Table 1.7 Boolean algebraic theorems

Theorem No.	*Theorem*
1.1	$A + 0 = A$
1.2	$A \cdot 1 = A$
1.3	$A + 1 = 1$
1.4	$A \cdot 0 = 0$
1.5	$A + A = A$
1.6	$A \cdot A = A$
1.7	$A + \bar{A} = 1$
1.8	$A \cdot \bar{A} = 0$
1.9	$A \cdot (B + C) = AB + AC$
1.10	$A + BC = (A + B)(A + C)$
1.11	$A + AB = A$
1.12	$A(A + B) = A$
1.13	$A + \bar{A}B = (A + B)$
1.14	$A(\bar{A} + B) = AB$
1.15	$AB + A\bar{B} = A$
1.16	$(A + B) \cdot (A + \bar{B}) = A$
1.17	$AB + \bar{A}C = (A + C)(\bar{A} + B)$
1.18	$(A + B)(\bar{A} + C) = AC + \bar{A}B$
1.19	$AB + \bar{A}C + BC = AB + \bar{A}C$
1.20	$(A + B)(\bar{A} + C)(B + C) = (A + B)(\bar{A} + C)$
1.21	$\overline{A \cdot B \cdot C \cdot \ldots} = \bar{A} + \bar{B} + \bar{C} + \ldots$
1.22	$\overline{A + B + C + \ldots} = \bar{A} \cdot \bar{B} \cdot \bar{C} \ldots$

Theorems 1.1 to 1.8 involve a single variable only. Each of these theorems can be proved by considering every possible value of the variable. For example, in Theorem 1.1,
if $A = 0$ then $0 + 0 = 0 = A$
and if $A = 1$ then $1 + 0 = 1 = A$
and hence the theorem is proved.

Theorems 1.9 to 1.20 involve more than one variable and can be proved by making a truth table. For example, Theorem 1.10 can be proved by making the truth table given in Table 1.8.

Table 1.8 Truth table to prove Theorem 1.10

A	B	C	BC	$A + BC$	$A + B$	$A + C$	$(A + B)(A + C)$
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

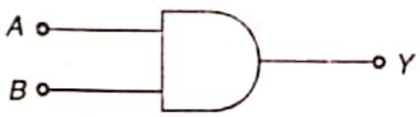
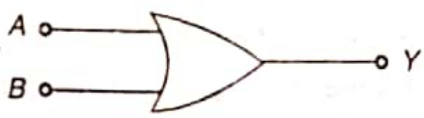
Table 1.10 (*Contd.*)

IC No.	*Description*
7411	Triple 3-input AND gates
7420	Dual 4-input NAND gates
7421	Dual 4-input AND gates
7427	Triple 3-input NOR gates
7430	8-input NAND gate
7432	Quad 2-input OR gates
7486, 74386	Quad EX-OR gates
74133	13-input NAND gate
74135	Quad EX-OR/NOR gates
74260	Dual 5-input NOR gates

1.8 SUMMARY

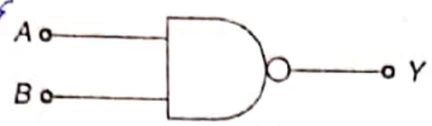
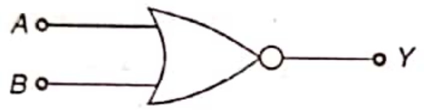
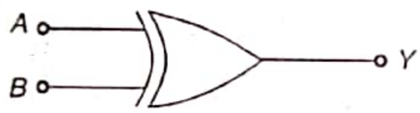
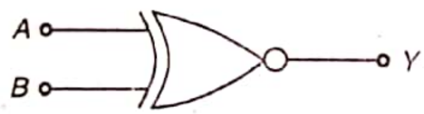
In this chapter, the basic concepts of the digital systems have been discussed. The basic features and advantages of these systems have been given briefly. The level of the treatment has been kept low to avoid any confusion. Table 1.11 summarizes the operation of all the gates introduced in this chapter. For convenience, two input gates have been taken and the different symbols used for various operations are also given. A brief exposure to Boolean algebra has also been given. The techniques for the simplification of logic equations will be discussed in Chapter 5.

Table 1.11 Summary of logic gates

Gate	*Logic diagram*	*Function*	*Truth table*
AND		$Y = A$ AND B $= A \cdot B$ $= A \cap B$ $= A \wedge B$ $= AB$	*Inputs* A B / *Output* Y 0 0 0 0 1 0 1 0 0 1 1 1
OR		$Y = A$ OR B $= A + B$ $= A \cup B$ $= A \vee B$	*Inputs* A B / *Output* Y 0 0 0 0 1 1 1 0 1 1 1 1
NOT (inverter)		$Y =$ NOT A $= \bar{A}$	*Input* A / *Output* Y 0 1 1 0

(*Contd.*)

Table 1.11 (*Contd.*)

Gate	Logic diagram	Function	Truth table: Inputs A	Inputs B	Output Y
NAND		$Y = A$ NOT AND B $= A$ NAND B $= \overline{A \cdot B}$ $= \overline{A \cap B}$ $= \overline{A \wedge B}$ $= A \uparrow B$ $= \overline{AB}$	0	0	1
			0	1	1
			1	0	1
			1	1	0
NOR		$Y = A$ NOT OR B $= A$ NOR B $= \overline{A + B}$ $= \overline{A \cup B}$ $= \overline{A \vee B}$ $= A \downarrow B$	0	0	1
			0	1	0
			1	0	0
			1	1	0
EX-OR		$Y = A$ EX-OR B $= A \oplus B$ $= A\bar{B} + \bar{A}B$	0	0	0
			0	1	1
			1	0	1
			1	1	0
EX-NOR		$Y = \overline{A \text{ EX-OR } B}$ $= A$ EX-NOR B $= A \odot B$ $= \overline{A\bar{B} + \bar{A}B}$ $= \bar{A}\,\bar{B} + AB$	0	0	1
			0	1	0
			1	0	0
			1	1	1

Glossary

Active-high input The input terminal is active (or enabled) when held at HIGH logic level.

Active-high output The output terminal is at HIGH logic level when active (or enabled).

Active-low input The input terminal is active (or enabled) when held at LOW logic level.

Active-low output The output terminal is at low logic level when active (or enabled).

Analog circuit An electronic circuit that processes analog signals.

Analog signal A continuous signal that can have any value in a given range. It is also known as continuous signal.