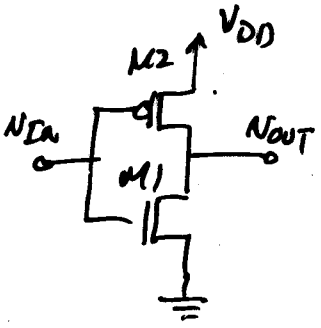
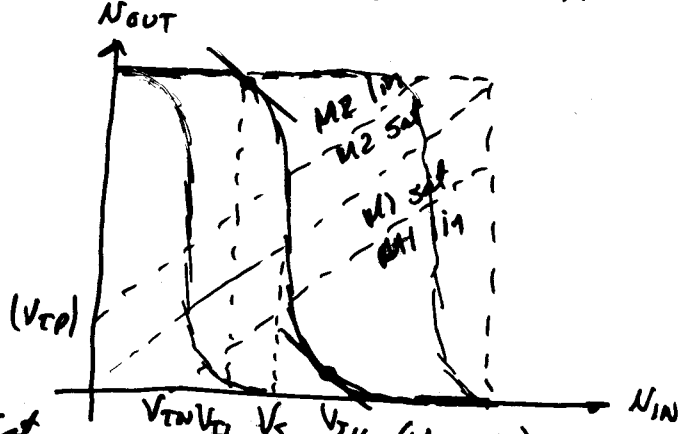
PROBLEM SESSION FOR EXAM 2

How can you determine whether a transistor is in saturation or the linear region when find V_{IH}, V_{IL}, V_{OL} and V_{OH}?

CMOS Inverter –





$V_{DS} > V_{DS}(sat) \Rightarrow$ Sat.

$V_{DS} < V_{DS}(sat) \Rightarrow$ Lin.

$V_{DS} = V_{DS}(sat)$

$$V_{DS}(sat) = \frac{(V_{GS}-V_T)E_cL}{(V_{GS}-V_T)+E_cL}$$

Short Channel

Long Channel $\leftarrow V_{DS}(sat) = V_{GS} - V_T$

$V_{IH} = ?$

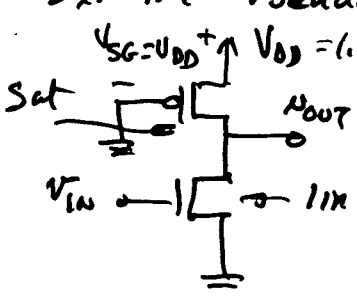
V_{OUT} is low $\leftarrow$ Assume that M1 is linear, M2 is Sat

V_{IN} is High $V_{GS} \cong V_{DD}$

$V_{IL} = ?$

$V_{out} \approx V_{OL}$ $V_{in} = V_{GS} \approx 0 \rightarrow$ M1 is sat, M2 is lin.

Ex. 4.9 Pseudo NMOS



V_{DD}

$$\frac{k_{sat}(V_{GS}-V_T)}{\cdots}$$

In Prob. 4.2a, the value of μ_e should be 270 $cm^2/V{\cdot}s$

No questions on flip-flops

Question on Exer. 5.4 (p. 220)

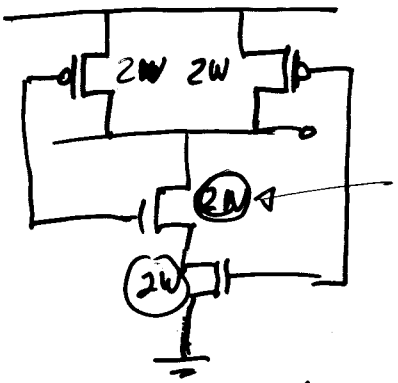
Why the "2" in

$$t_{PHL} = 0.7\left(2 \times 125\,k\Omega/\square\right)\frac{L}{W}(100fF)$$

$$t_{PHL} = 0.7\,R_{eff}\,C_L$$

Page 186, $R_{eqn} = 12.5\,k\Omega/\square \rightarrow R_n = R_{eqn} \times \frac{L}{W}$

...



Complex Logic Example

XOR $F = \bar{A}B + A\bar{B}$

NMOS Complex:

$$F = \overline{\bar{A}B + A\bar{B}} = \overline{\bar{A}B} \cdot \overline{A\bar{B}}$$

$$= (A + \bar{B}) \cdot (\bar{A} + B)$$

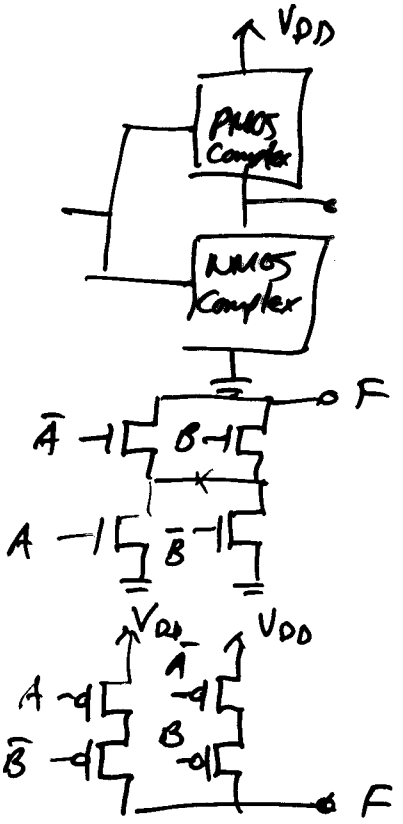
PMOS Complex:

Dual of $\bar{F}$

$$= A\bar{B} + \bar{A}B$$

$ab \Leftrightarrow a + b$

$(a+b)c \Leftrightarrow ab + c$



Example 5.1 – Sizing Transistors