EE 434

Lecture 35

Other Logic Design Styles

(Logical Effort)

Review from last time

- Dynamic power dissipation dominant in most useful CMOS Logic
  - Dependent upon f, C_L, V_{DD}
- Alternate Logic Styles often result in considerable improvements in performance in some applications
- Standard CMOS is still the dominant logic of choice

Logical Effort

Recall: $t = t_{REF} \sum_{i=1}^{n} \frac{FI_{i+1}}{OD_i}$

w H: $t = \sum_{i=1}^{n} g_i h_i$

g is the logical effort
h is the electrical effort

g: ratio of input capac. of gate to input cap. of inverter that can deliver the same output current

h: ratio of load capacitance to input capacitance

Using either approach will give the same results!

Other Logic Styles

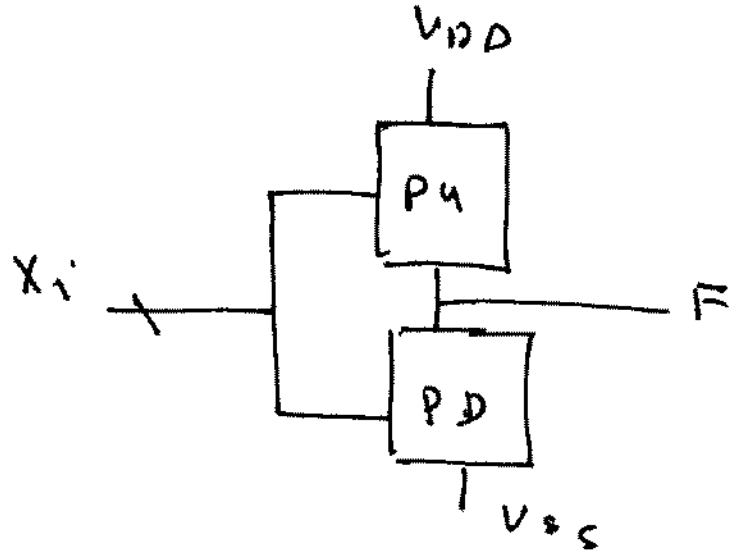
- Static CMOS
- Complex Logic Gates
- Pass Transistor Logic
- Pseudo NMOS
- Dynamic Logic Styles

Static CMOS:

- $V_H = V_{DD}$, $V_L = V_{SS}$
- Static power dissipation = 0
- Created around a PU, PD network concept

  (same Boolean info. carried in PU as in PD network)

Complex Logic Gates



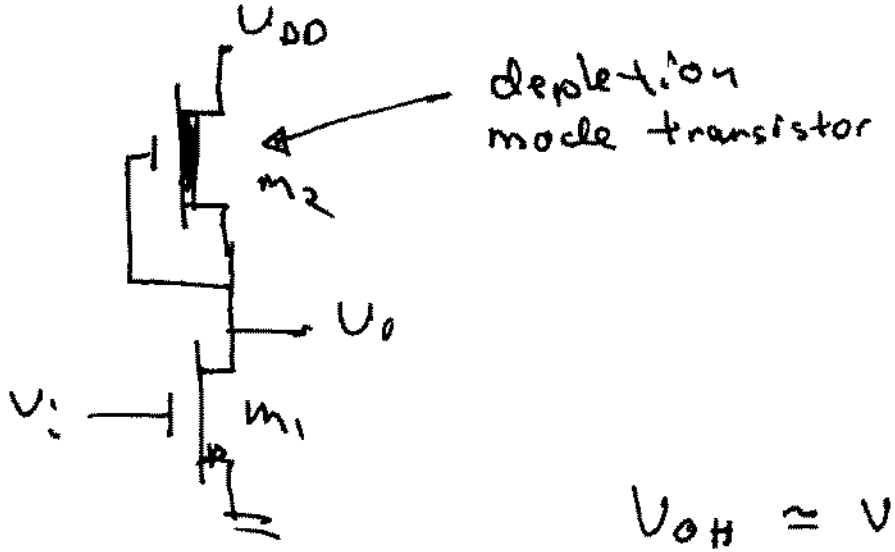
- allowed more complicated logic functions in PU & PD networks

Review

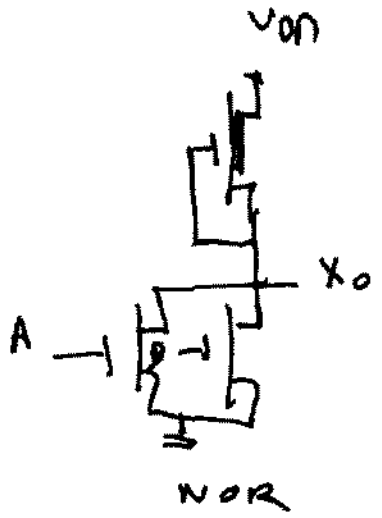
- Realize $\overline{F}$ with n-channel devices in PD network
  F with p-channel devices in PU network
- Dramatic Reduction in device count
- # Levels of logic is often reduced (to 2)

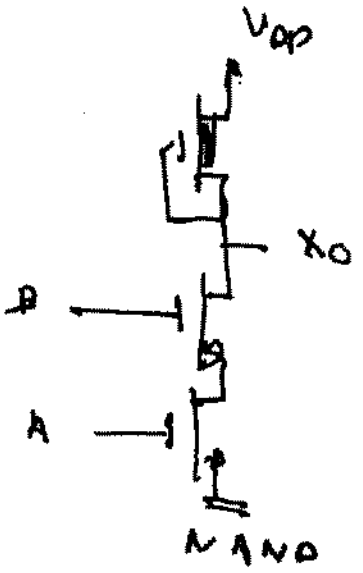
- nMOS Logic (pMOS)

dominant MOS Logic family until ~ 1985



nMOS





$V_{OH} \simeq V_{DD}$

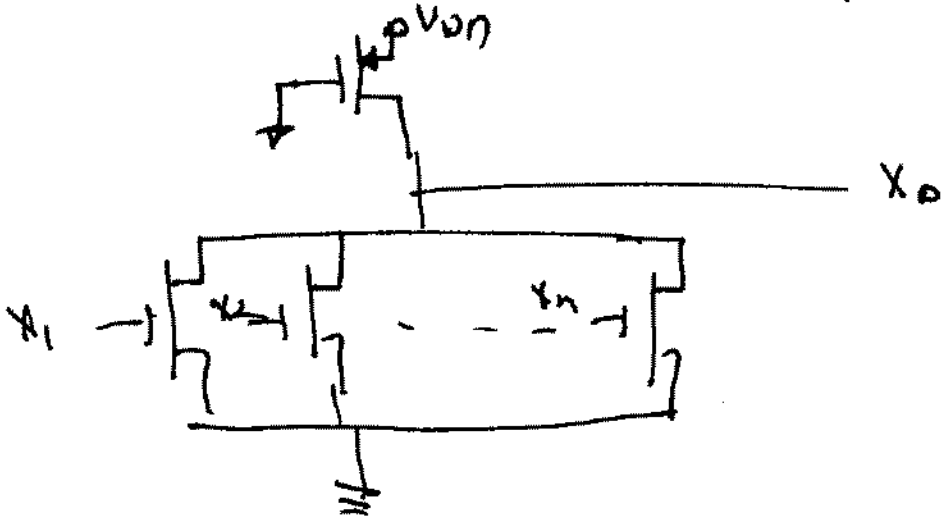
V_{OL} - depends upon sizing of M_1 & M_2

↓ "−" static power dissipation is not 0 when $V_o \sim V_L$

↓ "+"
- less transistors
- less interconnect traffic
- eliminate need for wells (area wells is big)
- cost of adding wells is also large

- Pseudo NMOS

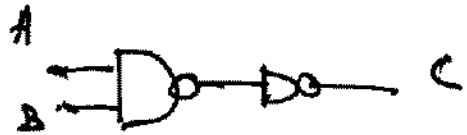
multiple-input NOR gates.



applicable primarily when a large number of inputs on a NOR gate are required!

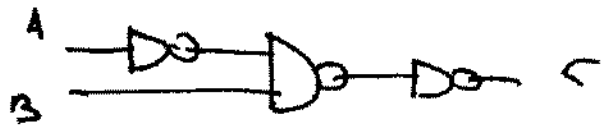
Pass Transistor Logic

Example : $A \cdot B$ static / cmos

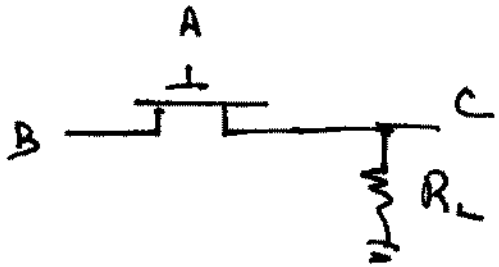


6 transistors
2 levels of logic

$\bar{A} \cdot B$



8 transistors
3 levels of logic



1 transistor solution (+ resistor)