EE 434
Lecture 5

Basic Logic Circuits
Quiz 3

A proposed two-input Boolean Gate is shown

a. Determine the Boolean output C if $A=B=1$

b. Is this a viable gate (give reasons for your answer)

Use a switch-level model for the MOS devices
And the number is ....

1 8 7 5 3
6 9 4 2
Quiz 3

A proposed two-input Boolean Gate is shown.

a. Determine the Boolean output $C$ if $A=B=1$

b. Is this a viable gate (give reasons for your answer)

Solution:

a. If $A=B=1$

\[ \text{B} = 1 \quad \text{A} = 1 \quad \rightarrow \quad C = 0 \]
Quiz 3

A proposed two-input Boolean Gate is shown

a. Determine the Boolean output C if A=B=1
b. Is this a viable gate (give reasons for your answer)

Solution:

b. If B=1 and A=0

B=1

A=0

Since C is undefined for this input condition, the circuit is not a viable Boolean gate
Review from Last Time

- Simple model of MOSFET was developed
  - hierarchical model structure will be developed
  - generally use simplest model that can be justified
- Simple CMOS gates were introduced
  - Zero power dissipation
  - Rail to Rail Swings
  - Infinitely Fast
  - Simple model may not give sufficiently accurate insight relating to these properties
Complex Gates

\[ Y = (A \cdot B) + (C \cdot D) \]
Complex Gates

Pull up and pull down network never both conducting

One of the two networks is always conducting

\[ Y = (A \cdot B) + (C \cdot D) \]
Consider

\[ Y = (A \cdot B) + (C \cdot D) \]

Alternate Implementation

3 levels of Logic

16 Transistors if Basic CMOS Gates are Used
Consider \( Y = A \cdot B \)

Standard CMOS Implementation

\[ \begin{align*}
A & \quad \text{AND gate} \quad Y \\
B & \quad \text{OR gate} \\
\end{align*} \]

2 levels of Logic

6 Transistors if Basic CMOS Gates are Used

Basic noninverting functions generally require more complexity if basic CMOS gates are used for implementation
Pass Transistor Logic

\[ Y = A \cdot B \]

Requires only 2 transistors rather than 6 for a standard CMOS gate (and a resistor).
Pass Transistor Logic

\[ Y = A \cdot B \]

Even simpler pass transistor logic implementations are possible

Requires only 1 transistor (and a resistor).
Pass Transistor Logic

Y = A • B

Requires only 1 transistor (and a resistor)

- Resistor may require more area than several hundred or even several thousand transistors
- Signal levels may not go to \(V_{DD}\)
- Static power dissipation may not be zero
- Signals may degrade unacceptably if multiple gates are cascaded
- "resistor" often implemented with a transistor to reduce area but signal swing and power dissipation problems still persist

-Pass transistor logic is widely used
Logic Design Styles

• Several different logic design styles are often used throughout a given design
• The designer has complete control over what is placed on silicon and governed only by cost and performance
• New logic design strategies have been proposed recently and others will likely emerge in the future
• The digital designer needs to be familiar with the benefits and limitations of varying logic styles to come up with a good solution for given system requirements