

1. Using K maps, obtain the simplified expressions in sum of products for the following functions:

a) $F(x, y, z) = \sum(2, 3, 6, 7)$

b) $F(w, x, y, z) = \sum(2, 3, 12, 13, 14, 15)$

c) $F(x, y, z) = x y + x' y' z' + x' y z'$

d) $F(A, B, C, D) = A' B C' + A' C' D + A B C' D' + B C D'$

e) $F(x, y, z) = \prod(0, 1, 4, 5)$

f) $F(A, B, C, D) = (A + B' + D')(A + B' + C')(A + B + D')(B + C' + D')$

2. Using K maps, obtain the simplified expressions in product of sums for the following functions:

a) $F(A, B, C, D) = \sum(7, 13, 14, 15)$

b) $F(a, b, c) = a' b' + b c + a' b c'$

c) $F(w, x, y, z) = x' z + w' x y' + w(x' y + x y')$

d) $F(A, B, C, D) = \prod(0, 1, 2, 3, 4, 10, 11)$

e) $F(A, B, C, D) = (A + B' + D')(A + B' + C')(A + B + D')(B + C' + D')$

3. Given the following truth table; Obtain the simplified functions in:

A	B	C	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) *Sum of Products.*

b) *Product of Sums.*

4. Simplify each of the following functions and implement them with NAND gates only.

a) $F(A, B, C, D, E) = A C' + A C E + A C E' + A' C D' + A' D' E'$

b) $F(A, B, C, D) = (B' + D')(A' + C' + D)(A + B' + C' + D)(A' + B + C' + D)$

5. Repeat Problem 4, using NOR gates only.

6. Implement the following functions with NAND gates only. Both the normal and complement inputs are available.

a) $F(A, B, C, D) = B D + B C D + A B' C' D' + A' B' C D'$ *with no more than 3-inputs six gates.*

b) $F(A, B, C, D) = (A B + A' B')(C D' + C' D)$ *with 2-input gates.*

7. Simplify the Boolean function F using (i) Sum of products (ii) Product of sums:

a) $F(A, B, C, D) = \sum m(0, 2, 3, 6, 7) + d(5, 8, 10, 11, 15)$

b) $F(w, x, y, z) = \sum m(0, 2, 3, 7, 8, 10) + d(5, 6, 11, 15)$

8. Implement the following functions using the given don't care conditions d. Assume that both normal and complement inputs are available.

a) $F(A, B, C, D) = A'B'C' + AB'D + A'B'CD'$, $d = ABC + AB'D'$ with no more than 2 NOR gates.

b) $F(A, B, C, D) = (A + D)(A' + B)(A' + C)$ with no more than three NAND gates.

c) $F(A, B, C, D) = B'D + B'C + ABCD$, $d = A'BD + AB'C'D'$ with NAND gates.

9. The Boolean expression $BE + B'DE'$ is a simplified version of the expression:

$$A'BE + BCDE + BC'D'E + A'B'DE' + B'C'DE'$$

Are there any don't care conditions? If so, what are they?

10. Implement the following function with either NAND or NOR gates. Use only four gates. Normal inputs are available only. d is the don't care conditions.

$$f = A'BD + A'CD + A'CD' + ABC'D, \quad d = ACD$$