(Affiliated To Tribhuvan University)

NIST College
Department of BScCSIT
First Semester
Digital Logic

Tutorial 2

Simplification of Boolean Functions

1. State and prove de-Morgan Theorem.
2. What do you mean by duality principle? Explain with examples.
3. Obtain the simplified expression in sum of products for the following Boolean functions:
   a. $F(x, y, z) = \sum(2,3,6,7)$
   b. $F(A, B, C, D) = \sum(7, 13, 14, 15)$
   c. $F(A, B, C, D) = \sum(4, 6\ 7, 15)$
   d. $F(w, x, y, z) = \sum(2,3,12, 13, 14, 15)$
4. Obtain the simplified expressions in sum of products for the following Boolean functions:
   a. $xy + x'y'z' + x'yz'$
   b. $a'b + bc' + b'c'$
   c. $a'b' + bc + a'bc'$
   d. $xy'z + xyz' + x'yz + xyz$
5. Obtain the simplified expressions in sum of products for the following Boolean Functions:
   a. $D(A' + B) + B'(C + AD)$
   b. $ABC + A'C'D' + A'B + A'CD' + AB'D'$
   c. $kl'm + klm'n' + k'm'n' + lmn'$
   d. $A'B'C'D' + AC'D + B'CD' + A'BCD + BC'D$
   e. $x'z + w'xy' + w(x'y+xy')$
6. Given the following truth table:

X	Y	Z	F_1	F_2
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

   a. Express F_1 and F_2 in product of maxterms.
   b. Obtain the simplified functions in sum of products.
   c. Obtain the simplified functions in product of sums.
7. Obtain the simplified expressions in (1) sum of products and (2) product of sums:
   a. $x'z' + y'z' + yz' + xyz$

b. $(A + B' + D)(A' + B + D)(C + D)\ (C' + D')$
c. $(A' + B' + D')\ (A + B' + C')\ (A' + B + D)\ (B + C' + D')$
d. $(A' + B' + D)\ (A' + D')\ (A + B + D')\ (A + B + C + D)$
e. $w'yz' + vw'z' + vw'z + v'wz + v'w'y'z'$

8. Simplify each of the following functions and implement them with NAND gates:
   a. $F_1 = AC' + ACE + ACE' + A'CD' + A'D'E'$
   b. $F_2 = (B' + D')\ (A' + C' + D)\ (A + B' + C' + D)\ (A' + B + C' + D')$
9. Repeat problem 6 for NOR implementation.
10. Simplify the Boolean function F using the don't care conditions d, in sum of product form:
    a. $F = A'B'D + A'CD + A'B,\ d = A'BC'D + ACD + AB'D'$
    b. $F = w'(x'y + x'y' + xyz) + x'z'(y + w),\ d = w'x(y'z + yz') + x'z'(y + w)$
    c. $F = y' + x'z',\ d = yz + xy$
    d. $F\ (A, B, C) = \sum(0, 1, 2, 5) + D(3, 4, 6)$
    e. $F = \sum(0, 2, 3, 5, 6, 7, 8, 9)\ ,\ d= (10,11, 12, 13, 14, 15)$
    f. $F = \sum(1, 2, 3, 4, 9)\ ,\ d=\sum(10, 11, 12, 13, 14, 15)$
11. Draw the logical diagram of simplified expression obtained in 8, and implement the simplified expressions obtained in 8 using (1) two level NAND gates only, and (2) two level NOR gates only.