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

ADMIN

- Very different material!
- Reading
  - Appendix: Read C.1, C.2, C.3. Skim C.5. (on your CD)

Appendix Goals

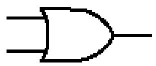
Establish an understanding of the basics of logic design for future material

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

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



Boolean Algebra

- <u>One</u> approach to expressing the logic function
- Operators:
  - NOT $x = \overline{A}$

    Output true if
  - AND: 'A logical product' $x = A \bullet B = AB$

    Output true if
  - OR : 'A logical sum' $x = A + B$

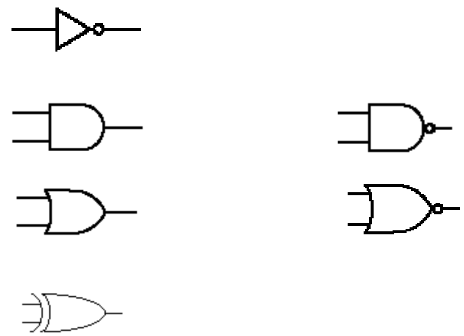
    Output true if
  - XOR $x = A \oplus B$

    Output true if
  - NAND $x = \overline{A \bullet B}$

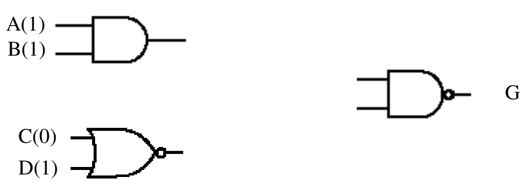
    Output true if
  - NOR $x = \overline{A + B}$

    Output true if

Gates



Example



<u>Equation</u>:

Truth Tables Part 1

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

$x = \overline{A}$

A	x
0	
1	

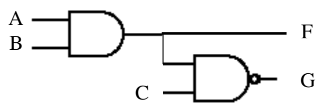
$x = A + B$

A	B	x
0	0	
0	1	
1	0	
1	1	

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		

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** $A+\overline{A}=1$ $A\bullet \overline{A}=0$
- **Commutative Law** $A+B=B+A$ $A\bullet B=B\bullet A$

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** $\overline{A+B}=\overline{A}\bullet\overline{B}$
  $\overline{A\bullet B}=\overline{A}+\overline{B}$