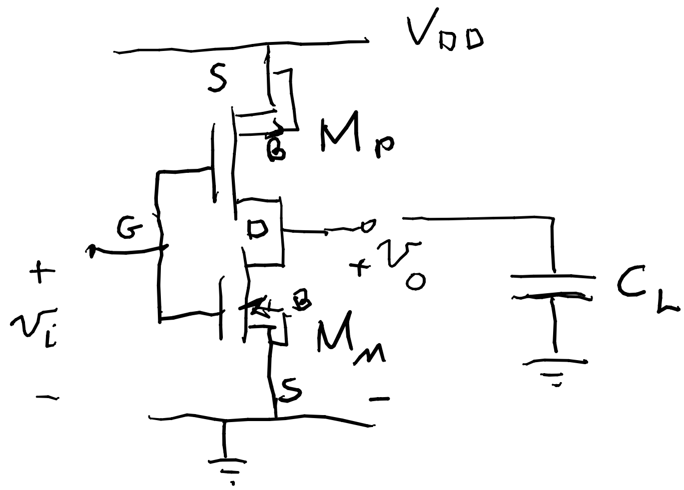
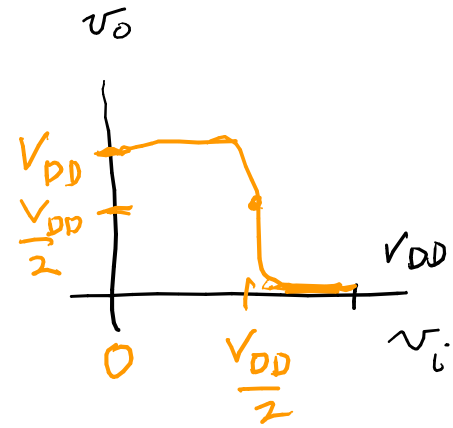
EE 303
03/08/06





state of transistors
need $v_{GS} - V_{th}$ versus v_{DS}

at the transition $v_i = v_o = V_{DD}/2$

if M_p = complement of M_n ; here V_{th} = threshold voltage = VTO

$v_{GS_n} = v_i$ $\quad$ $v_{GS} - VTO$ compared to v_{DS}

$v_{DS_n} = v_o$ $\quad$ here $v_i - VTO_n \leq v_i = v_o$

$\Rightarrow$ M_n is in saturation

$v_{SG_p} = V_{DD} - v_i$ $\quad$ $v_{SG_p} - |VTO_p|$ compared to v_{SD_p}

$v_{SD_p} = V_{DD} - v_o$

$$V_{DD} - v_i - |VTO_p| < V_{DD} - v_i = v_{SD_p} = V_{DD} - v_o$$

$\Rightarrow$ M_p is in saturation

at transition point (with no load)

$$-i_{D_p} = i_{D_n}$$

$$-i_{D_p} = i_{S_p} = \frac{KP_p}{2}\left(\frac{W}{L}\right)_p \left(v_{SG} - |VTO_p|\right)^2$$

$$= \frac{KP_p}{2}\left(\frac{W}{L}\right)_p \left(V_{DD} - v_i - |VTO_p|\right)^2$$

$$i_{D_n} = \frac{KP_n}{2}\left(\frac{W}{L}\right)_n \left(v_{GS} - |VTO_n|\right)^2$$

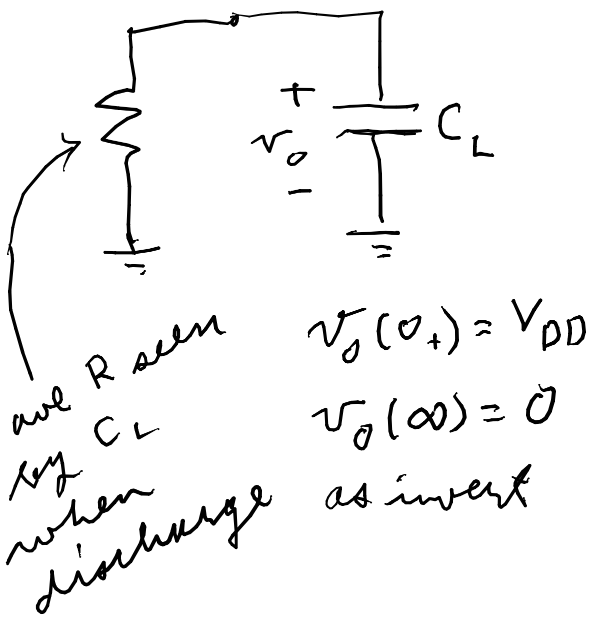
$$= \frac{KP_n}{2}\left(\frac{W}{L}\right)\left(v_i - |VTO_n|\right)^2$$

$$i_{S_p}\Big|_{v_i = \frac{V_{DD}}{2}} = i_{D_n}\Big|_{v_i = \frac{V_{DD}}{2}} \Rightarrow \frac{KP_p}{2}\left(\frac{W}{L}\right)_p \left(V_{DD} - \frac{V_{DD}}{2} - |VTO_p|\right)^2$$

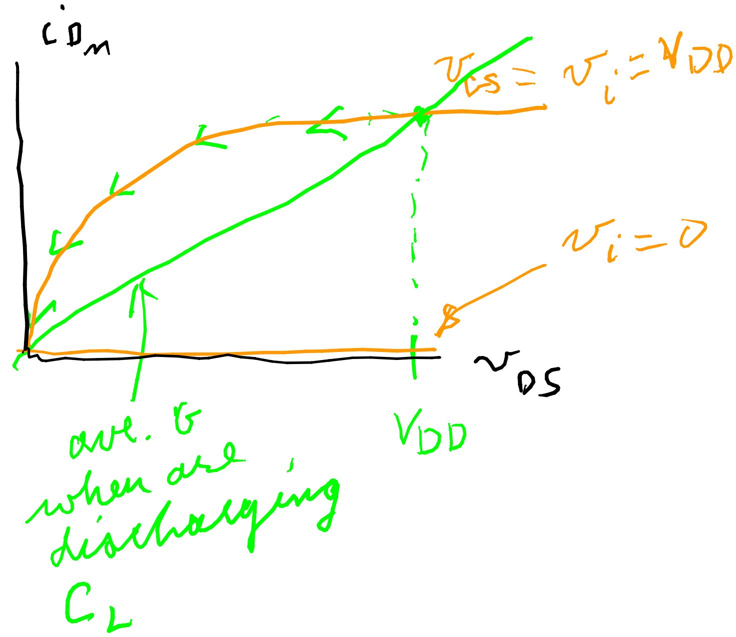
$$= \frac{KP_n}{2}\left(\frac{W}{L}\right)_n \left(\frac{V_{DD}}{2} - |VTO_n|\right)^2$$

$$\Rightarrow \left(\frac{W}{L}\right)_p = \left(\frac{W}{L}\right)_n \times \frac{KP_n}{KP_p} \times \left(\frac{\frac{V_{DD}}{2} - |VTO_n|}{\frac{V_{DD}}{2} - |VTO_p|}\right)^2$$

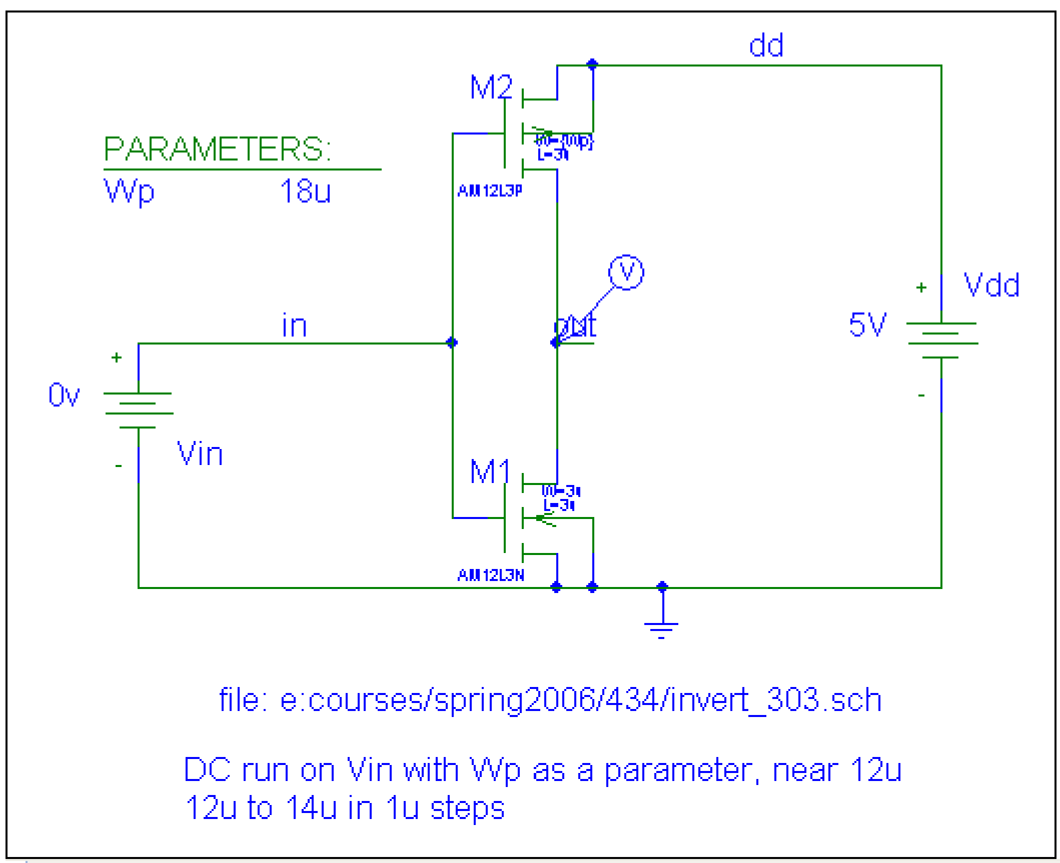
This allows design of inverters to transition at $v_i = v_o = \frac{V_{DD}}{2}$ by design of M_p given M_n



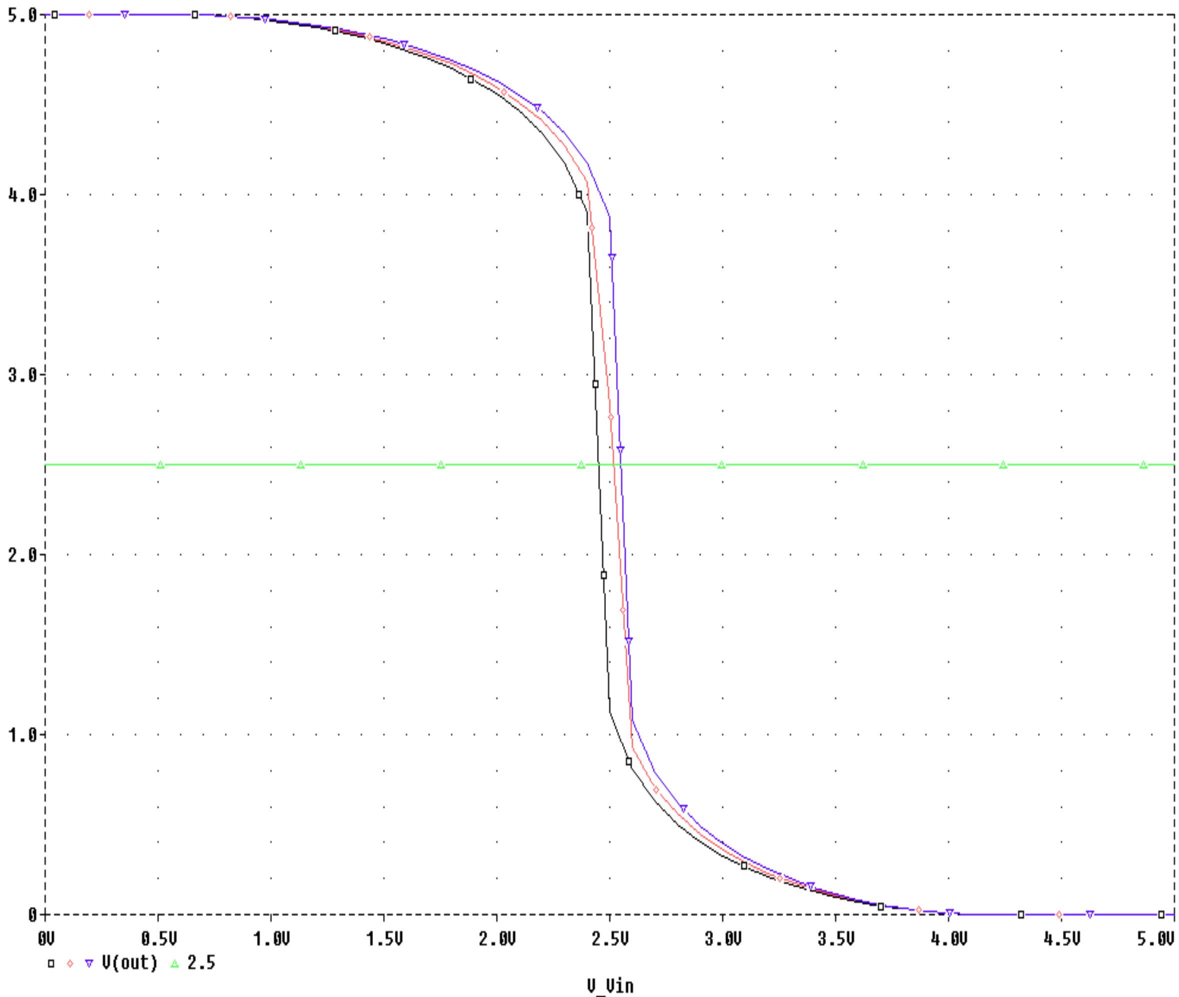
+
v_o
−
C_L
ave R seen by C_L when discharge
$v_o(0_+) = V_{DD}$
$v_o(\infty) = 0$
as invert



i_{D_n}
$v_{GS} = v_i = V_{DD}$
$v_i = 0$
v_{DS}
V_{DD}
ave. G when are discharging C_L



dd
M2
PARAMETERS:
Wp 18u
AMI2L3P
V
Vdd
in
out
5V
0v
Vin
M1
AMI2L3N
file: e:courses/spring2006/434/invert_303.sch
DC run on Vin with Wp as a parameter, near 12u
12u to 14u in 1u steps


5.0
4.0
3.0
2.0
1.0
0
0V
0.5V
1.0V
1.5V
2.0V
2.5V
3.0V
3.5V
4.0V
4.5V
5.0V
V(out)
2.5
V_Vin