Paper 7, TDC Part-3
Chapter– 1, Fundamental Concept of Digital Electronics
Boolean Algebra Lecture 1

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

L.S. College, BRA Bihar University,

Muzaffarpur, Bihar

Fundamental Concepts of Digital Electronics

- **BOOLEAN Algebra :-**

As a digital signal is discrete in nature and in the digital system these signals assume only one of the two values 0 or 1 at any time.

- ❖ A number system based on these two digits ‘0’ and ‘1’ is known as “Binary Number System”.
- ❖ For manipulations of binary number, George Boole developed rules in the middle of the 19th century, known as “Boolean Algebra”. This Boolean algebra is the basis of all digital systems.

Fundamental Concepts of Digital Electronics

Binary “Variables” can be represented by an English alphabet letter such as A, B, C etc. The Variable can have only one of the two possible values either ‘0’ or ‘1’ at any time.

The “Complement” is the inverse of a variable and is indicated by a bar over the variable (overbar) or by a prime symbol.

Complement of A is $\overline{A}$ or A'

Literal is a variable or the complement of a variable like A, A', B, B', X', Y, Z etc.

Fundamental Concepts of Digital Electronics

Boolean Algebra :-

Boolean Addition rule is equivalent to OR operation

$0 + 0 = 0$

$0 + 1 = 1$ or $1 + 0 = 1$

$1 + 1 = 1$

Boolean Multiplication rule is equivalent to AND operation

$0 . 0 = 0$

$0 . 1 = 0$ or $1 . 0 = 0$

$1 . 1 = 1$

Many theorems have been obtained by interchanging (i) (+) and (.) signs and (ii) 0 and 1 are called dual of each other.

Boolean Algebraic Theorem :-

1. Theorem No. 1.1) A + 0 = A

Proof : When A = 0 then A + 0 = 0 + 0 = 0

When A = 1 then A + 0 = 1 + 0 = 1

So A + 0 = A

2. Theorem No. 1.1) A . 1 = A

Proof : When A = 0 then A . 1 = 0 . 1 = 0

When A = 1 then A . 1 = 1 . 1 = 1

So A . 1 = A

Theorem 1.1 and 1.2 are called “Duals”

Fundamental Concepts of Digital Electronics

3. Theorem No. 1.3) $A + 1 = 1$

Proof : When $A = 0$ then $A + 1 = 0 + 1 = 1$

When $A = 1$ then $A + 1 = 1 + 1 = 1$

So $A + 0 = 1$

4. Theorem No. 1.4) $A . 0 = 0$

Proof : When $A = 0$ then $A . 0 = 0 . 0 = 0$

When $A = 1$ then $A . 1 = 1 . 0 = 0$

So $A . 0 = 0$

Theorem 1.3 and 1.4 are called “Duals”

Fundamental Concepts of Digital Electronics

5. Theorem No. 1.5) $A + A = A$

Proof : When $A = 0$ then $0 + 0 = 0 + 0 = 0$

When $A = 1$ then $1 + 1 = 1 + 1 = 1$

So $A + A = A$

6. Theorem No. 1.6) $A . A = A$

Proof : When $A = 0$ then $A . A = 0 . 0 = 0 = A$

When $A = 1$ then $A . A = 1 . 1 = 1 = A$

So $A . A = A$

Theorem 1.5 and 1.6 are called "Duals"

Fundamental Concepts of Digital Electronics

7. Theorem No. 1.7) $A + \overline{A} = 1$
8. Theorem No. 1.8) $A . \overline{A} = 0$

Theorem 1.7 and 1.8 are called “Duals”

These theorem can be proved in the same way as proved earlier.

Some other theorems are :-

9. Theorem No. 1.9) $A.(B+C) = AB + AC$

The proof of this theorem can be done through truth table.

Fundamental Concepts of Digital Electronics

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

Truth Table for Theorem A.(B+C) = AB + AC

Fundamental Concepts of Digital Electronics

So from truth table we can verify Theorem No. 1.9 that is A.(B+C) = AB + AC.

Value in the column A.(B+C) is equivalent to value in the column AB + AC for every combinations of inputs variable. This verifies the theorem.

In a truth table the total number of input combination is 2^n where n is number of variable. So for, n=2 number of input combination is $2^2 = 4$

n=3 number of input combination is $2^3 = 8$

n=4 number of input combination is $2^4 = 16$

In similar manner we can find total number input combinations for ‘n’ numbers of variable

Fundamental Concepts of Digital Electronics

10.Theorem No. 1.10) A + BC = (A+B) (A+C)

Proof of Theorem 1.10 can be done as follows,

By taking RHS of theorem

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

= A + A.B + A.C + B.C [From theorem 1.6 we know that A.A =A]

= A (1 + B + C) + B.C [From theorem 1.3 we know that 1 + any literal is 1]

= A.1 + B.C

= A + BC

Thank you

To be continued……..