ELECTRONIC PRINCIPLES AND DEVICES

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Unit-3 Digital Electronics

Basic Theorem and Properties of Boolean Algebra

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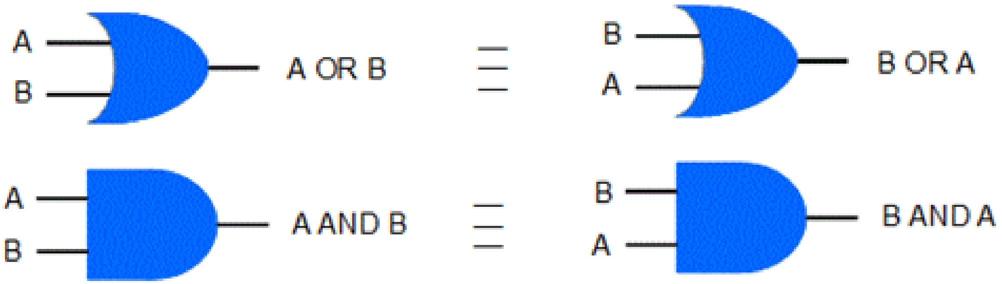
Basic Theorem and Properties of Boolean Algebra

- Boolean Laws and Theorems are used to simplify the Boolean expressions. Hence reduce the number of logic gates.

- **Commutative Laws:** (i) A+ B = B+ A
  (ii) A.B = B.A



Proof: Logic circuits

A	B	(A+B)	(B+A)	(A.B)	(B.A)
0	0	0	0	0	0
0	1	1	1	0	0
1	0	1	1	0	0
1	1	1	1	1	1

Proof: Truth Table

Basic Theorems and Properties of Boolean Algebra

- **Associative Law:**

$(A+B)+C = A+(B+C)$ Boolean addition

- Proof:

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

- From principle of duality: $(A.B).C = A.(B.C)$ Boolean Multiplication

Basic Theorem and Properties of Boolean Algebra

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❖ Distributive Law:

A + B.C = (A+B) . (A+C)

❖ Proof: Truth Table

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

Dual of distributive law:

A . (B+C) = A.B + A.C

❖ Proof: Truth Table

A	B	C	B+C	A(B+C)	AB	AC	AB+AC
0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	1	1	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

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❖ De Morgan's Theorem :

(i) The complement of the sum of 2 variables is equal to the product of the complements of individual variables:

$$\overline{A+B} = \overline{A}\,.\,\overline{B}$$

(ii) The complement of the product of 2 variables is equal to the sum of the complements of individual variables:

$$\overline{A.B} = \overline{A} + \overline{B}$$

A	B	$\overline{A}$	$\overline{B}$	$A+B$	$A.B$	$\overline{A+B}$	$\overline{A}\,.\,\overline{B}$	$\overline{A\,.\,B}$	$\overline{A}+\overline{B}$
0	0	1	1	0	0	1	1	1	1
0	1	1	0	1	0	0	0	1	1
1	0	0	1	1	0	0	0	1	1
1	1	0	0	1	1	0	0	0	0

Basic Theorem and Properties of Boolean Algebra

❖ Absorption Theorem:

(i) A+AB = A

LHS: $= A + AB$

$= A.1 + AB \rightarrow$ since $A.1 = A$

$= A(1+B) \rightarrow$ since $1 + B = 1$

$= A.1$

$= A = RHS$

(ii) A(A+B) = A

LHS $= A\,(A + B)$

$= A.A + A.B$

$= A+AB \rightarrow$ since $A\,.\,A = A$

$= A\,(1 + B)$

$= A.1$

$= A = RHS$

(iii) A+ĀB = A+B

LHS $= A + \bar{A}B$

$= (A + \bar{A})\,(A + B) \rightarrow$ since $A+BC = (A+B)(A+C)$

$= (1)\,.\,(A + B) \rightarrow$ since $A + \bar{A} = 1$

$= A + B = RHS$

(iv) A.(Ā+B) = AB

LHS $= A.(\bar{A} + B)$

$= A.\,\bar{A} + A.B \longrightarrow (A\,\bar{A} = 0)$

$= AB = RHS$

❖ Redundancy Laws

❖ Consensus Theorem:

$$AB + \bar{A}C + BC = AB + \bar{A}C$$

LHS $= AB + \bar{A}C + BC$

$= AB + \bar{A}C + BC.1$

$= AB + \bar{A}C + BC(A + \bar{A}) \rightarrow$ since $A + \bar{A} = 1$

$= AB + \bar{A}C + ABC + \bar{A}BC$

$= AB(1 + C) + \bar{A}C(1 + B)$

$1 + B = 1 + C = 1$

$= AB + \bar{A}C =$ RHS

❖ **BC is redundant term**

❖ Dual of consensus theorem:

$$(A+B)(\bar{A}+C)(B+C) = (A+B)(\bar{A}+C)$$

THANK YOU

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