
SI232

Slide Set #6: Digital Logic (Appendix B)

1

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

3

ADMIN

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

2

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



4

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 $x = \overline{A \bullet B}$

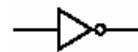
Output true if

– NOR $x = \overline{A + B}$

Output true if

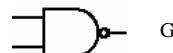
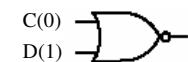
5

Gates



6

Example



Equation:

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	

$$x = A + B$$

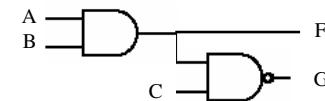
A	B	x
0	0	
0	1	
1	0	
1	1	

7

8

Truth Tables Part 2

- 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		

9

Exercise #1

- Show the truth table for NAND and NOR gates



A	B	x
0	0	
0	1	
1	0	
1	1	

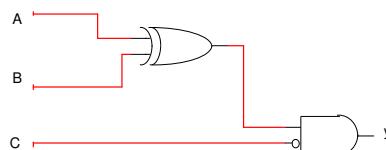


A	B	x
0	0	
0	1	
1	0	
1	1	

10

Exercise #2

- A.) Show the truth table for the following logic circuit



- B.) Write the Boolean equation for this circuit.

11

Exercise #3

- Draw a circuit for the following formula:
 $F = \overline{(A + B) \cdot C} + D$

12

Exercise #4 – For more thought

- Recall – how many entries are in a truth table for a function with n inputs?
- Consider – how many different truth tables are possible for a function with n inputs?

13

Laws of Boolean Algebra

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

14

Laws of Boolean Algebra

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

15