Lecture 3

Logic and Gates

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Binary Logic

- **Binary logic deals with variables that can take on two discrete values and operations for them.**

- **There are three basic logical operations AND, OR, and NOT.**

  - **AND is a binary operator represented by a dot "·". $Z = X \cdot Y$ means that Z is 1 if and only if X =1 and Y = 1.**

  - **OR is a binary operator represented by "+". $Z = X + Y$ means that Z is 1 if X =1 or Y = 1 (or both X and Y are 1).**

  - **Not is a unary operator represented by a bar over the variable. $Z = \overline{X}$ means Z =1 if X = 0 and Z = 0 if X = 1.**

Truth Tables

- **A truth table is a table showing the outputs of a function for all possible input combinations.**

X	Y	F
0	0	0
0	1	0
1	0	0
1	1	1

$F = X \cdot Y$

X	Y	F
0	0	0
0	1	1
1	0	1
1	1	1

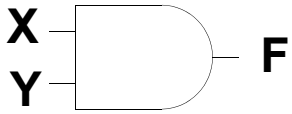
$F = X + Y$

X	F
0	1
1	0

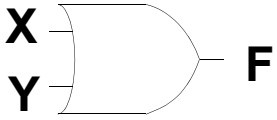
$F = \overline{X}$

Logic Gates

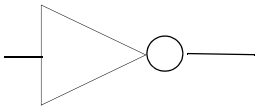
- Logic gates are electronic circuits which operate on one or more input signals to produce an output signal.



AND gate



OR gate

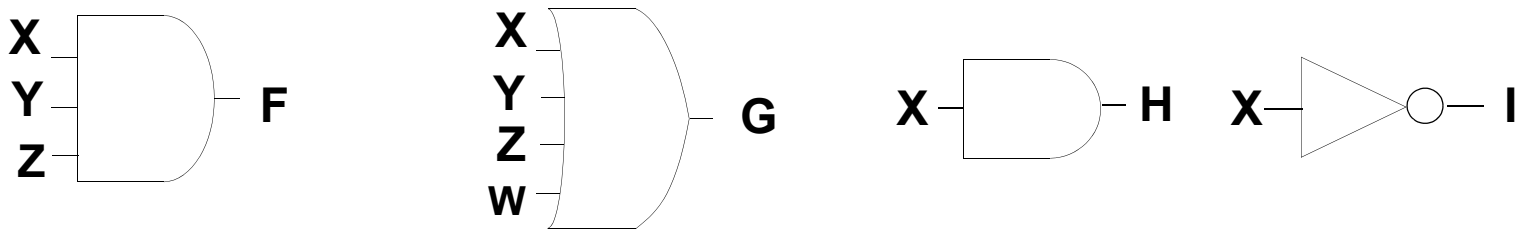


NOT gate (= INVERTER)

- The input terminals of a gate accept binary signals within the allowable range.

Gates with Multiple Inputs

- AND and OR gates may have more than two inputs.
- A multiple input AND gate produces 1 if and only if all the inputs are 1.
- A multiple input OR gate produces 1 if ( ).

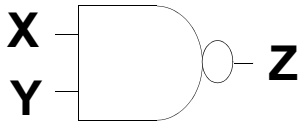


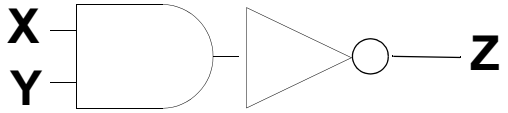
- Practice : Show the truth table for F, G, H and I from the above figure.

Two More Logic Gates

NAND (AND followed by NOT)

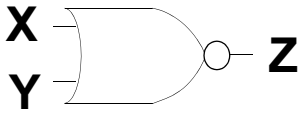
X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

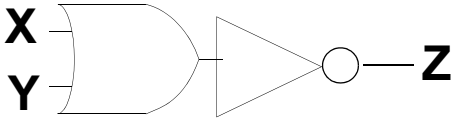




NOR (OR followed by NOT)

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0





Digital logic Gates

Name	Graphic symbol	Algebraic function	Truth table
AND		$F = x \cdot y$	$x\ y \mid F$: 0 0 | 0; 0 1 | 0; 1 0 | 0; 1 1 | 1
OR		$F = x + y$	$x\ y \mid F$: 0 0 | 0; 0 1 | 1; 1 0 | 1; 1 1 | 1
Inverter		$F = x'$	$x \mid F$: 0 | 1; 1 | 0
Buffer		$F = x$	$x \mid F$: 0 | 0; 1 | 1
NAND		$F = (xy)'$	$x\ y \mid F$: 0 0 | 1; 0 1 | 1; 1 0 | 1; 1 1 | 0
NOR		$F = (x + y)'$	$x\ y \mid F$: 0 0 | 1; 0 1 | 0; 1 0 | 0; 1 1 | 0
Exclusive-OR (XOR)		$F = xy' + x'y$ $= x \oplus y$	$x\ y \mid F$: 0 0 | 0; 0 1 | 1; 1 0 | 1; 1 1 | 0
Exclusive-NOR or equivalence		$F = xy + x'y'$ $= (x \oplus y)'$	$x\ y \mid F$: 0 0 | 1; 0 1 | 0; 1 0 | 0; 1 1 | 1

FIGURE 2.5
Digital logic gates