
IC220
Slide Set #6: Digital Logic
(Appendix B)

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Appendix Goals

Establish an understanding of the basics of logic design for future material

- **Gates**
 - Basic building blocks of logic
- **Combinational Logic**
 - Decoders, Multiplexors, PLAs
- **Clocks**
- **Memory Elements**
- **Finite State Machines**

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ADMIN

- Very different material!
- Reading
 - Appendix: Read B.1, B.2, B.3. Skim B.5.

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Logic Design – Digital Signals

- Only two valid, stable values
 - False =
 - True =
- Vs. voltage levels
 - Low voltage “usually”
 - High voltage “usually”
 - But for some technologies may be the reverse
- How can we make a function with these signals?
 1. Specify equations:

2. Implement with



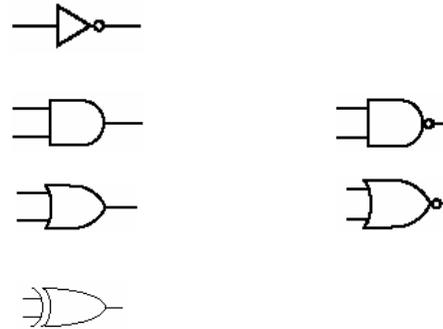
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Boolean Algebra

- One approach to expressing the logic function
- Operators:
 - NOT $x = \bar{A}$
Output true if
 - AND: 'A logical product' $x = A \bullet B = AB$
Output true if
 - OR: 'A logical sum' $x = A + B$
Output true if
 - XOR $x = A \oplus B$
Output true if
 - NAND $x = \overline{A \bullet B}$
Output true if
 - NOR $x = \overline{A + B}$
Output true if

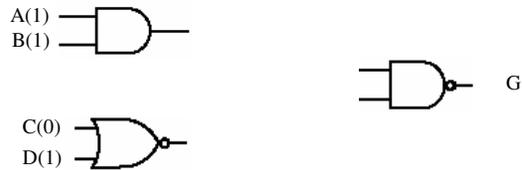
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Gates



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Example



Equation:

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Truth Tables Part 1

- Alternative way to specify logical functions
- List all outputs for all possible inputs
 - n inputs, how many entries?
 - Inputs usually listed in numerical order

$$x = \bar{A}$$

A	x
0	
1	

$$x = A + B$$

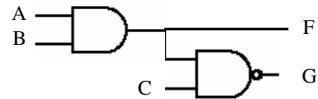
A	B	x
0	0	
0	1	
1	0	
1	1	

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Truth Tables Part 2

EX: B-1 to B-4

- Not just for individual gates
- Not just for one output



A	B	C	F	G
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

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Laws of Boolean Algebra

- Identity Law $A + 0 = A$ $A \cdot 1 = A$
- Zero and One Law $A + 1 = 1$ $A \cdot 0 = 0$
- Inverse Law $A + \bar{A} = 1$ $A \cdot \bar{A} = 0$
- Commutative Law $A + B = B + A$ $A \cdot B = B \cdot A$

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Laws of Boolean Algebra

- Associative Law $A + (B + C) = (A + B) + C$
 $A \cdot (B \cdot C) = (A \cdot B) \cdot C$
- Distributive Law $A \cdot (B + C) = (A \cdot B) + (A \cdot C)$
 $A + (B \cdot C) = (A + B) \cdot (A + C)$
- DeMorgan's Law $\overline{A + B} = \bar{A} \cdot \bar{B}$
 $\overline{A \cdot B} = \bar{A} + \bar{B}$

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