Logical Organization of Computer
CHAPTER 2

COMBINATIONAL LOGIC CIRCUITS

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1. BINARY LOGIC AND GATES

- Digital circuits are hardware components that manipulat
information. The circuits are implemented using transist
interconnections in complex semiconductor devices
integrated circuits. Each basic circuit is referred to as a *log*
- Each gate performs a specific logical operation. The ou
gates are applied to the inputs of other gates to form a
circuit.
- In order to describe the operational properties of digital
we need to introduce a mathematical notation that spec
operation of each gate and that can be used to analyze and
circuits known as *Boolean algebras*.

❑ Binary Logic

- Binary logic deals with binary variables, which take on two discrete values, and with the operations of mathematical logic applied to these variables.
- Associated with the binary variables are three basic logical operations called AND, OR, and NOT.
- **1. AND.** This operation is represented by a dot or by the absence of an operator. For example, $Z = X \cdot Y$ or $Z = XY$ is read "*Z* is equal to *X* AND *Y*." The logical operation AND is interpreted to mean that $Z = 1$ if and only if $X = 1$ and $Y = 1$; otherwise $Z = 0$.

$0 \cdot 0$

$0 \cdot 1$

$1 \cdot 0$

$1 \cdot 1$

❑ Binary Logic

2. OR. This operation is represented by a plus symbol. For example, $Z = X + Y$ is read "*Z* is equal to *X* OR *Y*," meaning that $Z = 1$ if $X = 1$ or if $Y = 1$, or if both $X = 1$ and $Y = 1$. $Z = 0$ if and only if $X = 0$ and $Y = 0$.

$0 + 0$

$0 + 1$

$1 + 0$

$1 + 1$

3. NOT. This operation is represented by a bar over the variable. For example, $Z = \overline{X}$ is read "*Z* is equal to NOT *X*," meaning that *Z* is what *X* is not. In other words, if $X = 1$, then $Z = 0$; but if $X = 0$, then $Z = 1$. The NOT operation is also referred to as the *complement* operation, since it changes a 1 to 0 and a 0 to 1.

❑ Binary Logic

- A *truth table* for an operation is a table of combinations binary variables showing the relationship between the that the variables take on and the values of the result operation.
- The truth tables for the operations AND, OR, and NOT are below.

❑ Binary Logic

❑ **TABLE 1**
Truth Tables for the Three Basic Logical Operations

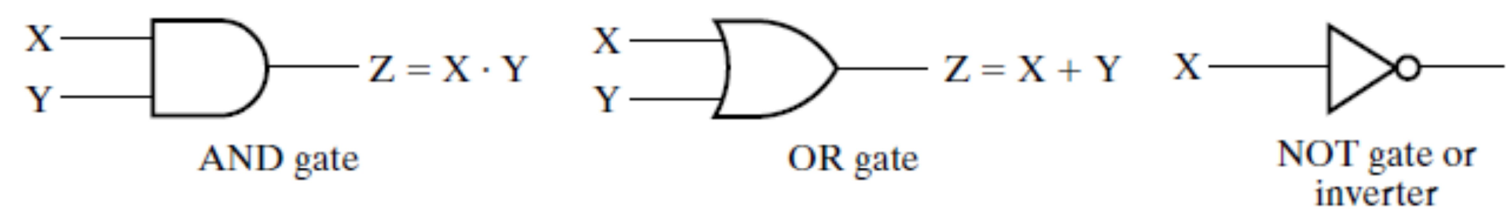
AND			OR			NOT	
X	Y	$Z = X \cdot Y$	X	Y	$Z = X + Y$	X	$Z = \overline{X}$
0	0	0	0	0	0	0	1
0	1	0	0	1	1	1	0
1	0	0	1	0	1		
1	1	1	1	1	1		

❑ Logic Gates

- Logic gates are electronic circuits that operate on one o
input signals to produce an output signal.
- The input terminals of logic gates accept binary signals wi
allowable range and respond at the output terminals with
signals that fall within a specified range.
- The intermediate regions between the allowed ranges in th
are crossed only during changes from 1 to 0 or from 0 to 1.
- These changes are called *transitions*, and the intermediate
are called the *transition regions*.

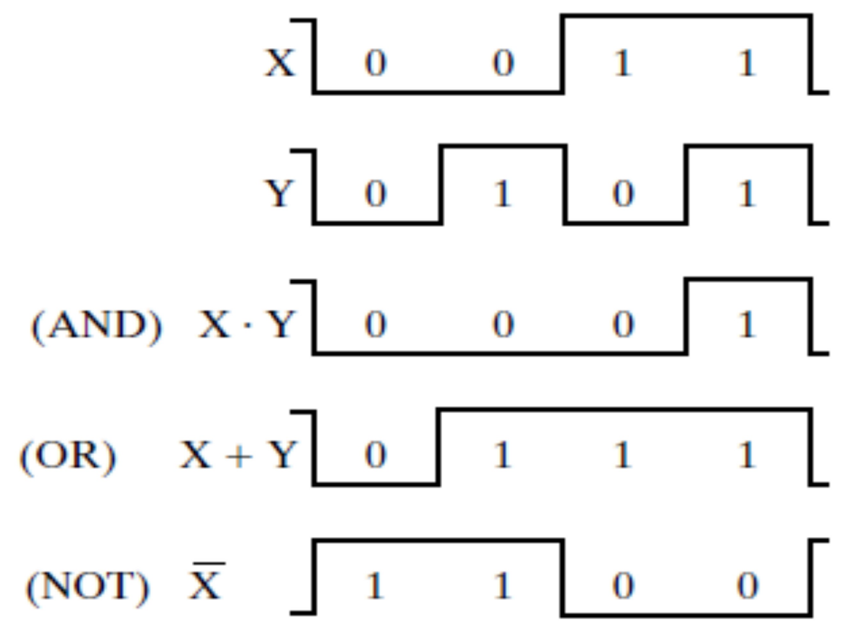
❑ Logic Gates

- The graphics symbols used to designate the three types of
AND, OR, and NOT—are shown below.



(a) Graphic symbols

❑ Logic Gates



(b) Timing diagram

2. BOOLEAN ALGEBRA

- A *Boolean expression* is an algebraic expression formed b binary variables, the constants 0 and 1, the logic o symbols, and parentheses.
- *Boolean function* can be described by a Boolean e consisting of a binary variable identifying the function foll an equals sign and a Boolean expression.

❑ Basic Identities of Boolean Algebra

Annulment Law – A term AND´ed with a "0" equals 0 or OR´ed with a "1" wi
equal 1

A . 0 = 0	A variable AND'ed with 0 is always equal to 0
A + 1 = 1	A variable OR'ed with 1 is always equal to 1

Identity Law – A term OR´ed with a "0" or AND´ed with a "1" will always equ
that term

A + 0 = A	A variable OR'ed with 0 is always equal to the variable
A . 1 = A	A variable AND'ed with 1 is always equal to the variabl