CSE 140: Components and Design Techniques for Digital Systems

Discussion Session 1

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Outline

- CMOS transistor as a switch
- Logic gates with CMOS transistors
- Introduction to Boolean Algebra
- Universal Gate
  - NOR
  - NAND
CMOS Transistor as a Switch

nMOS

pMOS
Logic gates with CMOS transistors

What logical gate does this circuit correspond to?

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<th>A</th>
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Boolean Algebra

- A set of rules to simplify logical expressions.
- For example: De Morgan’s Theorem
  - $A_1 \cdot A_2 \cdot A_3 \cdot \ldots \cdot A_N = \overline{A_1 + A_2 + A_3 + \ldots + A_N}$
  - $A_1 + A_2 + A_3 + \ldots + A_N = \overline{A_1 \cdot A_2 \cdot A_3 \cdot \ldots \cdot A_N}$
- Proof for 2 variables:

  $A \cdot B = \overline{A} + \overline{B}$
Simplify the following Boolean expressions using Boolean algebra. Label each step with the name of the Boolean theorem that you applied.

\[ \overline{X} + \overline{Y} + XY\overline{Z} \quad (hint: \overline{A} = A) \]

Solution:
Universal Gate

- Implement following logical expressions using NOR gate only.
- $H = a'b + ab'$
Universal Gate

- Implement following logical expressions using NAND gate only.
- \( H = a'b + ab' \)