EE 434
Lecture 5

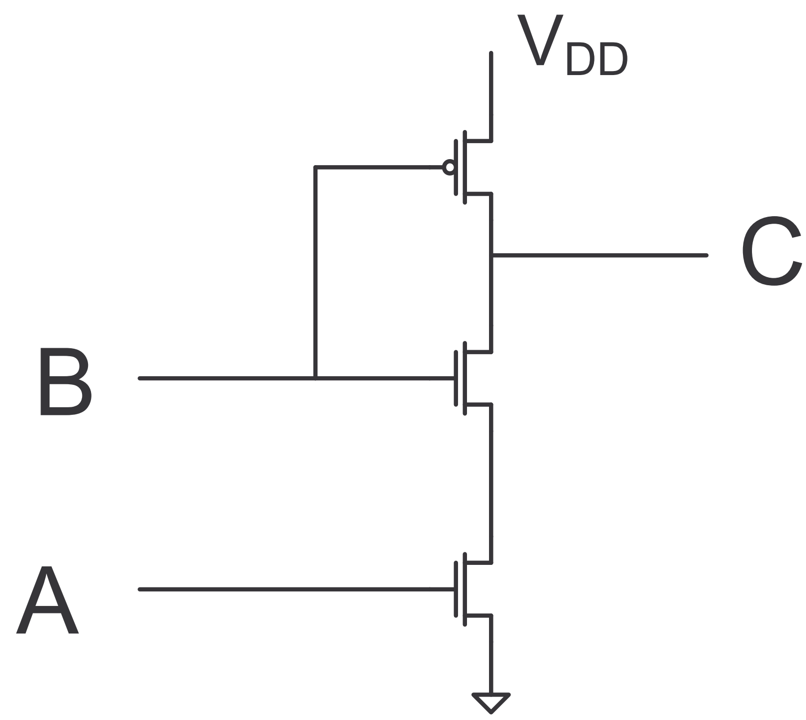
Basic Logic Circuits

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

8

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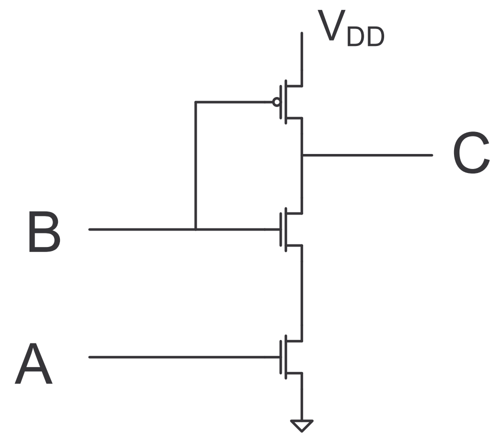
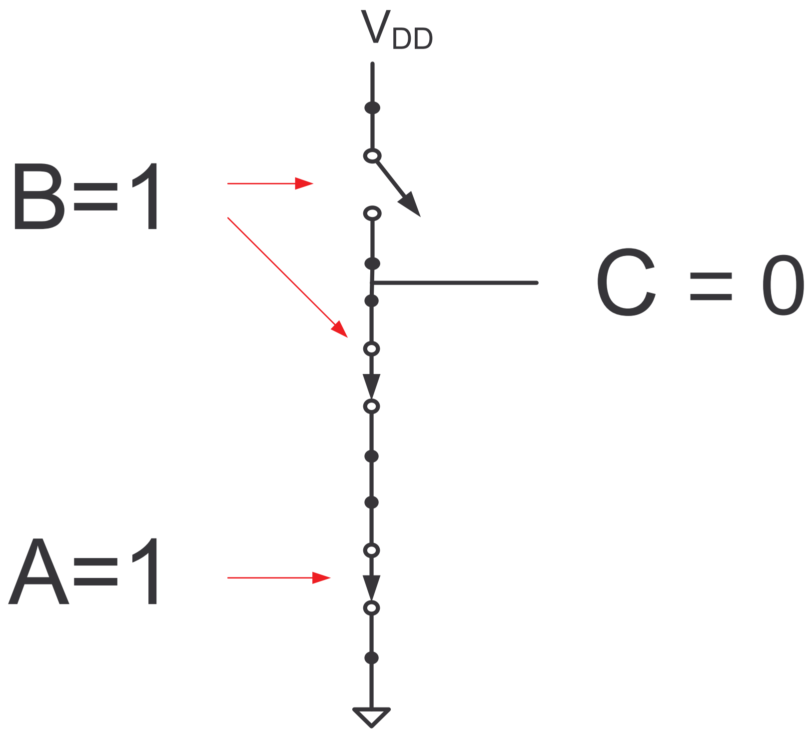


Solution:

a. If A=B=1



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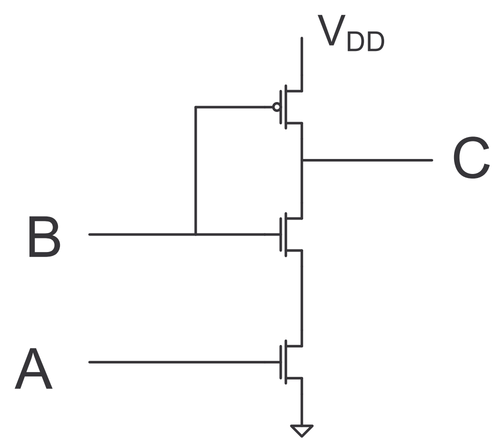
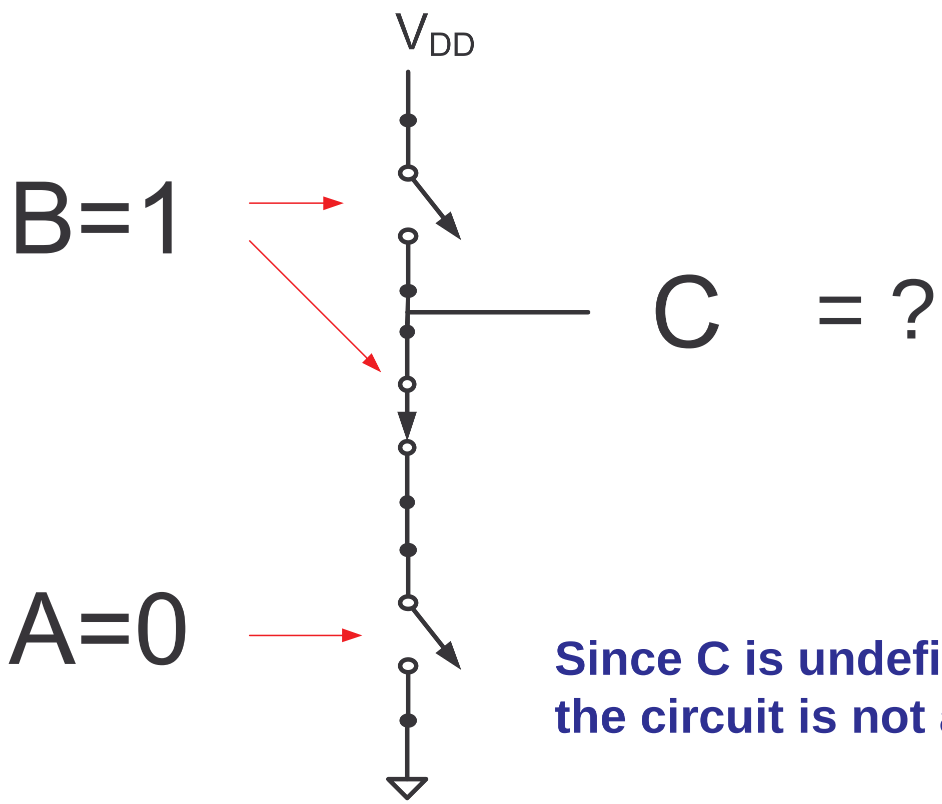


Solution:

b. If B=1 and A=0

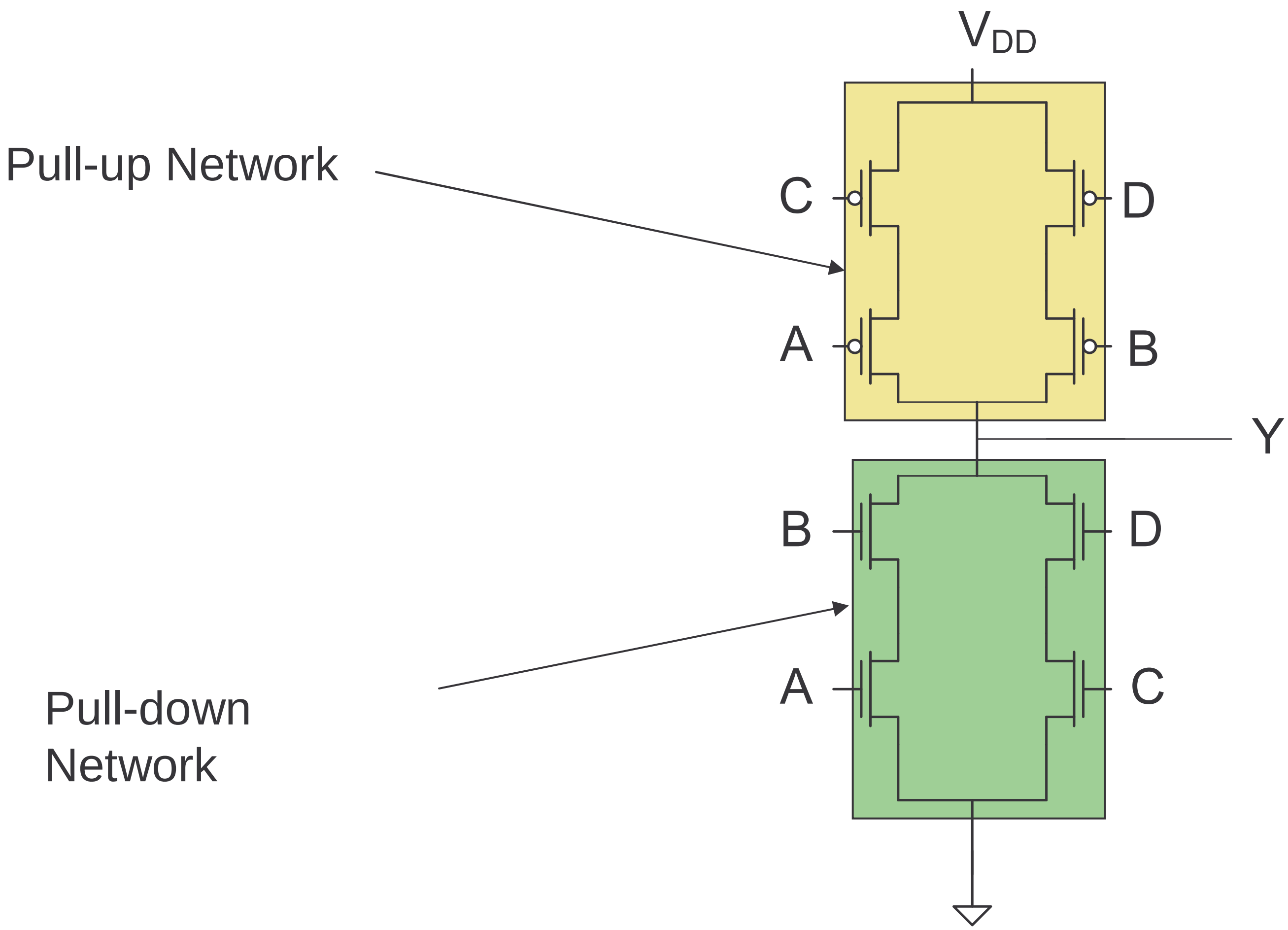


Since C is undefined for this input condition, the circuit is not a viable Boolean gate

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

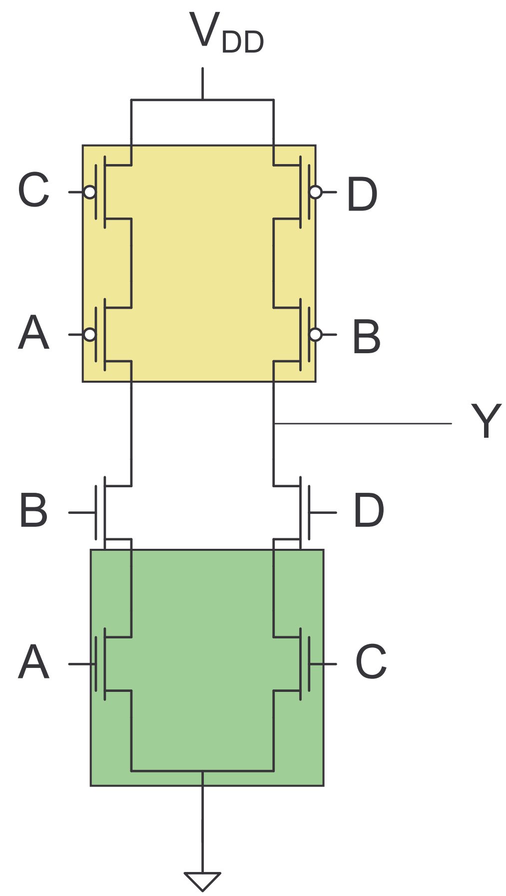


$$Y = \overline{(A \bullet B) + (C \bullet D)}$$

Complex Gates

Pull up and pull down network never both conducting

One of the two networks is always conducting

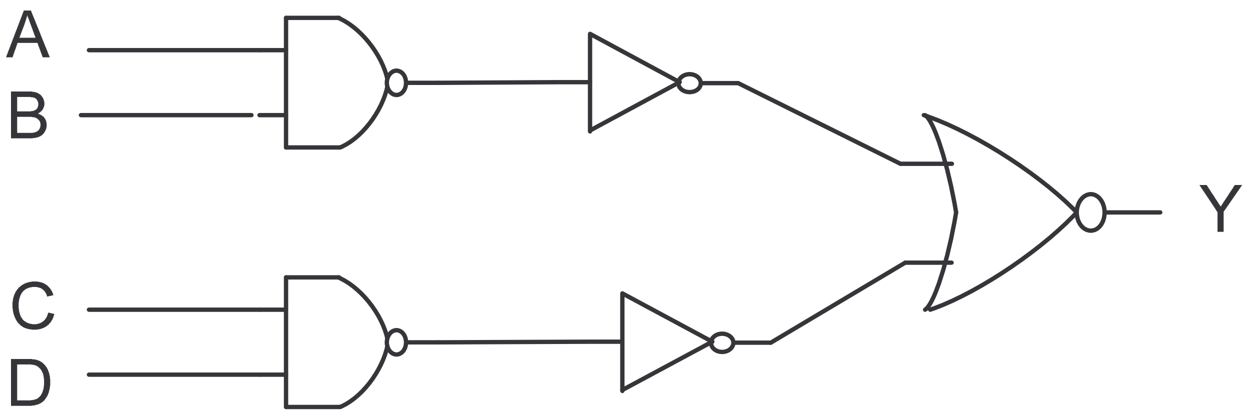


$$Y = \overline{(A \bullet B) + (C \bullet D)}$$

Consider

$$Y = \overline{(A \bullet B) + (C \bullet D)}$$

Alternate Implementation

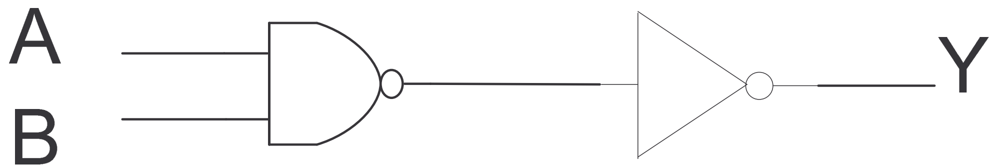


3 levels of Logic

16 Transistors if Basic CMOS Gates are Used

Consider $\mathbf{Y = A \bullet B}$

Standard CMOS Implementation

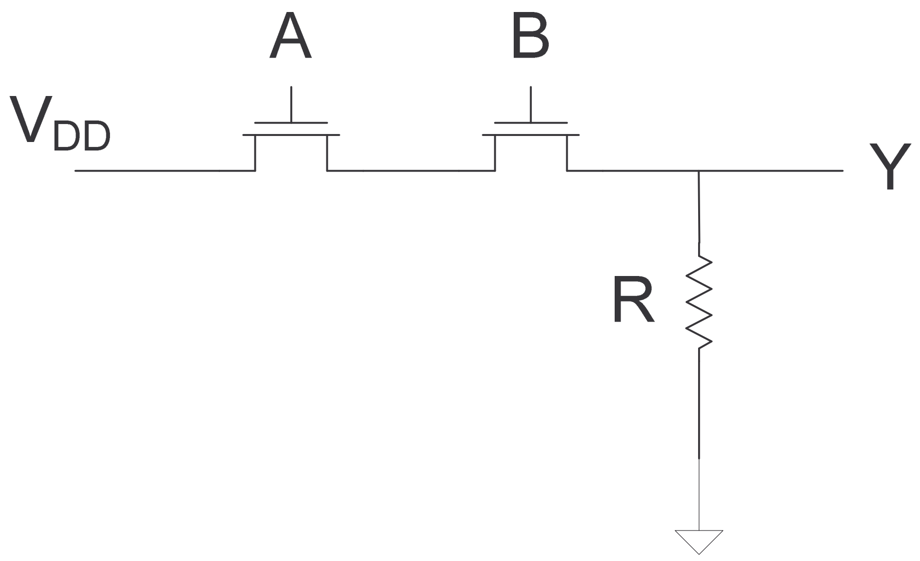


2 levels of Logic

6 Transistors if Basic CMOS Gates are Used

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

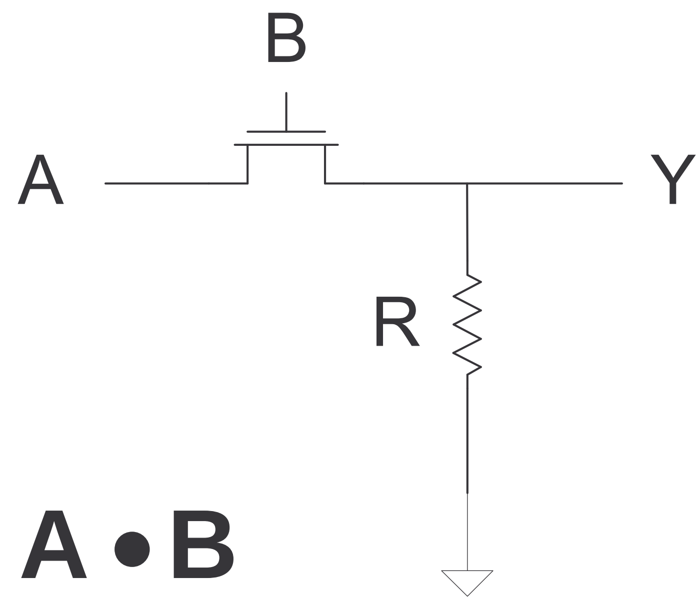
Pass Transistor Logic



$$Y = A \bullet B$$

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

Pass Transistor Logic

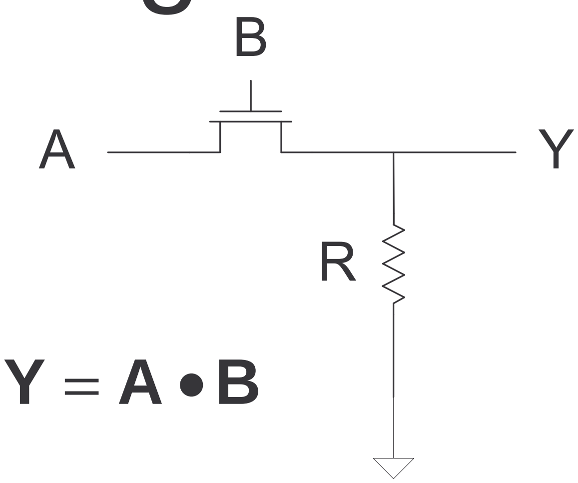


$$Y = A \bullet B$$

Even simpler pass transistor logic implementations are possible

Requires only 1 transistor (and a resistor).

Pass Transistor Logic



$$Y = A \bullet B$$

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