SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore-35

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

16EE203 – LINEAR AND DIGITAL CIRCUITS

UNIT III – MINIMIZATION TECHNIQUES AND GATES

2 MARKS

1. Define the following terms: Boolean variable, complement, literal

Answer:

a. Variable: The symbol which represents an arbitrary element of Boolean algebra is known as variable. Any single variable or a function of several variables can have either a 0 or 1.
   Example:

   Y = A + BC, variables A, B, and C can have either a 1 or 0 value, and function Y also can have either a 1 or 0 value.

b. Complement: A complement of a variable is represented by a “bar” over the letter. For example, the complement of variable A is represented by A or A’.
c. Literal: Each occurrence of a variable in Boolean function either in a complemented or un-complemented form is called a literal.

2. State the fundamental postulates of Boolean algebra.

Answer:

The postulates of a mathematical system form the basic assumption from which it is possible to deduce the theorems, laws and properties of the system.

a. Closure: Closure with respect to the operator + : When two binary elements are operated by operator + the result is a unique binary element.
   Closure: Closure with respect to the operator **.** (dot) : When two binary elements are operated by operator **.** (dot), the result is a unique binary element.

b. An identity element with respect to +, designated by 0: A + 0 = 0 + A = A
   An identity element with respect to **.** (dot), designated by 1: A **.** 1 = 1 **.** A = A

c. Commutative with respect to + : A + B = B + A
   Commutative with respect to **.** (dot) : A **.** B = B **.** A

d. Distributive property of **.** (dot) over + : A . (B + C) = (A **.** B) + (A **.** C)
   Distributive property of + over **.** (dot) : A + (B . C) = (A + B) **.** (A + C)

e. Associative property of + : A + (B + C) = (A + B) + C
   Associative property of **.** : A **.** (B **.** C) = (A **.** B) **.** C

f. For every binary element, there exists complement element. For example, if A is an element, we have A' is a complement of A i.e., if A = 0, then A' = 1 and vice versa.

g. There exist at least two elements, say A and B in the set of binary elements such that A not equals B.

3. State the associativity laws of Boolean algebra

Answer:

Associative property of + operator : A + (B + C) = (A + B) + C

Associative property of **.** (dot) operator: A **.** (B **.** C) = (A **.** B) **.** C

4. List down the basic theorems of Boolean algebra.

Answer:

Theorems	(a)	(b)
Theorem 1 (Idempotency)	A + A = A	A . A = 1
Theorem 2	A + 1 = A	A . 0 = 0
Theorem 3 (Involution)	(A')' = A	
Theorem 4 (Absorption)	A + AB = A	A (A + B) = A
Theorem 5	A + A'B = A + B	A . (A' + B) = AB
Theorem 6 (Associative)	A (B + C) = (A + B) + C	A (BC) = (AB) C

5. Explain De-Morgan's Theorem

De Morgan suggested two theorems that form important part of Boolean algebra.

They are,

(1) The complement of a product is equal to the sum of the complements.
(AB)' = A' + B'

(2) The complement of a sum term is equal to the product of the complements.
(A + B)' = A'B'

6. **Mention any two advantages of De-Morgan's Theorem**

   Answer:

   (i) It is used in simplifying the Boolean expressions

   (ii) It allows the implementation of same Boolean expression using different logic gates (NAND or NOR).

7. **Define the principle of duality theorem.**

   Answer:

   The principle of duality theorem says that, starting with a Boolean relation, another

   Boolean relation can be derived by using the following procedure:

   a. Changing each OR sign to an AND sign

   b. Changing each AND sign to an OR sign and

   c. Complementing any 0 or 1 appearing in the expression.

8. **Define Boolean expression.**

   Answer:

   Boolean expressions are constructed by connecting the Boolean constants and variables with the Boolean operations. These Boolean expressions are also known as Boolean formulas. We use Boolean expressions to describe switching function or Boolean functions.

   For example, if the Boolean expression (A + B') C is used to describe the function f, then Boolean function is written as

   f (A, B, C) = (A + B') C or f = (A + B') C

9. Simplify the given function: F = A'BC + A'B'C + ABC' + ABC

Answer:

F = A'BC + A'B'C + ABC' + ABC

= A'C (B + B') + AB (C' + C)

= A'C + AB

10..What is sum of product form?

Answer:

A product term is any group of literals that are ANDed together. For example, ABC, XY, and so on. A sum term is any group of literals that are ORed together such as A + B + C, X + Y and so on. A sum of products (SOP) is a group of product terms ORed together. For example,

$$f(A, B, C) = AB + AB'C'$$

11.What is product of sum form?

Answer:

A product of sums (POS) is any groups of sum terms ANDed together. For example,

$$f(A, B, C) = (A + B + C) . (B' + C)$$

12. What is standard SOP and POS forms:

Answer:

If each term in sum of product (SOP) form contains all the literals then the SOP form is known as standard or canonical SOP form.

If each term in Product of sum (POS) form contains all the literals then the POS form is known as standard or canonical POS form.

13.What is min term and max term?

Answer:

Each individual term in standard SOP form is called min term and each individual term in standard POS form is called max term. The concept of min terms and max terms allow us to introduce very convenient shorthand notations to express logical functions.

14.Mention the steps involved in converting SOP to standard SOP.

Answer:

Step 1: Find missing literal in each product term if any.

Step 2: AND each product term having literal (s) with term (s) form by ORing the literal and its complement

Step 3: Expand the terms by applying distributive law and reorder the literals in the product terms.

Step 4: Reduce the expression by omitting repeated product terms if any. Because A + A = A.

15.Convert the given expression in standard SOP form: f (A, B, C) = AC + AB + BC

Answer:

Step 1: Finding missing literal in each product
term AC = Literal B is missing

AB = Literal C is missing
BC = Literal A is missing
Steps 2: AND product term with (missing literal + its complement)
f (A, B, C) = AC (B + B') + AB (C + C') + BC (A + A')

Step 3: Expand the terms and reorder literals
f (A, B, C) = ABC + AB'C + ABC + ABC' + ABC + A'BC

Step 4: Omit repeated product terms (allowing only one time):
f (A, B, C) = <u>ABC</u> + AB'C + <u>ABC</u> + ABC' + <u>ABC</u> + A'BC   Since A + A = A
f (A, B, C) = ABC + AB'C + ABC' + A'BC

16.Define: Don't care conditions.

Answer:

In some logic circuits, certain input conditions never occur; therefore the corresponding output never appears. In such cases the output level is not defined, it can be either HIGH or LOW. These output levels are indicated by 'X' or 'd' in the truth tables and are called don't care outputs or don't care conditions or incompletely specified functions.

17.Define logic gates.

Answer:

Logic gates are the basic elements that make up a digital system. The electronic gate is a circuit that is able to operate on a number of binary inputs in order to perform a particular logical function. The types of gates available are the NOT, AND, OR, NAND, NOR, exclusive-OR, and exclusive-NOR.

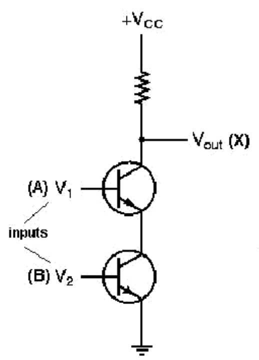
18.Write the Boolean function of an XOR gate give its truth table.

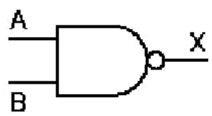
Boolean Expression: Y = AB' + A'B
Truth Table:

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

19. What are Universal gates? Give examples.

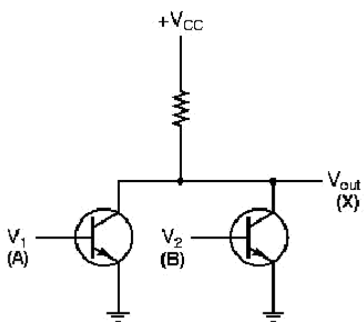
Answer:
The NAND and NOR gates are known as universal gates, since any logic function can be implemented using NAND and NOR gates.

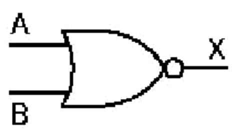




A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

(a) NAND Gate





A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(b) NOR Gate

20.Write the Boolean function of an NAND and NOR gate give its truth table.

a) **NAND Gate:** Boolean Expression: Y = (A.B)’ Truth Table:

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

b) NOR Gate: Boolean Expression: Y = (A+B)’
Truth table:

Input		Output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

21**. Define binary logic?**

Binary logic consists of binary variables and logical operations. The variables are designated by the alphabets such as A, B, C, x, y, z, etc., with each variable having only two distinct values: 1 and 0. There are three basic logic operations: AND, OR, and NOT.

22.What are the basic digital logic gates?

The three basic logic gates are

- AND gate
- OR gate
- NOT gate

23.What is a Logic gate?

Logic gates are the basic elements that make up a digital system. The electronic gate is a circuit that is able to operate on a number of binary inputs in order to perform a particular logical function.

24. Which gates are called as the universal gates? What are its advantages?

The NAND and NOR gates are called as the universal gates. These gates are used to perform any type of logic application.

25. What are basic properties of Boolean algebra?

The basic properties of Boolean algebra are commutative property, associative Property and distributive property.

26. State the associative property of boolean algebra.

The associative property of Boolean algebra states that the OR ing of several variables results in the same regardless of the grouping of the variables. The associative property is stated as follows:

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

27. State the commutative property of Boolean algebra.

The commutative property states that the order in which the variables are OR ed makes no difference. The commutative property is:

A+B=B+A

28. State the distributive property of Boolean algebra.

The distributive property states that AND ing several variables and OR ing the result

With a single variable is equivalent to OR ing the single variable with each of the the several Variables and then AND ing the sums.

The distributive property is: A+BC=(A+B) (A+C)

29.Reduce A (A + B)

A (A + B) = AA + AB = A (1 + B) [1 + B = 1] = A.

30. Reduce A'B'C' + A'BC' + A'BC

A'B'C' + A'BC' + A'BC = A'C'(B' + B) + A'B'C = A'C' + A'BC [A + A' = 1]

= A'(C' + BC)

= A'(C' + B) [A + A'B = A + B]