# Dr. SNS RAJALAKSHMI COLLEGE OF ARTS & SCIENCE (Autonomous)
## Coimbatore -641049

## DEPARTMENT OF GRAPHIC & CREATIVE DESIGN AND DATA ANALYTICS

## COURSE NAME : COMPUTER SYSTEM ARCHITECTURE (23UCU402)

I YEAR /I SEMESTER

Unit II- LOGICAL GATES

**Topic 1: Boolean Algebra**

# Boolean Algebra

✓**Boolean algebra** is the category of algebra in which the variable's values are the truth values, **true and false,** ordinarily denoted 1 and 0 respectively.

✓It is used to **analyze and simplify digital circuits** or **digital gates**.

✓It is also called **Binary Algebra** or **logical Algebra**.

✓It has been fundamental in the development of digital electronics and is provided for in all modern programming languages. It is also used in set theory and statistics.

✓The important operations performed in Boolean algebra are – **conjunction (∧), disjunction (∨) and negation (¬)**.

# Rules in Boolean algebra

1.Only two values(1 for high and 0 for low) are possible for the variable used in Boolean algebra.

2.The **overbar(-)** is used for representing the **complement** variable. So, the complement of variable C is represented as .

3.The plus(+) operator is used to represent the **ORing** of the variables.

4.The dot(.) operator is used to represent the **ANDing** of the variables.

# Boolean Algebra

| Name | AND form | OR form |
|---|---|---|
| Identity law | $1A = A$ | $0 + A = A$ |
| Null law | $0A = 0$ | $1 + A = 1$ |
| Idempotent law | $AA = A$ | $A + A = A$ |
| Inverse law | $A\bar{A} = 0$ | $A + \bar{A} = 1$ |
| Commutative law | $AB = BA$ | $A + B = B + A$ |
| Associative law | $(AB)C = A(BC)$ | $(A + B) + C = A + (B + C)$ |
| Distributive law | $A + BC = (A + B)(A + C)$ | $A(B + C) = AB + AC$ |
| Absorption law | $A(A + B) = A$ | $A + AB = A$ |
| De Morgan's law | $\overline{AB} = \bar{A} + \bar{B}$ | $\overline{A + B} = \bar{A}\bar{B}$ |

# De Morgan's First Law

✓De Morgan's First Law states that **(A.B)' = A'+B'.**

✓The first law states that the complement of the product of the variables is equal to the sum of their individual complements of a variable.

✓The truth table that shows the verification of De Morgan's First law is given as follows:

| A | B | A' | B' | (A.B)' | A'+B' |
|---|---|----|----|--------|-------|
| 0 | 0 | 1  | 1  | 1      | 1     |
| 0 | 1 | 1  | 0  | 1      | 1     |
| 1 | 0 | 0  | 1  | 1      | 1     |
| 1 | 1 | 0  | 0  | 0      | 0     |

# De Morgan's Second Law

✓De Morgan's Second law states that **(A+B)' = A'. B'.**

✓The second law states that the complement of the sum of variables is equal to the product of their individual complements of a variable.

✓The following truth table shows the proof for De Morgan's second law.

| A | B | A' | B' | (A+B)' | A'. B' |
|---|---|----|----|--------|--------|
| 0 | 0 | 1  | 1  | 1      | 1      |
| 0 | 1 | 1  | 0  | 0      | 0      |
| 1 | 0 | 0  | 1  | 0      | 0      |
| 1 | 1 | 0  | 0  | 0      | 0      |

# Examples

**Question:** Simplify the following expression:

$$c + \bar{B}C$$

Solution:

Given:

$$C + \bar{B}C$$

According to Demorgan's law, we can write the above expressions as

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

From Commutative law:

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

From Complement law

$$1 + \bar{B} = 1$$

Therefore,

$$C + \bar{B}C = 1$$

# Examples

**Draw a truth table for A(B+D).**
Solution: Given expression A(B+D).

| A | B | D | B+D | A(B+D) |
|---|---|---|-----|--------|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |

# Assessment - Questions

1. What is meant by Boolean algebra?

2. What are some applications of Boolean algebra?

3. What are the three main Boolean operators?

4. Is the value 0 represents true or false?

5. Mention the six important laws of Boolean algebra.

# Assessment - Answer

1.  **What is meant by Boolean algebra?**
    In Mathematics, Boolean algebra is called logical algebra consisting of binary variables that hold the values 0 or 1, and logical operations.

2. **What are some applications of Boolean algebra?**
    In electrical and electronic circuits, Boolean algebra is used to simplify and analyze the logical or digital circuits.

3. **What are the three main Boolean operators?**
    The three important Boolean operators are:
    AND (Conjunction)
    OR (Disjunction)
    NOT (Negation)

4.**Is the value 0 represents true or false?**
    In Boolean logic, zero (0) represents false and one (1) represents true. In many applications, zero is interpreted as false and a non-zero value is interpreted as true.

5. **Mention the six important laws of Boolean algebra.**
    The six important laws of Boolean algebra are:
    Commutative law
    Associative law
    Distributive law
    Inversion law
    AND law
    OR law

# References

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# Thank You