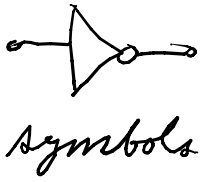
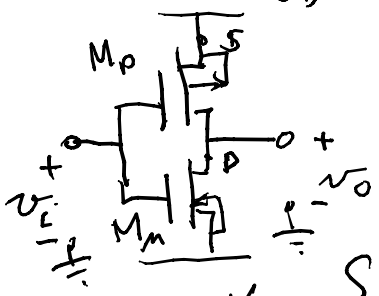
EE303
03/06/06

Inverters - CMOS

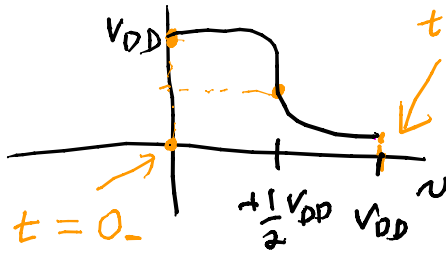


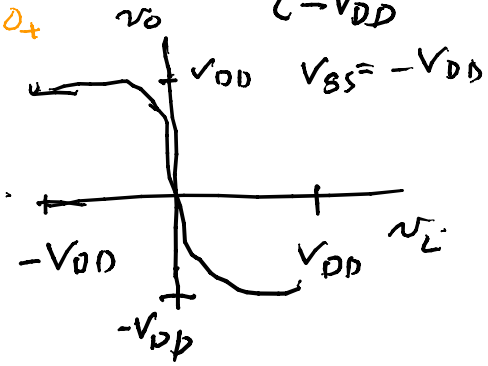
symbols



v_o gnd = V_{SS}

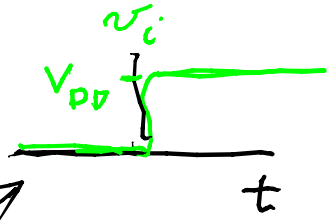
$V_{SS} = \begin{cases} 0 = \text{gnd} \\ -V_{DD} \end{cases}$





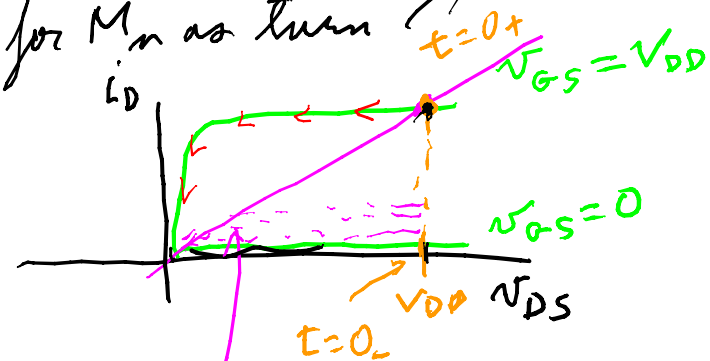
use this below

normally for computers v_i jumps from one level to another



or

for M_n as turn

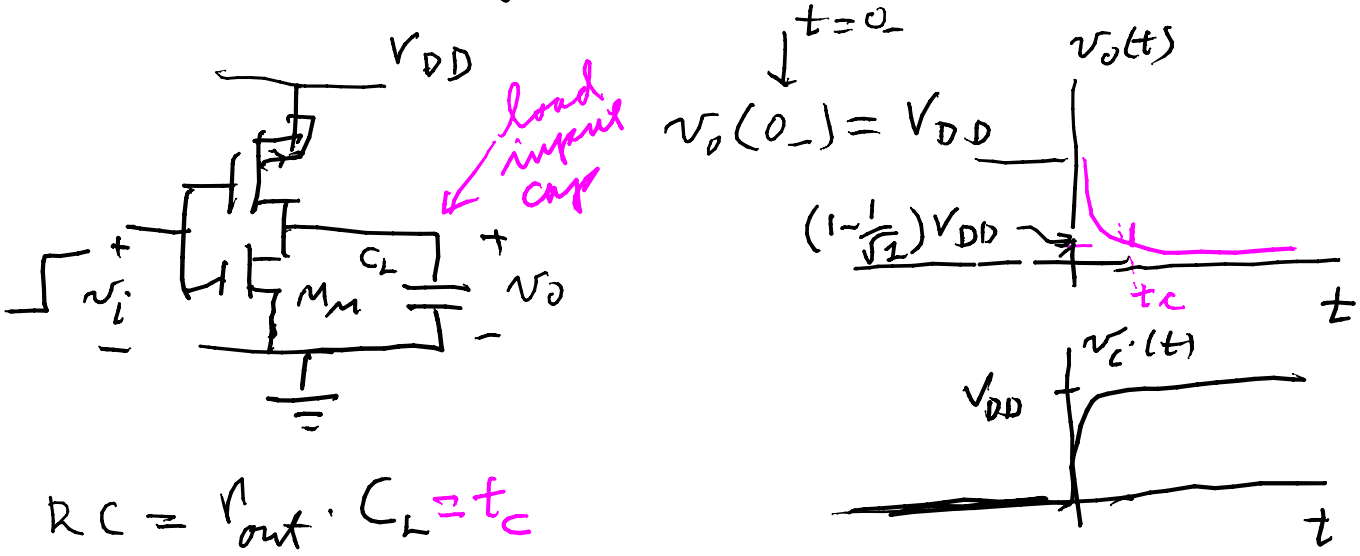


for getting delay need the RC time constant

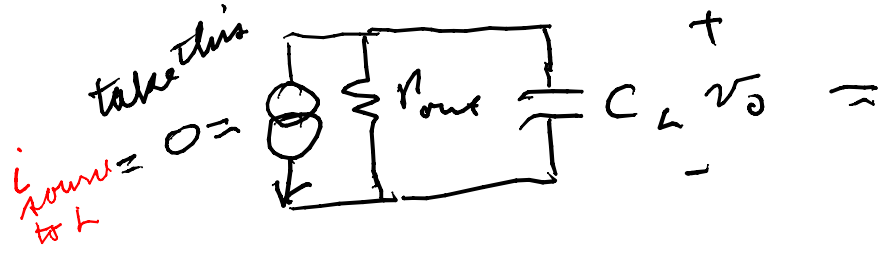
"average" conductance" curve = $g_{out} = 1/R_{out}$
(as pass from V_{DD} to 0 through ohmic region)

this gives the resistance to charge or discharge a load capacitor (could be C_{in} of another inverter)

time constants of RC circuits are R*C



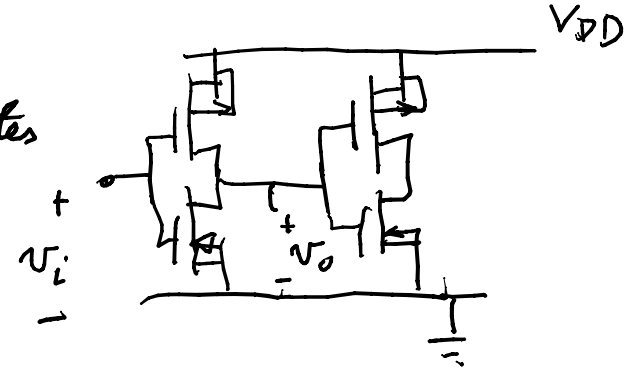
$RC = r_{out} \cdot C_L = t_c$



$$r_{out} = \frac{1}{\text{slope}} = \frac{1}{\frac{K_P}{2}\frac{W}{L}(V_{DD}-V_{TO})^2} = \frac{V_{DD}}{\frac{K_P}{2}\frac{W}{L}(V_{DD}-V_{TO})^2}$$

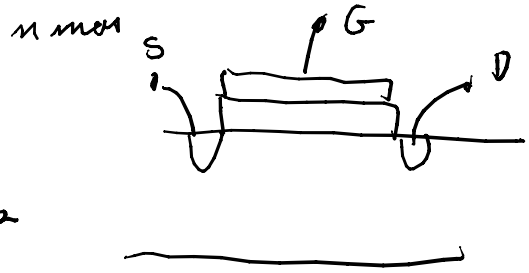
V_{DD}

Ex: load = 2nd inverter



to get delay to go through 1st stage

$$C_L = C_{gd_n} + C_{gd_p}$$



assume $C_{gd} \approx \frac{1}{2}\frac{(W \cdot L)\,\epsilon_{SiO_2}}{t_{ox}}$

$\approx C_{gd}$

say

$C_{gd} = 5\,pf \Rightarrow C_L = 10\,pf$

desire t.constant $\Rightarrow r_{out} \cdot C_L$; let $V_{DD} = 5v$

$VTO = 1v$

$W = L \Rightarrow N$

$KP = 20 \times 10^{-4}\ amp^2/V^2$

$$r_{out} = \frac{V_{DD}}{\frac{KP}{2}\frac{W}{L}(V_{DD} - VTO)^2}$$

$$= \frac{5}{10\times10^{-4}\times1\times(5-1)^2} = \frac{5}{10^{-3}\times16} = \frac{5\times10^3}{16} = \frac{50}{10}\times10^2$$

$$= 3.1\times10^2$$

$$t_c = 3.1\times10^2 \times 10\times10^{-12} = 31\times10^{-10} = 3.1\times10^{-9}$$

$= 3.1$ nano sec

delay time better calculated as time to fall to $V_{DD}/2$ (probably about 2 nano)