

Digital Logic Design

Lecture 05: Combinational Logic Circuit & Boolean Algebra

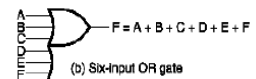
Combinational Logic Circuits

- Logic Gates: Control the flow of information?
- Represent Logical Operations (Functions)
 - Inputs are like arguments to a function
 - Outputs are like result of the function
 - Fundamental Set
 - AND
 - OR
 - NOT
 - Transmission Gate
- Truth Tables...









Digital Logic Gates



Gates with more than Two Inputs



Digital Logic Gates

Graphic Symbols																			
Name	Distinctive shape	Rectangular shape	Algebraic equation	Truth table															
AND			$F = XY$	<table><tr><td>X</td><td>Y</td><td>F</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	X	Y	F	0	0	0	0	1	0	1	0	0	1	1	1
X	Y	F																	
0	0	0																	
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OR			$F = X + Y$	<table><tr><td>X</td><td>Y</td><td>F</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	X	Y	F	0	0	0	0	1	1	1	0	1	1	1	1
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NOT (Inverter)			$F = \bar{X}$	<table><tr><td>X</td><td>F</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	X	F	0	1	1	0									
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Buffer			$F = X$	<table><tr><td>X</td><td>F</td></tr><tr><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td></tr></table>	X	F	0	0	1	1									
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NAND			$F = \overline{X \cdot Y}$	<table><tr><td>X</td><td>Y</td><td>F</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	X	Y	F	0	0	1	0	1	1	1	0	1	1	1	0
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NOR			$F = \overline{X + Y}$	<table><tr><td>X</td><td>Y</td><td>F</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	X	Y	F	0	0	1	0	1	0	1	0	0	1	1	0
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Exclusive-OR (XOR)			$F = XY + \overline{X}\overline{Y}$ $= X \oplus Y$	<table><tr><td>X</td><td>Y</td><td>F</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	X	Y	F	0	0	0	0	1	1	1	0	1	1	1	0
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Binary Boolean Operations

- All possible outcomes of a 2-input Boolean function

A	B	F ₀	F ₁	F ₂	F ₃	F ₄	F ₅	F ₆	F ₇	F ₈	F ₉	F ₁₀	F ₁₁	F ₁₂	F ₁₃	F ₁₄	F ₁₅
0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
NULL	A·B	A		B	A⊕B	A+B	A⊙B	B	A		A·B	Identity					