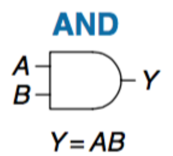
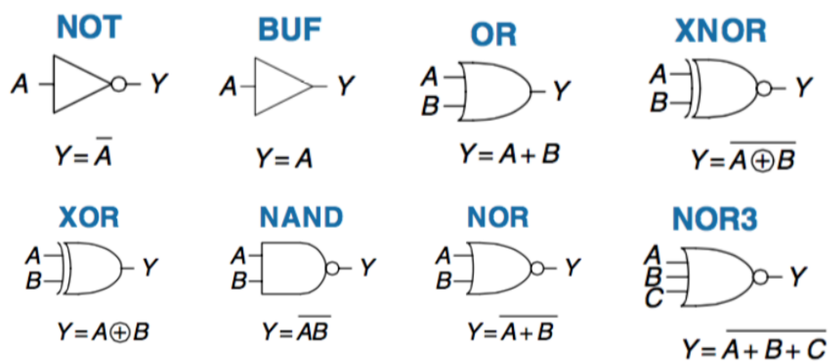
EE 16B Fall 2015 — Designing Information Devices and Systems II — Section 4B

1. Common Logic Gates A *truth table* is a list of all possible inputs of a Boolean function and the associated outputs. For example, the truth table of the AND function ($Y = AB$) is:



A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Write the truth tables for these common logic gates.



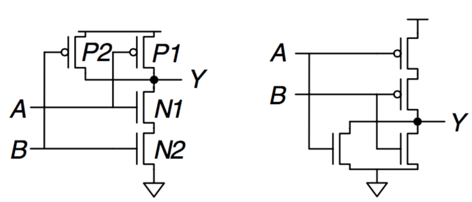
2. Building Gates with Transistors

For each transistor schematic below:

(a) Write down the truth table and identify the logic function.

(b) Show which switches are ON and which are OFF when $A = 1$ and $B = 0$.

(c) Are the switches ever configured such that current flows directly from V_{DD} to ground? Show which combination of inputs can make this occur, or explain why it cannot.

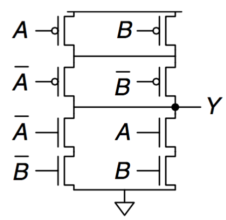


3. **More Gates**

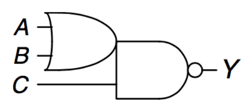
   (a) Write the symbol, Boolean logic equation, truth table, and transistor schematic for a 3-input NAND gate.

   (b) Can you build an AND gate out of transistors? Draw a schematic, or explain why you cannot.

4. **Transistors to Logic Functions** Write the truth table and a Boolean logic function for the schematic.



5. **Logic Functions to Transistors** Write the truth table and a Boolean logic function for the gate shown. Then implement the gate with transistors, using as few transistors as possible.



6. **Simplifying Boolean Algebra** Write a truth table for each Boolean function.

   (a) $Y = AC + \overline{A}\overline{B}C$

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

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

7. **De Morgan's Theorem**

   De Morgan's Theorem is a property of Boolean logic. It states:

$$\overline{B_0 \cdot B_1 \cdot B_2 \cdot \ldots} = \overline{B_0} + \overline{B_1} + \overline{B_2} + \ldots$$

   Prove De Morgan's Theorem for three variables B_0, B_1, and B_2.

   Note: In Boolean algebra, the fact that each variable can be either zero or one gives us a powerful tool for proving general properties. The technique of *perfect induction*, also known as "proof by exhaustion", simply shows that the theorem holds for all possible values of the variables. You might find this technique helpful here. (Start by writing a truth table...)