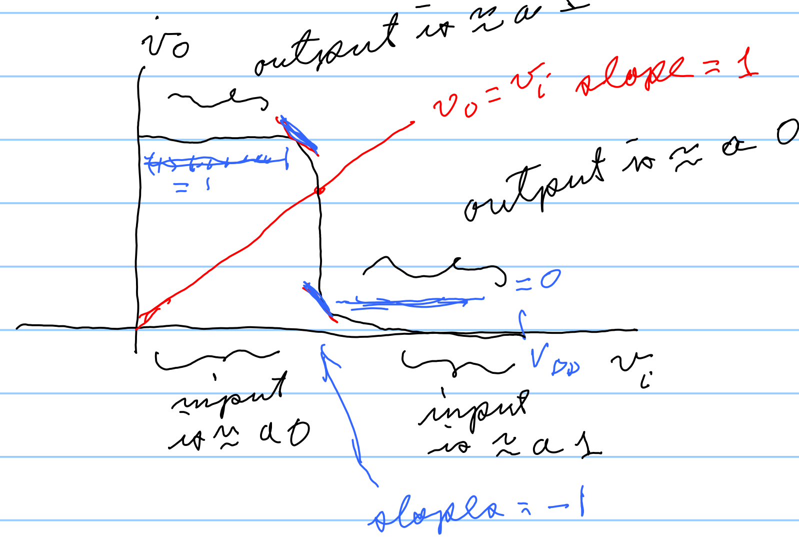


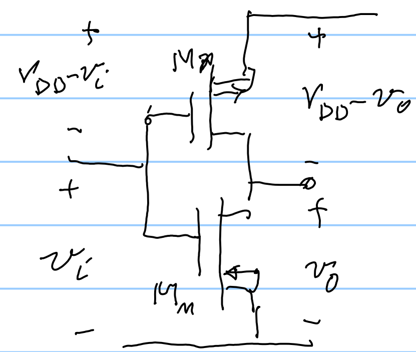


For an intermediate v_i

intersect at some intermediate point

More





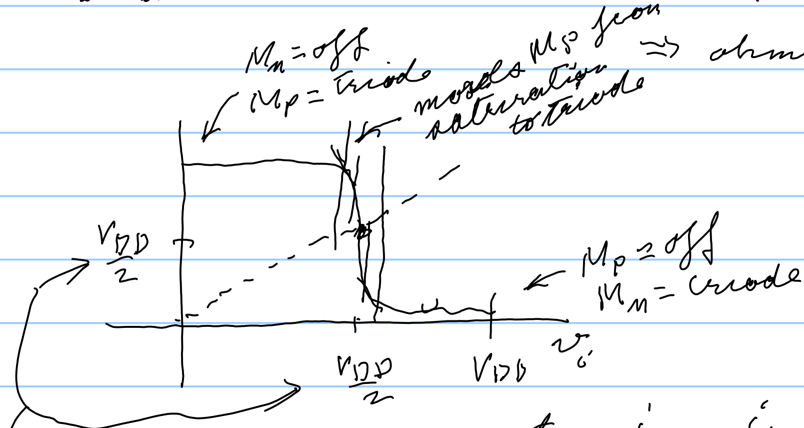
M_p $\quad v_{SD} = V_{DD} - v_o \qquad v_{SG} - |V_{th}| = V_{DD} - v_i - |V_{th}|$

N_n $\quad V_{DS} = v_o \qquad V_{GS} - V_{th} = v_i - V_{th}$

for $v_i = 0$ $\quad M_n = \text{off}$ & $M_p \Rightarrow \quad v_{SD} = V_{DD} - v_o = V_{DD} - V_{DD} = 0, \quad v_{SG} = V_{DD} - v_i = V_{DD}$

$v_o = V_{DD}$ $\qquad |v_{SD}| = 0 \leq |v_{SG} - |V_{th}|| = V_{DD} - |V_{th}|$

$\Rightarrow$ ohmic = triode region



when $v_i = v_o \Rightarrow M_n$ & M_p both in saturation

if perfectly complementary $i_{D_n} = -i_{D_p}$ when $v_{SG_p} = v_{GS_n}, \quad v_{SD_p} = v_{DS_n}$

near $v_i = V_{DD}/2 = v_0$ then we are in saturation. But one changes when $v_i = V_{DD}/2 + V_{th}$ as v_0 lowers

sat $v_0 \geq v_{in} - V_{th}$ if increase v_i then v_0 lowers

becomes $v_0 \leq v_{in} - V_{th}$

Interested in where $\frac{dv_0}{dv_{in}} = -1$

then $i_{D_n} = -i_{D_p} \Rightarrow k_n\left(2(v_{in} - V_{th})v_0 - v_0^2\right) = k_n\left(V_{DD} - v_{in} - V_{th}\right)^2$

M_n in ohmic $\qquad$ M_p in sat.

gives $f(v_0, v_{in}) = 0 = k_n\left[\left[2(v_{in} - V_{th})v_0 - v_0^2\right] - \left(V_{DD} - v_{in} - V_{th}\right)^2\right]$

desire $\frac{dv_0}{dv_{in}}$