Introduction to Digital Circuits 2

Truth Table:

- The operations of a logic circuit can be defined by what is called a truth table.
- A truth table lists all the possible combinations of the input variables and shows the relationship between the input variables and the resulting output.
- They grow exponentially in size with the number of variables. A truth table with three input variables has eight rows, 2^3 since there are eight possible valuations of these variables. For four-input variables the truth table has 16 rows, 2^4 ,and so on.

x1	***x2***	***x1*x2***	***x1+x2***
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	1

Types of Logic Gates:

AND Gate

x1
x2

x1 . x2

OR Gate

x1
x2

x1+x2

NOT Gate

x

x’

Boolean Algebra:

- To simplify a function and design a less costly circuit and more efficient circuit we use Boolean Algebra.

If assuming Boolean algebra only takes one of two values, 0 or 1, then the following is true:

1a) $0 * 0 = 0$ *1b)* $1 + 1 = 1$

2a) $1 * 1 = 1$ *2b)* $0 + 0 = 0$

3a) $0 * 1 = 1 * 0 = 0$ *3b)* $1 + 0 = 0 + 1 = 1$

4a) If x = 0 , then x = 1 *4b) If x = 1 , then x = 0*

If assuming Boolean algebra takes one or more variables, then the following terms are true:

1a)	***x + 0 = x***	***1b)***	***x . 1 = x***
2a)	***x + x' = 1***	***2b)***	***x . x' = 0***
3a)	***x + x = x***	***3b)***	***x . x = x***
4a)	***x + 1 = 1***	***4b)***	***x . 0 = 0***
5a)	***(x')' = x***		

Commutative:	***a)***	***x + y = y + x***	***b) xy = yx***
Associative:	***a)***	***x + (y + z) = (x + y) + z***	***b) x(yz) = (xy)z***
Distributive:	***a)***	***x (y + z) = xy + xz***	***b) x + yz = (x+y) . (x+z)***
DeMorgan:	***a)***	***(x + y)' = x' . y'***	***b) (xy)' = x' + y'***
Absorption:	***a)***	***x + xy = x***	***b) x (x+y) = x***

DeMorgan's Law:

- The ***dual*** of an expression is obtained by replacing all addition operators with multiplication operators, and vice versa, and by replacing all 0s with 1s, and vice versa. (DeMorgan law)

- Example:
  Find the complement of the functions F1 =x'yz' +x'y'z and F2 = x(y'z'+yz) by applying DeMorgan's theorem as many times as necessarily

  F1' = (x'yz' +x'y'z)'
  = (x'yz')'(x'y'z)'
  = (x+y'+z)(x+y+z')
  F2' = [x(y'z'+yz)]'
  = x'+(y'z'+yz)'
  = x'+(y'z')'. (yz)'
  = x'+(y+z)(y'+z')

Procedures to represent a function in Sum of minterms and product of maxterms:

- To find the sum of product of a given function from truth table (***SoP)***:
  1. Make the truth table for the function
  2. Look at those rows that function is 1
  3. Write down the corresponding product terms and sum them together to find sum of minterms
- To find the product of sums ***(PoS)***:
  1. From the truth table for the function, ***f***
  2. Find the SoP of the complement of the function, ***f'*** (use the terms whose functional values are 0)
  3. find out ***(f')'*** which will result in f but with product of maxterms

Example of SoP and PoS:

Given the function f= AB + A'C , find its Representation in sum of minterm and product of maxterm.

1. Make the truth table for function by putting the value of function to 1 for those terms that AB=1 or A'C = 1
2. Finding the ***sum of minterms*** form of function:

   f=A'B'C+A'BC+ABC'+ABC
3. Find the complement of function by summing the minterms that are 0 in the function.

   f'=A'B'C'+A'BC'+AB'C'+AB'C
4. Complement **f'** one more time and the result would be **f** in terms of ***Product of maxterm***

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

ABC	**AB**	**A'C**	***f***
000	0	0	0
001	0	1	1
010	0	0	0
011	0	1	1
100	0	0	0
101	0	0	0
110	0	0	1
111	1	0	1

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