

Textbook problems

Simplify the following Boolean Functions using three-variable maps.

1. Problem 1-8(b)

b. $F(x, y, z) = E(1, 2, 3, 6, 7)$

| x\yz | 00 | 01 | 11 | 10 |
|------|----|----|----|----|
| 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 |

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

2. Problem 1-8(c)

c. $F(x, y, z) = E(3, 5, 6, 7)$

| x\yz | 00 | 01 | 11 | 10 |
|------|----|----|----|----|
| 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 |

$$F(x, y, z) = xy + yz + xz$$

Simplify The following Boolean Functions Using four-variable maps.

3. Problem 1-9(b)

b. $F(A, B, C, D) = E(3, 7, 11, 13, 14, 15)$

| AB\CD | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 0 | 0 | 1 | 0 |
| 01 | 0 | 0 | 1 | 0 |
| 11 | 0 | 1 | 1 | 1 |
| 10 | 0 | 0 | 1 | 0 |

$$F(A, B, C, D) = ABD + CD + ABC$$

4. Problem 1-9(d)

d. $F(A, B, C, D) = E(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$

| AB\CD | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 1 | 0 | 0 | 1 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 0 | 1 | 1 | 0 |
| 10 | 1 | 0 | 0 | 1 |

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

5. Problem 1-11

Simplify The following Boolean function in sum-of-products form by means of a four-variable map. Draw the logic diagram with (a) AND-OR gates; (b) NAND gates.

$$F(A, B, C, D) = \Sigma (0, 2, 8, 9, 10, 11, 14, 15)$$

| AB\CD | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 1 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |

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

6. Problem 1-12

Simplify the following Boolean function in product-of-sums form by means of a four-variable map. Draw the logic diagram with (a) OR-AND gates; (b) NOR gates.

$$F(w, x, y, z) = \Sigma (2, 3, 4, 5, 6, 7, 11, 14, 15)$$

| wx\yz | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 0 | 0 | 1 | 1 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 0 | 0 | 1 | 1 |
| 10 | 0 | 0 | 1 | 0 |

$$F(A, B, C, D) = (w+x+y)(w'+y)(w'+x+z)$$

7. Problem 1-13

Simplify The Boolean function Together with the don't-care conditions d in (1) sum-of-products form and (2) product-of-sums form.

$$F(w, x, y, z) = \Sigma (0, 1, 2, 3, 7, 8, 10)$$

$$d(w, x, y, z) = \Sigma (5, 6, 11, 15)$$

| AB\CD | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 1 | 1 | 1 | 1 |
| 01 | 0 | X | 1 | X |
| 11 | 0 | 0 | X | 1 |
| 10 | 1 | 0 | X | 0 |

$$(1) F(w, x, y, z) = A'B' + CD + B'C'D' + BC$$

$$(2) F(w, x, y, z) = (B'+C)(A'+D')(A'+B+C')$$

Boolean expression simplify

8. Simplify the following Boolean expression using two-variable Karnaugh maps:

(Hint: Write a truth table for the function and then use Karnaugh map to simplify)

a. $F(x, y) = x'y' + yy + x'yy'$

| x | y | x'y' | yy | x'yy' | x'y' + yy + x'yy' |
|---|---|------|----|-------|-------------------|
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |

| x\y | 0 | 1 |
|-----|---|---|
| 0 | 1 | 1 |
| 1 | 0 | 1 |

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

b. $F(x, y) = xy + x'y'y' + x'yy'$

| x | y | xy | x'y'y' | x'yy' | xy + x'y'y' + x'yy' |
|---|---|----|--------|-------|---------------------|
| 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 |

| x\y | 0 | 1 |
|-----|---|---|
| 0 | 1 | 1 |
| 1 | 0 | 1 |

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

9. Simplify the following Boolean expression using three-variable Karnaugh maps:
(Hint: Write a truth table for the function and then use Karnaugh map to simplify)

a. $F(A, B, C) = A'BC + A'BC' + AB'C' + AB'C$

| A | B | C | A'BC | A'BC' | AB'C' | AB'C | A'BC + A'BC' + AB'C' + AB'C |
|---|---|---|------|-------|-------|------|-----------------------------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

| A\BC | 00 | 01 | 11 | 10 |
|------|----|----|----|----|
| 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |

$F(x, y) = AB' + A'B$

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

| A | B | C | A'B | BC' | B'C' | A'B + BC' + B'C' |
|---|---|---|-----|-----|------|------------------|
| 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| A\BC | 00 | 01 | 11 | 10 |
|------|----|----|----|----|
| 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 |

$F(x, y) = B'C' + BC + A'B$

10. Simplify the following Boolean expression using four-variable Karnaugh maps:

$F(A, B, C, D) =$

$$A'B'C'D' + A'B'C'D + A'B'CD + A'BC'D' + A'BC'D + A'BCD + ABC'D' + ABC'D + ABCD$$

0000 0001 0011 0100 0101 0111 1100 1101 1111

AB\CD 00 01 11 10

00 1 1 1 0

01 1 1 1 0

11 1 1 1 0

10 0 0 0 0

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

11. Simplify the following Boolean functions using Karnaugh map

a. $F(X, Y, Z) = \sum m(3, 4, 6, 7)$

X\YZ 00 01 11 10

0 0 0 1 0

1 1 0 1 1

$$F(X, Y, Z) = XZ' + YZ$$

b. $F(X, Y, Z) = \sum m(0, 2, 4, 5, 6)$

X\YZ 00 01 11 10

0 1 0 0 1

1 1 1 0 1

$$F(X, Y, Z) = Z' + XY'$$

c. $F(W, X, Y, Z) = \sum m(0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14)$

WX\YZ 00 01 11 10

00 1 1 0 1

01 1 1 0 1

11 1 1 0 1

10 1 1 0 0

$$F(W, X, Y, Z) = Y' + W'Z' + XZ'$$

d. $F(A, B, C, D) = \sum m(1, 3, 7, 11, 15)$ and $d(A, B, C, D) = \sum m(0, 2, 5)$

AB\CD 00 01 11 10

00 X 1 1 X

01 0 X 1 0

11 0 0 1 0

10 0 0 1 0

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

e. $F(w, x, y, z) = \Sigma m(1, 4, 5, 6, 12, 14, 15)$

| wx\yz | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 0 | 1 | 0 | 0 |
| 01 | 1 | 1 | 0 | 1 |
| 11 | 1 | 0 | 1 | 1 |
| 10 | 0 | 0 | 0 | 0 |

$F(w, x, y, z) = xy'z' + w'y'z + wxy + xyz'$

12. Simplify the following expressions in (1) sum of products and (2) product of sums:

(Hint: Write a truth table for the function and then use Karnaugh map to simplify)

a. $F(x, y) = x'y' + y'y' + yy' + xy$

| | 00 | 01 | 11 |
|-----|----|----|----|
| x\y | 0 | 1 | |
| 0 | 1 | 0 | |
| 1 | 0 | 1 | |

(1) $F(x, y) = x'y' + xy$

(2) $F(x, y) = (x'+y)(x+y')$

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

| A | B | C | D | 1 | 2 | 3 | 4 | F |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

| AB\CD | 00 | 01 | 11 | 10 |
|-------|----|----|----|----|
| 00 | 1 | 1 | 0 | 1 |
| 01 | 1 | 1 | 0 | 0 |
| 11 | 1 | 0 | 0 | 1 |
| 10 | 0 | 1 | 0 | 1 |

(1) $F(A, B, C, D) = A'C' + ABD' + B'CD' + ABD + B'C'D$

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