

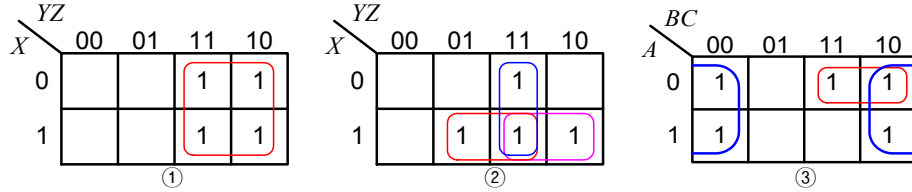
# 디지털논리회로

이론, 실습, 시뮬레이션

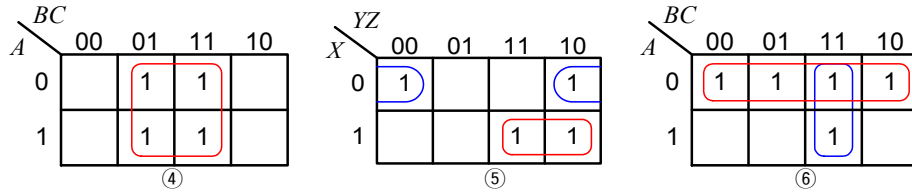
(Problem Solutions of Chapter 6)

### 1. 3변수 카르노 맵을 이용한 간소화

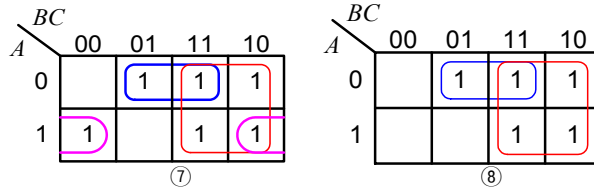
- ①  $F(X, Y, Z) = \Sigma m(2, 3, 6, 7) = Y$   
 ②  $F(X, Y, Z) = \Sigma m(3, 5, 6, 7) = XY + YZ + ZX$   
 ③  $F(A, B, C) = \Sigma m(0, 2, 3, 4, 6) = \overline{A}B + \overline{C}$



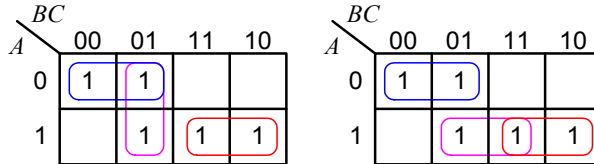
- ④  $F(A, B, C) = \Sigma m(1, 3, 5, 7) = C$   
 ⑤  $F(X, Y, Z) = XY + Y\overline{Z} + \overline{X}Y\overline{Z} = XY + \overline{X}\overline{Z}$   
 ⑥  $F(A, B, C) = \overline{A}\overline{B} + BC + \overline{A}B\overline{C} = \overline{A} + BC$



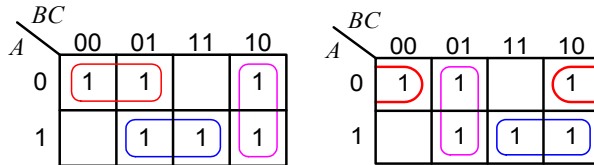
- ⑦  $F(A, B, C) = \Sigma m(1, 2, 3, 4, 6, 7) = A\overline{C} + \overline{A}C + B = (A \oplus C) + B$   
 ⑧  $F(A, B, C) = \Sigma m(1, 2, 3, 6, 7) = B + \overline{A}C$



- ⑨  $F(A, B, C) = \Sigma m(0, 1, 5, 6, 7) = AB + \overline{A}\overline{B} + AC = AB + \overline{A}\overline{B} + \overline{B}C$



- ⑩  $F(A, B, C) = \Sigma m(0, 1, 2, 5, 6, 7) = \overline{A}\overline{B} + AC + B\overline{C} = AB + \overline{A}\overline{C} + \overline{B}C$

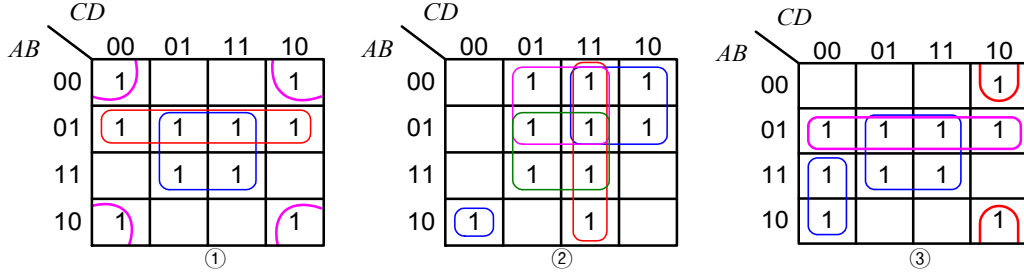


### 2. 4변수 카르노 맵을 이용한 간소화

- ①  $F(A, B, C, D) = \Sigma m(0, 2, 4, 5, 6, 7, 8, 10, 13, 15)$   
 $F(A, B, C, D) = \overline{A}B + BD + \overline{B}\overline{D}$   
 ②  $F(A, B, C, D) = \Sigma m(1, 2, 3, 5, 6, 7, 8, 11, 13, 15)$   
 $F(A, B, C, D) = \overline{A}C + \overline{A}D + BD + CD + \overline{A}\overline{B}\overline{C}\overline{D}$

③  $F(A,B,C,D) = \Sigma m(2,4,5,6,7,8,10,12,13,15)$

$$F(A,B,C,D) = \overline{A}B + BD + A\overline{C}\overline{D} + \overline{B}C\overline{D}$$



④  $F(A,B,C,D) = \Sigma m(0,1,2,3,4,5,6,8,9,10,12,15)$

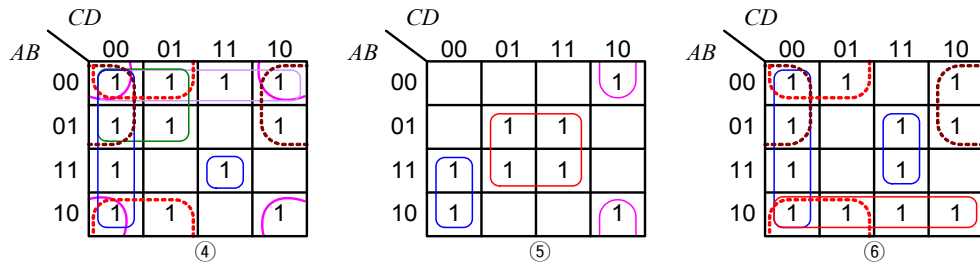
$$F(A,B,C,D) = \overline{A}\overline{B} + \overline{A}C + \overline{A}\overline{D} + \overline{B}C + \overline{B}\overline{D} + \overline{C}\overline{D} + ABCD$$

⑤  $F(A,B,C,D) = \Sigma m(2,5,7,8,10,12,13,15)$

$$F(A,B,C,D) = A\overline{C}\overline{D} + BD + \overline{B}C\overline{D}$$

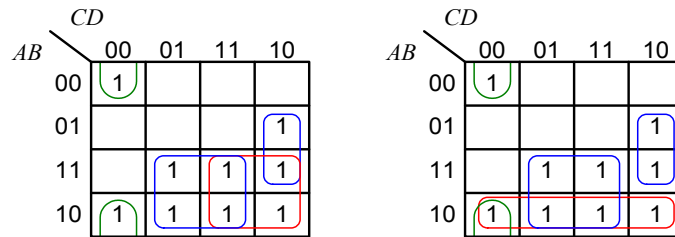
⑥  $F(A,B,C,D) = \Sigma m(0,1,2,4,6,7,8,9,10,11,12,15)$

$$F(A,B,C,D) = \overline{A}\overline{B} + \overline{A}\overline{D} + \overline{B}C + CD + BCD$$



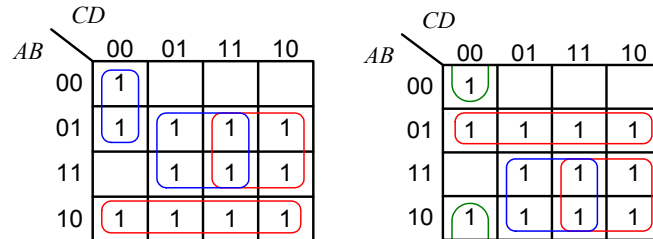
⑦  $F(A,B,C,D) = \Sigma m(0,6,8,9,10,11,13,14,15)$  (2가지 답)

$$F(A,B,C,D) = AC + AD + B\overline{C}\overline{D} + \overline{B}C\overline{D} = \overline{A}\overline{B} + AD + B\overline{C}\overline{D} + \overline{B}C\overline{D}$$



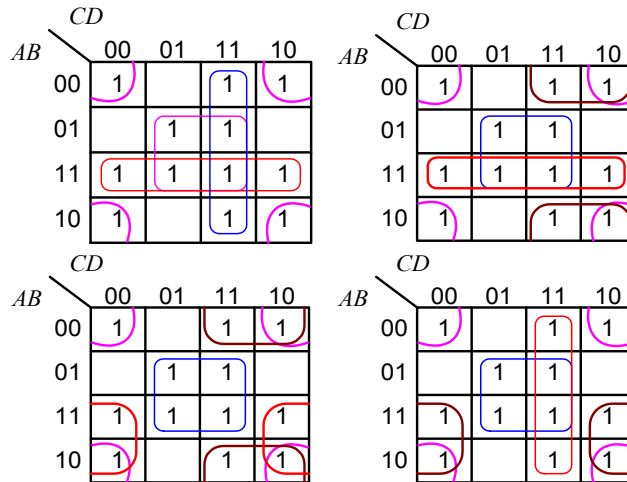
⑧  $F(A,B,C,D) = \Sigma m(0,4,5,6,7,8,9,10,11,13,14,15)$  (2가지 답)

$$F(A,B,C,D) = \overline{A}\overline{B} + BC + BD + A\overline{C}\overline{D} = \overline{A}\overline{B} + AC + AD + \overline{B}C\overline{D}$$



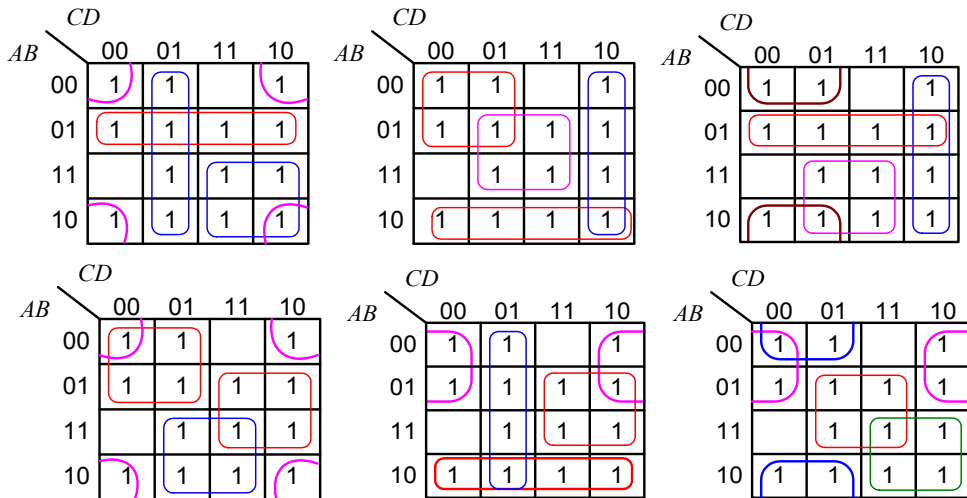
⑨  $F(A,B,C,D) = \Sigma m(0,2,3,5,7,8,10,11,12,13,14,15)$  (4가지 답)

$$\begin{aligned} F(A,B,C,D) &= \overline{A}\overline{B} + BD + CD + \overline{B}\overline{D} = \overline{A}\overline{B} + \overline{B}C + BD + \overline{B}\overline{D} \\ &= \overline{A}\overline{D} + \overline{B}C + BD + \overline{B}\overline{D} = \overline{A}\overline{D} + BD + \overline{B}\overline{D} + CD \end{aligned}$$



⑩  $F(A,B,C,D) = \Sigma m(0,1,2,4,5,6,7,8,9,10,11,13,14,15)$  (6가지 답)

$$\begin{aligned} F(A,B,C,D) &= \overline{A}B + AC + \overline{B}\overline{D} + \overline{C}D = \overline{A}\overline{B} + \overline{A}\overline{C} + BD + \overline{C}\overline{D} \\ &= \overline{A}B + \overline{A}D + \overline{B}C + \overline{C}D = \overline{A}\overline{C} + AD + BC + \overline{B}\overline{D} \\ &= \overline{A}B + \overline{A}D + BC + \overline{C}D = AC + BD + \overline{A}\overline{D} + \overline{B}\overline{C} \end{aligned}$$

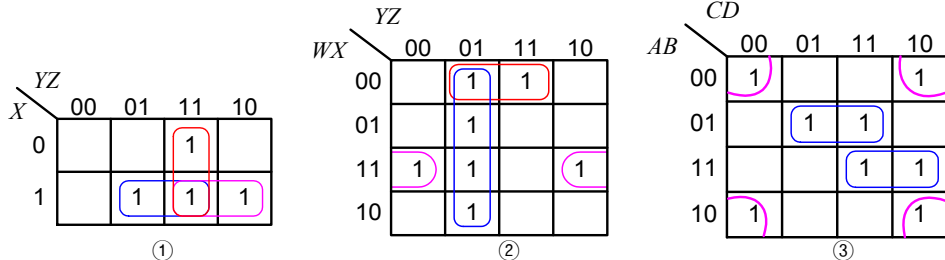


### 3. 카르노 맵에 의한 간소화

①  $F = XY + YZ + \overline{X}\overline{Y}Z = XY + YZ + XZ$

②  $F = \overline{Y}Z + WX\overline{Y} + WX\overline{Z} + \overline{W}\overline{X}Z = \overline{Y}Z + \overline{W}\overline{X}Z + WX\overline{Z}$

③  $F = ABC + \overline{B}\overline{D} + \overline{A}BD = ABC + \overline{A}BD + \overline{B}\overline{D}$  (간소화 되지 않음)



④  $F = \overline{A}D + BD + \overline{B}C + \overline{A}\overline{B}D = D + \overline{B}C$

⑤  $F = \bar{X}Z + \bar{W}X\bar{Y} + W(\bar{X}Y + X\bar{Y}) = W\bar{X}Y + X\bar{Y} + \bar{X}Z$

⑥  $F = ABC + CD + \bar{B}\bar{C}D + \bar{B}C = AC + \bar{B}C + BD$

④

		CD	00	01	11	10
AB	00			1	1	1
	01			1	1	
	11			1	1	
	10			1	1	1

⑤

		YZ	00	01	11	10
WX	00			1	1	
	01		1	1		
	11		1	1		
	10			1	1	1

⑥

		CD	00	01	11	10
AB	00				1	1
	01			1	1	
	11			1	1	1
	10				1	1

⑦  $F = \bar{A}\bar{B}C + \bar{B}\bar{C}D + BCD + AC\bar{D} + \bar{A}\bar{B}C + \bar{A}B\bar{C}D = AC + \bar{A}BD + \bar{B}\bar{D} + CD$

⑧  $F = \bar{W}YZ + X\bar{Y}Z + WY + WX\bar{Y}\bar{Z} + WZ + XY\bar{Z}$   
 $= WX + WY + WZ + XY + XZ + YZ$

⑦

		CD	00	01	11	10
AB	00		1		1	1
	01			1	1	
	11				1	1
	10		1		1	1

⑧

		YZ	00	01	11	10
WX	00				1	
	01		1	1	1	1
	11		1	1	1	1
	10		1	1	1	1

#### 4. 무관조건을 고려한 카르노 맵을 이용한 간소화

①  $F(A,B,C) = \Sigma m(0,1,2,4,5) + \Sigma d(3,6,7)$   
 $F(A,B,C) = 1$

②  $F(A,B,C,D) = \Sigma m(0,6,8,13,14) + \Sigma d(2,4,10)$   
 $F(A,B,C,D) = \bar{B}\bar{D} + \bar{C}\bar{D} + AB\bar{C}D$

③  $F(A,B,C,D) = \Sigma m(1,3,5,7,9,15) + \Sigma m(4,6,12,13)$   
 $F(A,B,C,D) = \bar{A}D + BD + \bar{C}D$

①

		BC	00	01	11	10
A	0		1	1	x	1
	1		1	1	x	x

②

		CD	00	01	11	10
AB	00		1			x
	01		x			1
	11			1		1
	10		1			x

③

		CD	00	01	11	10
AB	00			1	1	
	01		x	1	1	x
	11		x	x	1	
	10			1		

④  $F(A,B,C,D) = \Sigma m(0,1,2,3,7,8,10) + \Sigma d(5,6,11,15)$   
 $F(A,B,C,D) = \bar{A}D + \bar{B}\bar{D}$

⑤  $F(A,B,C,D) = \Sigma m(3,4,13,15) + \Sigma d(1,2,5,6,8,10,12,14)$   
 $F(A,B,C,D) = AB + \bar{B}\bar{C} + \bar{A}\bar{B}C$

		CD			
	AB	00	01	11	10
00		1	1	1	1
01			x	1	x
11				x	
10		1		x	1

④

		CD			
	AB	00	01	11	10
00			x	1	x
01		1	x		x
11		x	1	1	x
10		x			x

⑤

⑥  $F(A,B,C,D) = \Sigma m(1,3,5,6,7,13,14) + \Sigma d(8,10,12)$  (2가지 답)

$$F(A,B,C,D) = \overline{A}D + B\overline{C}\overline{D} + A\overline{B}\overline{C} = \overline{A}D + B\overline{C}\overline{D} + \overline{B}\overline{C}D$$

		CD			
	AB	00	01	11	10
00			1	1	
01			1	1	1
11		x	1		1
10		x			x

		CD			
	AB	00	01	11	10
00			1	1	
01			1	1	1
11		x	1		1
10		x			x

⑦  $F(A,B,C,D) = \Sigma m(3,8,10,13,15) + \Sigma d(0,2,5,7,11,12,14)$  (8가지 답)

$$\begin{aligned} F(A,B,C,D) &= BD + \overline{B}\overline{D} + CD = AB + \overline{B}\overline{D} + CD = AB + \overline{A}\overline{D} + CD = \overline{A}\overline{D} + BD + CD \\ &= AB + \overline{B}C + \overline{B}\overline{D} = \overline{B}C + BD + \overline{B}\overline{D} = \overline{A}\overline{D} + \overline{B}C + BD = AB + \overline{A}\overline{D} + \overline{B}C \end{aligned}$$

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

		CD			
	AB	00	01	11	10
00		x		1	x
01			x	x	
11		x	1	1	x
10		1		x	1

⑧  $F(A,B,C,D) = \Sigma m(4,6,9,10,11,12,13,14) + \Sigma d(2,5,7,8)$  (3가지 답)

$$F(A,B,C,D) = \overline{A}\overline{B} + \overline{B}\overline{C} + \overline{C}\overline{D} = \overline{A}\overline{B} + \overline{B}\overline{C} + \overline{B}\overline{D} = \overline{A}\overline{B} + \overline{A}\overline{C} + \overline{B}\overline{D}$$

CD \ AB	00	01	11	10
00				x
01	1	x	x	1
11	1	1		1
10	x	1	1	1

CD \ AB	00	01	11	10
00				x
01	1	x	x	1
11	1	1		1
10	x	1	1	1

CD \ AB	00	01	11	10
00				x
01	1	x	x	1
11	1	1		1
10	x	1	1	1

⑨  $F(A,B,C,D) = \Sigma m(1,3,6,8,11,14) + \Sigma d(2,4,5,13,15)$  (3가지 답)

$$F(A,B,C,D) = ACD + \bar{A}\bar{B}D + B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} = \bar{A}\bar{B}D + \bar{B}\bar{C}\bar{D} + B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D}$$

$$= \bar{A}\bar{C}\bar{D} + \bar{B}\bar{C}\bar{D} + B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D}$$

CD \ AB	00	01	11	10
00		1	1	x
01	x	x		1
11		x	x	1
10	1		1	

CD \ AB	00	01	11	10
00		1	1	x
01	x	x		1
11		x	x	1
10	1		1	

CD \ AB	00	01	11	10
00		1	1	x
01	x	x		1
11		x	x	1
10	1		1	

⑩  $F(A,B,C,D) = \Sigma m(0,2,3,5,7,8,9,10,11) + \Sigma d(4,15)$  (3가지 답)

$$F(A,B,C,D) = \bar{A}\bar{B} + \bar{B}\bar{D} + CD + \bar{A}BD = \bar{A}\bar{B} + \bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}BD = \bar{A}\bar{B} + \bar{B}\bar{D} + CD + \bar{A}\bar{B}\bar{C}$$

CD \ AB	00	01	11	10
00	1		1	1
01	x	1	1	
11			x	
10	1	1	1	1

CD \ AB	00	01	11	10
00	1		1	1
01	x	1	1	
11			x	
10	1	1	1	1

CD \ AB	00	01	11	10
00	1		1	1
01	x	1	1	
11			x	
10	1	1	1	1

⑪  $F(A,B,C,D) = \Sigma m(0,2,4,5,10,12,15) + \Sigma d(8,14)$  (2가지 답)

$$F(A,B,C,D) = \bar{B}\bar{D} + \bar{C}\bar{D} + \bar{A}\bar{B}\bar{C} + ABC = \bar{B}\bar{D} + \bar{B}\bar{D} + \bar{A}\bar{B}\bar{C} + ABC$$

CD \ AB	00	01	11	10
00	1			1
01	1	1		
11	1		1	x
10	x			1

CD \ AB	00	01	11	10
00	1			1
01	1	1		
11	1		1	x
10	x			1

⑫  $F(A,B,C,D) = \Sigma m(5,7,9,11,13,14) + \Sigma d(2,6,10,12,15)$  (4가지 답)

$$F(A,B,C,D) = AD + BD + CD = AD + BD + AB = AD + BD + AC = AD + BD + BC$$

CD \ AB	00	01	11	10
00				x
01		1	1	x
11	x	1	x	1
10		1	1	x

CD \ AB	00	01	11	10
00				x
01		1	1	x
11	x	1	x	1
10		1	1	x

		CD			
AB		00	01	11	10
	00				x
	01		1	1	x
	11	x	1	x	1
	10		1	1	x

		CD			
AB		00	01	11	10
	00				x
	01		1	1	x
	11	x	1	x	1
	10		1	1	x

## 5. POS 형태의 간소화

①  $F(X, Y, Z) = \Sigma m(2, 3, 6, 7) = Y$

②  $F(X, Y, Z) = \Sigma m(3, 5, 6, 7) = (X + Y)(Y + Z)(Z + X)$

		YZ			
X		00	01	11	10
	0	0	0		
	1	0	0		

①

		YZ			
X		00	01	11	10
	0	0	0		0
	1	0			

②

③  $F(X, Y, Z) = \Sigma m(0, 2, 3, 4, 6) = (Y + \bar{Z})(\bar{X} + \bar{Z})$

④  $F(X, Y, Z) = \Sigma m(1, 3, 5, 7) = Z$

		YZ			
X		00	01	11	10
	0		0		
	1		0	0	

③

		YZ			
X		00	01	11	10
	0	0			0
	1	0			0

④

⑤  $F(A, B, C, D) = \Pi M(1, 3, 5, 7, 13, 15) = (\bar{A} + B)D$

⑥  $F(W, X, Y, Z) = \Sigma m(0, 2, 5, 6, 7, 8, 10) = (\bar{W} + \bar{X})(X + \bar{Z})(\bar{X} + Y + Z)$

⑦  $F(A, B, C, D) = \Sigma m(0, 2, 4, 5, 6, 7, 8, 10, 13, 15) = (B + \bar{D})(\bar{A} + \bar{B} + D)$

		CD			
AB		00	01	11	10
	00	0			0
	01	0			0
	11	0			0
	10	0	0	0	0

⑤

		YZ			
WX		00	01	11	10
	00		0	0	
	01	0			
	11	0	0	0	0
	10		0	0	

⑥

		CD			
AB		00	01	11	10
	00		0	0	
	01				
	11	0			0
	10		0	0	

⑦

⑧  $F(A, B, C, D) = \Sigma m(0, 2, 3, 5, 7, 8, 10, 11, 14, 15) = (\bar{A} + \bar{B} + C)(A + \bar{B} + D)(B + C + \bar{D})$

⑨  $F(A, B, C, D) = \Sigma m(1, 3, 5, 10, 11, 12, 13, 14, 15) = (A + D)(A + \bar{B} + \bar{C})(\bar{A} + B + C)$

		CD			
AB		00	01	11	10
	00		0		
	01	0			0
	11	0	0		
	10		0		

⑧

		CD			
AB		00	01	11	10
	00	0			0
	01	0		0	0
	11				
	10	0	0		

⑨



## 6. SOP와 POS 형태의 간소화

①  $F = (AB + C)(B + \overline{CD})$

		CD			
AB		00	01	11	10
00					
01				1	1
11		1	1	1	1
10					

		CD			
AB		00	01	11	10
00		0	0	0	0
01		0	0		
11					
10		0	0	0	0

$SOP = AB + BC, \quad POS = \overline{\overline{B} + \overline{AC}} = B(A + C)$

②  $F = \overline{X} + X(X + \overline{Y})(Y + \overline{Z})$

		YZ			
X		00	01	11	10
0		1	1	1	1
1		1		1	1

		YZ			
X		00	01	11	10
0					
1			0		

$SOP = \overline{X} + X(X + \overline{Y})(Y + \overline{Z}) = \overline{X} + Y + \overline{Z}, \quad POS = \overline{\overline{X} \overline{Y} \overline{Z}} = \overline{X} + Y + \overline{Z}$

③  $F = A\overline{C} + \overline{B}D + \overline{A}CD + ABCD$

		CD			
AB		00	01	11	10
00			1	1	
01				1	
11		1	1	1	
10		1	1	1	

		CD			
AB		00	01	11	10
00		0			0
01		0	0		0
11					0
10					0

$SOP = A\overline{C} + \overline{B}D + CD$   
 $POS = (A + D)(\overline{C} + D)(A + \overline{B} + C)$

④  $F = (\overline{A} + \overline{B} + \overline{D})(A + \overline{B} + \overline{C})(\overline{A} + B + \overline{D})(B + \overline{C} + \overline{D})$

		CD			
AB		00	01	11	10
00				0	
01				0	0
11			0	0	
10			0	0	

		CD			
AB		00	01	11	10
00		1	1		1
01		1	1		
11		1			1
10		1			1

$SOP = \overline{A}\overline{C} + \overline{A}\overline{D} + \overline{B}\overline{D}$   
 $POS = (\overline{A} + \overline{D})(\overline{C} + \overline{D})(A + \overline{B} + \overline{C})$

⑤  $F = (\overline{A} + \overline{B} + D)(\overline{A} + \overline{D})(A + B + \overline{D})(A + \overline{B} + C + D)$

		CD			
AB		00	01	11	10
00			0	0	
01		0			
11		0	0	0	0
10			0	0	

		CD			
AB		00	01	11	10
00		1			1
01			1	1	1
11					
10		1			1

$$SOP = \overline{A}BC + \overline{A}BD + \overline{B}\overline{D}$$

$$POS = (\overline{A} + \overline{B})(B + \overline{D})(\overline{B} + C + D)$$

## 7. SOP 표현

①  $f = (a+b+c+\overline{d})(b+\overline{c}+d)(a+c)$

$$f = \overline{\overline{(a+b+c+\overline{d})(b+\overline{c}+d)(a+c)}} = \overline{\overline{a}\overline{b}\overline{c}d + \overline{b}cd + \overline{a}\overline{c}} = \Sigma m(0,1,2,4,5,10)$$

$$= \Sigma m(3,6,7,8,9,11,12,13,14,15) = \overline{a}\overline{c} + bc + cd$$

		$cd$			
		00	01	11	10
$ab$	00			1	
	01			1	1
	11	1	1	1	1
	10	1	1	1	

②  $f = (\overline{a}+b+\overline{c})(b+\overline{c}+d)(\overline{b}+\overline{d})$

$$f = \overline{\overline{(\overline{a}+b+\overline{c})(b+\overline{c}+d)(\overline{b}+\overline{d})}} = \overline{\overline{a}\overline{b}c + \overline{b}cd + bd} = \Sigma m(2,5,7,10,11,13,15)$$

$$= \Sigma m(0,1,3,4,6,8,9,12,14) = \overline{a}\overline{b}d + \overline{b}\overline{c} + bd$$

		$cd$			
		00	01	11	10
$ab$	00	1	1	1	
	01	1			1
	11	1			1
	10	1	1		

③  $f = (\overline{w}+x)(y+z)(\overline{w}+y)(x+\overline{y}+z)$

$$f = \overline{\overline{(\overline{w}+x)(y+z)(\overline{w}+y)(x+\overline{y}+z)}} = \overline{\overline{w}\overline{x} + \overline{y}z + w\overline{y} + x\overline{y}z}$$

$$= \Sigma m(0,2,4,8,9,10,11,12,13) = \Sigma m(1,3,5,6,7,14,15) = xy + \overline{w}z$$

		$yz$			
		00	01	11	10
$wx$	00		1	1	
	01		1	1	1
	11			1	1
	10				

④  $F = (A+B+C)(\overline{B}+C+D)(A+\overline{B}+D)(B+\overline{C}+\overline{D})$

$$F = \overline{\overline{(A+B+C)(\overline{B}+C+D)(A+\overline{B}+D)(B+\overline{C}+\overline{D})}}$$

$$= \overline{\overline{A}\overline{B}C + \overline{B}\overline{C}D + \overline{A}B\overline{D} + \overline{B}CD}} = \Sigma m(0,1,3,4,6,11,12)$$

$$= \Sigma m(2,5,7,8,9,10,13,14,15) = \overline{A}\overline{B}C + A\overline{C}D + \overline{B}CD + BD$$

		CD			
AB		00	01	11	10
	00				1
	01		1	1	
	11		1	1	1
	10	1	1		1

## 8. SOP를 POS로 변환

①  $F = AC + \overline{A}\overline{D}$

$$F = A(B + \overline{B})C(D + \overline{D}) + \overline{A}(B + \overline{B})(C + \overline{C})\overline{D} = \Sigma m(0, 2, 4, 6, 10, 11, 14, 15)$$

$$= \Pi M(0, 2, 4, 6, 10, 11, 14, 15) = \Pi M(1, 3, 5, 7, 8, 9, 12, 13) = (\overline{A} + C)(\overline{A} + \overline{D})$$

		CD			
AB		00	01	11	10
	00		0	0	
	01		0	0	
	11	0	0		
	10	0	0		

②  $f = \overline{w}xy + wxy + xz$

$$f = \overline{w}xy(z + \overline{z}) + wxy(z + \overline{z}) + (w + \overline{w})x(y + \overline{y})z = \Sigma m(4, 5, 7, 13, 14, 15)$$

$$= \Pi M(0, 1, 2, 3, 6, 8, 9, 10, 11, 12) = x(\overline{w} + y + z)(w + \overline{y} + z)$$

		yz			
wx		00	01	11	10
	00	0	0	0	0
	01				0
	11	0			
	10	0	0	0	0

③  $f = \overline{b}cd + \overline{a}\overline{b}d + \overline{b}c\overline{d}$

$$f = (a + \overline{a})\overline{b}cd + \overline{a}\overline{b}(c + \overline{c})d + (a + \overline{a})\overline{b}c\overline{d} = \Sigma m(1, 2, 3, 5, 10, 13)$$

$$= \Pi M(1, 2, 3, 5, 10, 13) = \Pi M(0, 4, 6, 7, 8, 9, 11, 12, 14, 15) = (\overline{a} + b + \overline{d})(\overline{b} + \overline{c})(c + d)$$

		cd			
ab		00	01	11	10
	00	0			
	01	0		0	0
	11	0		0	0
	10	0	0	0	

## 9. SOP 및 POS의 최소항과 최대항 표현

①  $F(A, B, C, D) = \Sigma m(2, 3, 5, 7, 10, 13, 14, 15)$  (답 : SOP 1개, POS 1개)

$$SOP = A\overline{C}\overline{D} + \overline{A}\overline{B}C + BD$$

$$POS = (\overline{A} + B + \overline{D})(A + \overline{B} + D)(B + C)(C + D)$$

		CD			
		00	01	11	10
AB	00			1	1
	01		1	1	
	11		1	1	1
	10				1

		CD			
		00	01	11	10
AB	00	0	0		
	01	0			0
	11	0			
	10	0	0	0	

②  $F(A,B,C,D) = \Sigma m(3,4,9,13,14,15) + \Sigma d(2,5,10,12)$  (답 : SOP 1개, POS 2개)

$$SOP = AB + B\bar{C} + A\bar{C}D + \bar{A}\bar{B}C$$

$$POS = (B+D)(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})(A+C+\bar{D})$$

$$= (B+D)(A+B+C)(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})$$

		CD			
		00	01	11	10
AB	00			1	x
	01	1	x		
	11	x	1	1	1
	10		1		x

		CD			
		00	01	11	10
AB	00	0	0		x
	01		x	0	0
	11	x			
	10	0		0	x

		CD			
		00	01	11	10
AB	00	0	0		x
	01		x	0	0
	11	x			
	10	0		0	x

③  $F(A,B,C,D) = \Sigma m(4,6,11,12,13) + \Sigma d(3,5,7,9,10,15)$  (답 : SOP 2개, POS 8개)

$$SOP = \bar{A}B + B\bar{C} + CD = \bar{A}B + B\bar{C} + AD$$

$$POS = (A+B)(B+C)(\bar{A}+\bar{B}+\bar{C}) = (A+\bar{D})(B+D)(\bar{A}+\bar{B}+\bar{C})$$

$$= (B+C)(B+D)(\bar{A}+\bar{B}+\bar{C}) = (A+B)(B+D)(\bar{A}+\bar{B}+\bar{C})$$

$$= (A+B)(B+C)(\bar{A}+\bar{C}+D) = (A+B)(B+D)(\bar{A}+\bar{C}+D)$$

$$= (A+\bar{D})(B+D)(\bar{A}+\bar{C}+D) = (B+C)(B+D)(\bar{A}+\bar{C}+D)$$

		CD			
		00	01	11	10
AB	00			x	
	01	1	x	x	1
	11	1	1	x	
	10		x	1	x

		CD			
		00	01	11	10
AB	00			x	
	01	1	x	x	1
	11	1	1	x	
	10		x	1	x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

		CD			
		00	01	11	10
AB	00	0	0	x	0
	01		x	x	
	11			x	0
	10	0	x		x

- ④  $F(A,B,C,D) = \Sigma m(1,5,6,7,8,9,10,12,13,14,15)$  (답 : SOP 1개, POS 2개)

$$SOP = A\bar{D} + BC + \bar{C}D$$

$$POS = (A+B+\bar{C})(A+C+D)(B+\bar{C}+\bar{D}) = (A+B+D)(A+C+D)(B+\bar{C}+\bar{D})$$

		CD			
		00	01	11	10
AB	00		1		
	01		1	1	1
	11	1	1	1	1
	10	1	1		1

		CD			
		00	01	11	10
AB	00	0		0	0
	01	0			
	11				
	10			0	

		CD			
		00	01	11	10
AB	00	0		0	0
	01	0			
	11				
	10			0	

- ⑤  $F(A,B,C,D) = \Sigma m(0,2,4,6,7,9,11,12,13,14,15)$  (답 : SOP 2개, POS 1개)

$$SOP = AB + AD + \bar{A}\bar{D} + BC = AD + \bar{A}\bar{D} + BC + B\bar{D}$$

$$POS = (A+B+\bar{D})(\bar{A}+B+D)(A+C+\bar{D})$$

		CD			
		00	01	11	10
AB	00	1			1
	01	1		1	1
	11	1	1	1	1
	10		1	1	

		CD			
		00	01	11	10
AB	00	1			1
	01	1		1	1
	11	1	1	1	1
	10		1	1	

		CD			
		00	01	11	10
AB	00		0	0	
	01		0		
	11				
	10	0			0

- ⑥  $F(A,B,C,D) = \Sigma m(1,4,5,6,7,9,11,13,15)$  (답 : SOP 1개, POS 1개)

$$SOP = AD + \bar{A}B + \bar{C}D$$

$$POS = (\bar{A}+D)(A+B+\bar{C})(B+D)$$

		CD			
		00	01	11	10
AB	00		1		
	01	1	1	1	1
	11		1	1	
	10		1	1	

		CD			
		00	01	11	10
AB	00	0		0	0
	01				
	11	0			0
	10	0			0

- ⑦  $F(A,B,C,D) = \Sigma m(2,4,5,6,7,10,11,15)$  (답 : SOP 1개, POS 1개)

$$SOP = \bar{A}B + ACD + \bar{A}C\bar{D}$$

$$POS = (\bar{A}+C)(B+C)(\bar{A}+\bar{B}+D)(A+B+\bar{D})$$

		CD			
		00	01	11	10
AB	00				1
	01	1	1	1	1
	11			1	
	10			1	1

		CD			
		00	01	11	10
AB	00	0	0	0	
	01				
	11	0	0		0
	10	0	0		

- ⑧  $F(A,B,C,D) = \Sigma m(0,4,6,9,10,11,14) + \Sigma d(1,3,5,7)$  (답 : SOP 1개, POS 1개)

$$SOP = \overline{A}B + \overline{A}\overline{C} + A\overline{C}\overline{D} + \overline{B}D$$

$$POS = (A+B+\overline{C})(\overline{A}+C+D)(\overline{B}+\overline{D})$$

		CD			
		00	01	11	10
AB	00	1	x	x	
	01	1	x	x	1
	11				1
	10		1	1	1

		CD			
		00	01	11	10
AB	00		x	x	0
	01		x	x	
	11	0	0	0	
	10	0			

- ⑨  $F(A,B,C,D) = \Sigma m(4,6,9,10,11,13) + \Sigma d(2,12,15)$  (답 : SOP 2개, POS 2개)

$$SOP = \overline{A}B\overline{D} + \overline{A}\overline{B}C + AD = \overline{A}B\overline{D} + \overline{B}C\overline{D} + AD$$

$$POS = (A+\overline{D})(B+C+D)(\overline{A}+\overline{B}+\overline{C}) = (A+\overline{D})(B+C+D)(\overline{A}+\overline{B}+D)$$

		CD			
		00	01	11	10
AB	00				x
	01	1			1
	11	x	1	x	
	10		1	1	1

		CD			
		00	01	11	10
AB	00				x
	01	1			1
	11	x	1	x	
	10		1	1	1

		CD			
		00	01	11	10
AB	00	0	0	0	x
	01		0	0	
	11	x		x	0
	10	0			

		CD			
		00	01	11	10
AB	00	0	0	0	x
	01		0	0	
	11	x		x	0
	10	0			

- ⑩  $F(A,B,C,D) = \Sigma m(0,1,2,5,7,9) + \Sigma d(6,8,11,13,14,15)$  (답 : SOP 4개, POS 2개)

$$SOP = BD + \overline{B}\overline{C} + \overline{A}C\overline{D} = BC + \overline{C}\overline{D} + \overline{A}\overline{B}\overline{D} = BD + \overline{B}\overline{C} + \overline{A}\overline{B}\overline{D} = BD + \overline{C}\overline{D} + \overline{A}\overline{B}\overline{D}$$

$$POS = (\overline{A}+D)(\overline{B}+D)(B+\overline{C}+D) = (A+\overline{C})(\overline{B}+D)(B+\overline{C}+\overline{D})$$

		CD			
		00	01	11	10
AB	00	1	1		1
	01		1	1	x
	11		x	x	x
	10	x	1	x	

		CD			
		00	01	11	10
AB	00	1	1		1
	01		1	1	x
	11		x	x	x
	10	x	1	x	

		CD			
		00	01	11	10
AB	00	1	1		1
	01		1	1	x
	11		x	x	x
	10	x	1	x	

		CD			
AB		00	01	11	10
00	1	1			1
01			1	x	
11		x	x	x	
10	x	1	x		

		CD			
AB		00	01	11	10
00				0	
01	0				x
11	0	x	x	x	
10	x		x	0	

		CD			
AB		00	01	11	10
00				0	
01	0				x
11	0	x		x	x
10	x		x	0	

⑪  $F(A,B,C,D) = \Sigma m(0,1,4,6,10,14) + \Sigma d(5,7,8,9,11,12,15)$  (답 : SOP 13개, POS 3개)

$$\begin{aligned}
 SOP &= AC + \overline{A}\overline{C} + BC = \overline{A}\overline{C} + \overline{A}D + BC = \overline{A}B + AC + \overline{B}\overline{C} = \overline{A}\overline{B} + \overline{A}\overline{C} + BC \\
 &= \overline{A}\overline{B} + AC + \overline{A}\overline{C} = \overline{A}\overline{B} + \overline{A}\overline{C} + \overline{A}D = \overline{A}\overline{B} + \overline{A}\overline{C} + \overline{A}D = \overline{A}\overline{B} + \overline{A}D + \overline{B}\overline{C} \\
 &= \overline{A}\overline{B} + \overline{B}\overline{C} + \overline{A}D = AC + \overline{A}\overline{C} + \overline{A}D = \overline{A}D + \overline{B}\overline{C} + \overline{A}D = \overline{A}\overline{C} + \overline{A}D + \overline{B}\overline{C}
 \end{aligned}$$

$$POS = (\overline{B} + \overline{D})(A + B + \overline{C}) = (\overline{A} + \overline{D})(A + B + \overline{C}) = (\overline{A} + C)(A + B + \overline{C})$$

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
AB		00	01	11	10
00	1	1			
01	1	x	x	1	
11	x		x	1	
10	x	x	x	1	

		CD			
		00	01	11	10
AB	00			0	0
	01		x	x	
	11	x	0	x	
	10	x	x	x	

		CD			
		00	01	11	10
AB	00			0	0
	01		x	x	
	11	x	0	x	
	10	x	x	x	

		CD			
		00	01	11	10
AB	00			0	0
	01		x	x	
	11	x	0	x	
	10	x	x	x	

⑫  $F(A,B,C,D) = \Sigma m(1,3,7,11,13,14) + \Sigma d(0,2,5,8,10,12,15)$  (답 : SOP 6개, POS 17개)

$$\begin{aligned} \text{SOP} &= \overline{A}\overline{B} + BD + AC = \overline{A}D + BD + AC = \overline{A}D + AB + CD = AB + \overline{A}\overline{B} + CD \\ &= AB + \overline{A}D + \overline{B}C = AB + \overline{A}D + AC \end{aligned}$$

$$\text{POS} = (A+D)(\overline{A}+B+C)$$

		CD			
		00	01	11	10
AB	00	x	1	1	x
	01		x	1	
	11	x	1	x	1
	10	x		1	x

		CD			
		00	01	11	10
AB	00	x	1	1	x
	01		x	1	
	11	x	1	x	1
	10	x		1	x

		CD			
		00	01	11	10
AB	00	x	1	1	x
	01		x	1	
	11	x	1	x	1
	10	x		1	x

		CD			
		00	01	11	10
AB	00	x	1	1	x
	01		x	1	
	11	x	1	x	1
	10	x		1	x

		CD			
		00	01	11	10
AB	00	x	1	1	x
	01		x	1	
	11	x	1	x	1
	10	x		1	x

		CD			
		00	01	11	10
AB	00	x			x
	01	0	x		0
	11	x		x	
	10	x	0		x

## 10. 5변수 카르노 맵을 이용한 간소화

①  $F(A,B,C,D,E) = \Sigma m(0,1,4,5,16,17,21,25,29)$

$$F(A,B,C,D,E) = \overline{A}\overline{B}\overline{D} + \overline{A}\overline{D}E + \overline{B}\overline{C}\overline{D}$$

		DE			
		00	01	11	10
BC	00	1	1		
	01	1	1		
	11				
	10				

		DE			
		00	01	11	10
BC	00	1	1		
	01		1		
	11		1		
	10		1		

②  $F(A,B,C,D,E) = \overline{A}\overline{B}\overline{C}\overline{E} + \overline{A}\overline{B}\overline{C}\overline{D} + \overline{B}\overline{D}\overline{E} + \overline{B}\overline{C}\overline{D} + C\overline{D}\overline{E} + B\overline{D}\overline{E}$   
 $= \overline{A}\overline{B}\overline{D} + B\overline{D}\overline{E} + \overline{B}\overline{C}\overline{D} + C\overline{D}\overline{E} + \overline{B}\overline{D}\overline{E}$



A=0					A=1				
BC \ DE	DE				BC \ DE	DE			
	00	01	11	10		00	01	11	10
00	1	1			00	1			
01	1	1		1	01	1	1		1
11				1	11				1
10				1	10				1

③  $F(A,B,C,D,E) = \Sigma m(0,5,7,9,11,13,15,18,19,22,23,25,27,28,29,31)$

$F(A,B,C,D,E) = BE + \overline{A}BD + \overline{A}CE + ABCD + \overline{A}\overline{B}\overline{C}\overline{D}E$

A=0					A=1				
BC \ DE	DE				BC \ DE	DE			
	00	01	11	10		00	01	11	10
00	1				00			1	1
01		1	1		01			1	1
11		1	1		11	1	1	1	
10		1	1		10		1	1	

④  $F(A,B,C,D,E) = \Sigma m(0,2,4,7,8,10,15,17,20,21,23,25,26,27,29,31)$

$F(A,B,C,D,E) = \overline{A}\overline{C}\overline{E} + \overline{A}DE + CDE + ABCD + \overline{B}\overline{C}\overline{D}E$

A=0					A=1				
BC \ DE	DE				BC \ DE	DE			
	00	01	11	10		00	01	11	10
00	1			1	00		1		
01	1		1		01	1	1	1	
11			1		11		1	1	
10	1			1	10		1	1	1

⑤  $F(A,B,C,D,E) = \Sigma m(1,3,10,14,21,26,28,30) + \Sigma d(5,12,17,29)$

$F(A,B,C,D,E) = \overline{B}\overline{D}E + B\overline{D}E + B\overline{C}E + \overline{A}\overline{B}\overline{C}E$

A=0					A=1				
BC \ DE	DE				BC \ DE	DE			
	00	01	11	10		00	01	11	10
00		1	1		00		X		
01		X			01		1		
11	X			1	11	1	X		1
10				1	10				1

⑥  $F(A,B,C,D,E) = \Sigma m(0,1,2,4,5,6,10,13,14,18,21,22,24,26,29,30)$

$F(A,B,C,D,E) = DE + \overline{A}\overline{B}\overline{D} + CDE + AB\overline{C}E$

A=0					A=1				
BC \ DE	DE				BC \ DE	DE			
	00	01	11	10		00	01	11	10
00	1	1		1	00				1
01	1	1		1	01		1		1
11		1		1	11		1		1
10				1	10	1			1

## 11. 6변수 카르노 맵을 이용한 간소화

①  $F(A,B,C,D,E,F) = \Sigma m(0,4,6,8,9,11,12,13,15,16,20,22,24,25,27,28,29,31,32,34,36,38,40,41,42,43,45,47,48,49,54,56,57,59,61,63)$

$$F = AB\bar{D}\bar{E} + CF + \bar{C}DEF + \bar{A}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{D}\bar{F} + \bar{A}\bar{B}\bar{C}\bar{F}$$

$$F = AB\bar{D}\bar{E} + CF + \bar{C}DEF + \bar{A}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{D}\bar{F} + \bar{B}\bar{C}\bar{E}\bar{F}$$

$$F = AB\bar{D}\bar{E} + CF + \bar{C}DEF + \bar{A}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{D}\bar{F} + \bar{B}\bar{C}\bar{D}\bar{F}$$

$$F = AB\bar{D}\bar{E} + CF + \bar{C}DEF + \bar{A}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{D}\bar{F} + \bar{A}\bar{B}\bar{C}\bar{D}$$

		AB=00				AB=01				AB=11				AB=10			
CD	EF	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
		00	1			00	1			00	1	1		00	1		1
		01	1			01	1			01			1	01	1		1
		11	1	1	1	11	1	1	1	11	1	1	1	11		1	1
		10	1	1	1	10	1	1	1	10	1	1	1	10	1	1	1

		AB=00				AB=01				AB=11				AB=10			
CD	EF	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
		00	X			00	X			00	X	X		00	1		1
		01	X			01	X		X	01			X	01	1		X
		11	X	X	X	11	X	X	X	11		X	X	11		X	X
		10	X	X	X	10	X	X	X	10	X	X	X	10	1	X	1

		AB=00				AB=01				AB=11				AB=10			
CD	EF	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
		00	X			00	X			00	X	X		00	1		1
		01	X		X	01	X		X	01			X	01	1		X
		11	X	X	X	11	X	X	X	11		X	X	11		X	X
		10	X	X	X	10	X	X	X	10	X	X	X	10	1	X	1

②  $F(A,B,C,D,E,F) = \Sigma m(4,5,6,7,8,10,13,15,18,20,21,22,23,26,29,30,31,33,36,37,38,39,40,42,49,52,53,54,55,60,61)$

$$F = \bar{C}\bar{D} + \bar{A}DF + \bar{A}BEF + AB\bar{D}\bar{E} + \bar{A}\bar{C}\bar{E}\bar{F} + \bar{B}\bar{C}\bar{D}\bar{F}$$

		AB=00				AB=01				AB=11				AB=10			
CD	EF	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
		00				00			1	00	1			00		1	
		01	1	1	1	01	1	1	1	01	1	1	1	01	1	1	1
		11		1	1	11		1	1	11	1	1		11			
		10	1			10			1	10				10	1		1

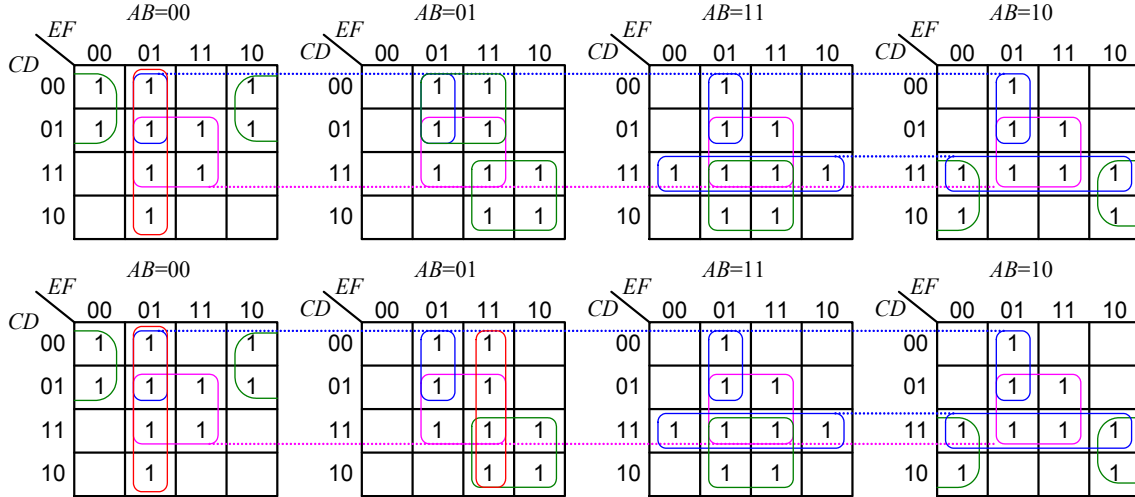
③

$$F(A,B,C,D,E,F) = \Sigma m(2,3,6,7,8,12,14,17,19,21,23,25,27,28,29,30,32,33,34,35,40,44,46,49,51,53,55,57,59,61,62,63)$$

$$= \bar{B}\bar{C}\bar{E}\bar{F} + \bar{B}\bar{D}\bar{F} + \bar{B}\bar{C}\bar{F} + \bar{A}\bar{B}\bar{C}\bar{E} + \bar{C}\bar{D}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{C}\bar{D} + \bar{B}\bar{E}\bar{F} + \bar{A}\bar{B}\bar{F} + \bar{A}\bar{C}\bar{D}\bar{F}$$

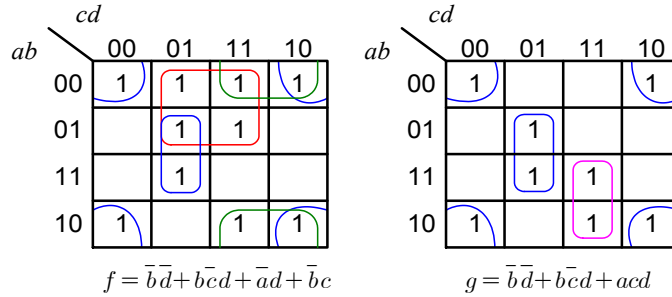
		AB=00				AB=01				AB=11				AB=10			
CD	EF	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
		00			1	00		1	1	00		1	1	00	1	1	1
		01			1	01		1	1	01		1	1	01			
		11	1			11	1			11	1	1		11	1		1
		10	1			10		1	1	10		1	1	10			

$$\begin{aligned}
 \textcircled{4} \quad F(A,B,C,D,E,F) &= \Sigma m(0,1,2,4,5,6,7,9,13,15,17,19,21,23,26,27,29,30,31,33, \\
 &\quad 37,39,40,42,44,45,46,47,49,53,55,57,59,60,61,62,63) \\
 &= DF + ACD + \overline{C}EF + \overline{A}BCF + \overline{A}BEF + \overline{A}BCE + \overline{A}BCF + \overline{A}BCF + \overline{A}BCF + \overline{A}BCF \\
 &= DF + ACD + \overline{C}EF + \overline{A}BCF + \overline{A}BEF + \overline{A}BCE + \overline{A}BCF + \overline{A}BCF + \overline{A}BEF
 \end{aligned}$$

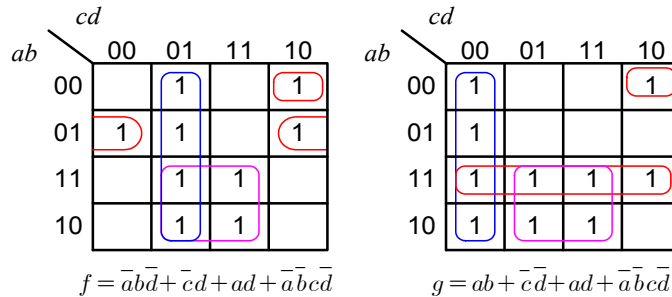


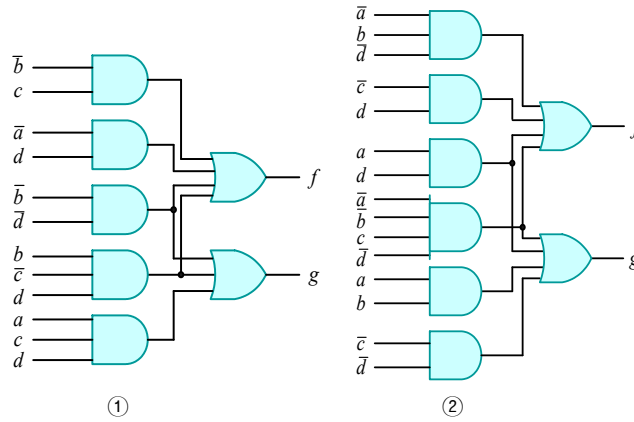
## 12. 여러 개의 출력함수 표현

①  $f(a,b,c,d) = \Sigma m(0,1,2,3,5,7,8,10,11,13)$ ,  $g(a,b,c,d) = \Sigma m(0,2,5,8,10,11,13,15)$ , 7개의 게이트

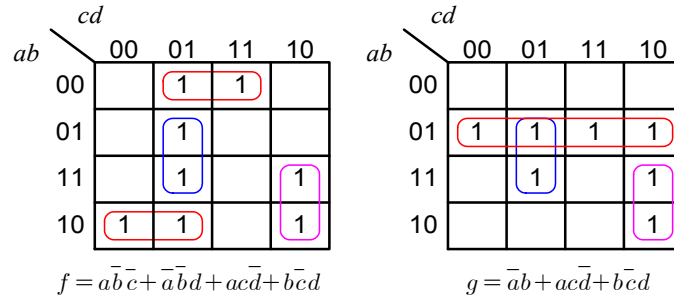


②  $f(a,b,c,d) = \Sigma m(1,2,4,5,6,9,11,13,15)$ ,  $g(a,b,c,d) = \Sigma m(0,2,4,8,9,11,12,13,14,15)$ , 8개의 게이트

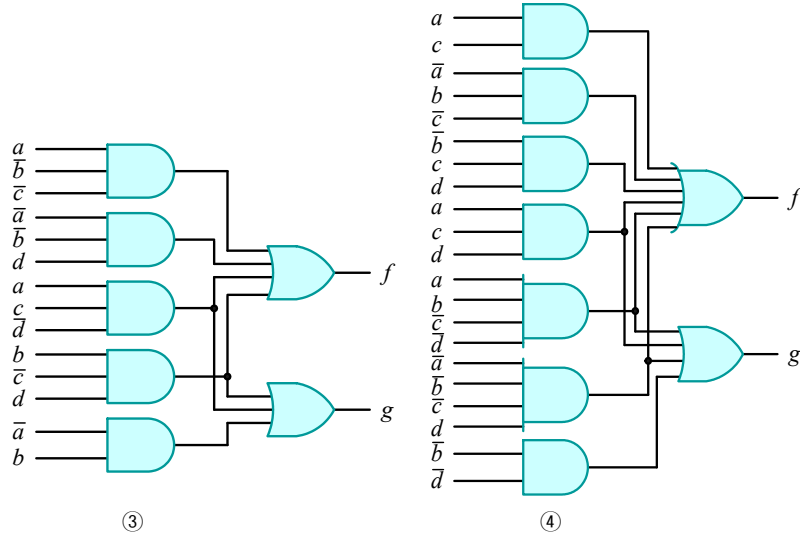
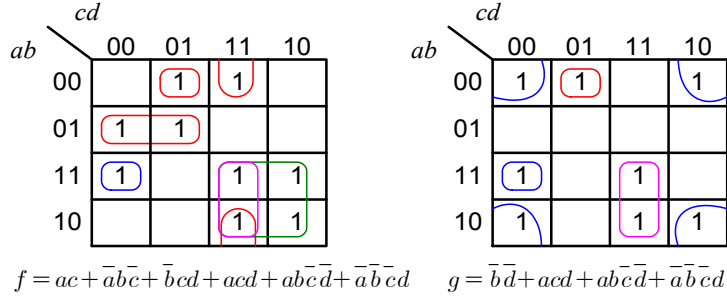




③  $f(a,b,c,d) = \Sigma m(1,3,5,8,9,10,13,14)$ ,  $g(a,b,c,d) = \Sigma m(4,5,6,7,10,13,14)$ , 7개의 게이트

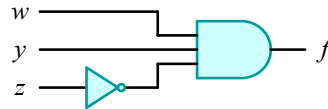


④  $f(a,b,c,d) = \Sigma m(1,3,4,5,10,11,12,14,15)$ ,  $g(a,b,c,d) = \Sigma m(0,1,2,8,10,11,12,15)$ , 9개의 게이트



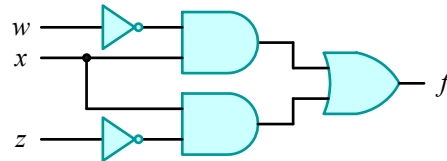
### 13. 논리회로 간소화

①  $f = wy\bar{z} + x\bar{y}(xy + yz) = wy\bar{z}$



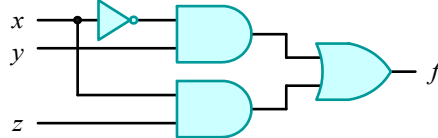
②  $f = \bar{w}x + x\bar{z} + \bar{w}x(wyz + \bar{y} + \bar{z}) = \bar{w}x + x\bar{z} + \bar{w}x\bar{y} + \bar{w}x\bar{z} = \bar{w}x + x\bar{z}$

yz \ wx	00	01	11	10
00				
01	1	1	1	1
11	1			
10				

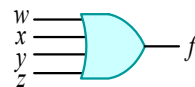


③  $f = \bar{x}yz + \bar{x}y\bar{z} + xz = \bar{x}y + xz$

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



④  $f = (\bar{w}\bar{x}\bar{y})y + \bar{w}\bar{x}\bar{y} + z = wy + xy + y + w + x + y + z = (w + x + 1)y + w + x + z = w + x + y + z$

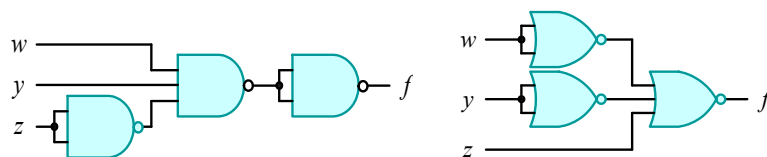


⑤  $F = \overline{X + (\overline{X + Y})} + \overline{Y + (\overline{X + Y})} = X \odot Y$

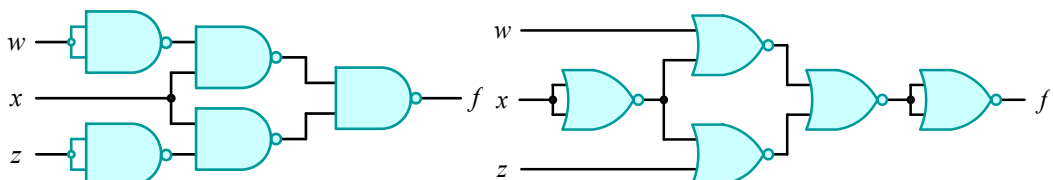


### 14. 논리회로의 NAND와 NOR 게이트만의 표현

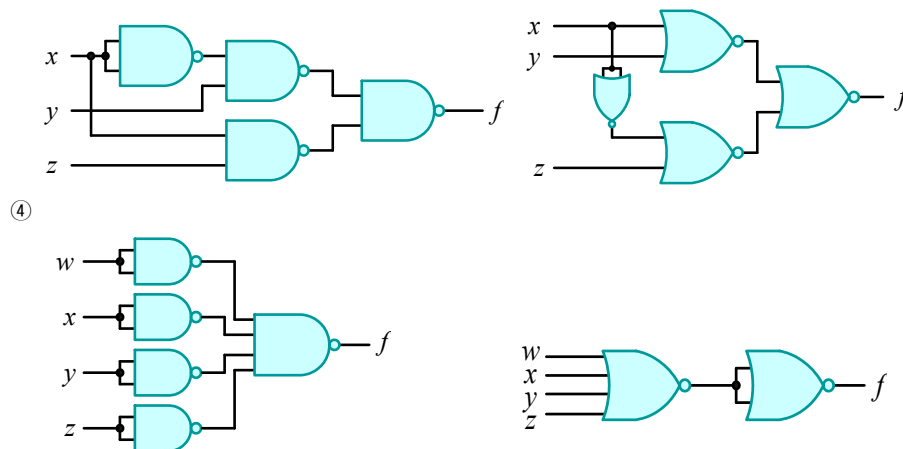
①



②



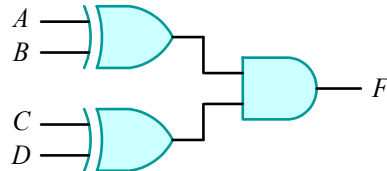
③



### 15. 논리식의 XOR와 AND 게이트 표현

$$F = A\bar{B}C\bar{D} + \bar{A}B\bar{C}D + A\bar{B}\bar{C}D + \bar{A}B\bar{C}\bar{D} = (\bar{A}\bar{B} + \bar{A}B)C\bar{D} + (\bar{A}\bar{B} + \bar{A}B)\bar{C}D$$

$$= (\bar{A}\bar{B} + \bar{A}B)(C\bar{D} + \bar{C}D) = (A \oplus B)(C \oplus D)$$



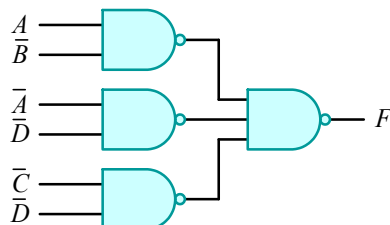
### 16. 불 대수식의 간략화 및 NAND 게이트만에서의 표현

①  $F = \bar{A}\bar{B} + \bar{C}\bar{D} + \bar{A}\bar{C}\bar{D} = \bar{A}\bar{B} + \bar{A}\bar{D} + \bar{C}\bar{D}$

		CD			
		00	01	11	10
AB	00	1			1
	01	1			1
	11	1			
	10	1	1	1	1

간략화된 논리식을 이중 부정을 하고 드모르간의 정리를 적용하면 다음과 같이 NAND 게이트만으로 나타낼 수 있다.

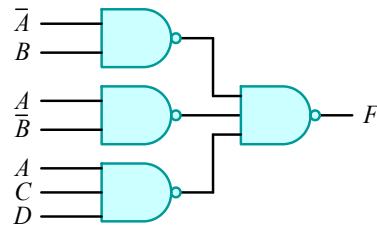
$$F = \overline{\bar{A}\bar{B} + \bar{A}\bar{D} + \bar{C}\bar{D}} = \overline{(\bar{A}\bar{B})(\bar{A}\bar{D})(\bar{C}\bar{D})}$$



②  $F = \bar{A}\bar{B} + A(\bar{B} + CD) = \bar{A}\bar{B} + \bar{A}B + ACD$

		CD			
AB		00	01	11	10
00					
01		1	1	1	1
11				1	
10		1	1	1	1

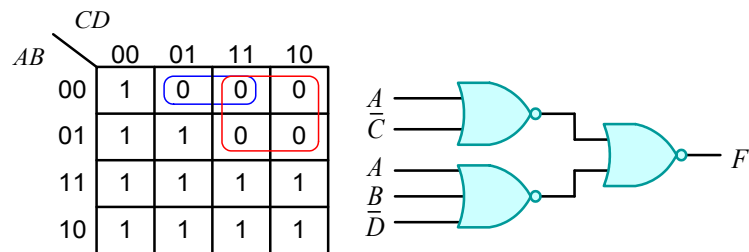
$$F = \overline{\overline{AB} + \overline{AB} + ACD} = \overline{(\overline{AB})(\overline{AB})(ACD)}$$



### 17. 불 대수식의 간략화 및 NOR 게이트만으로는 표현

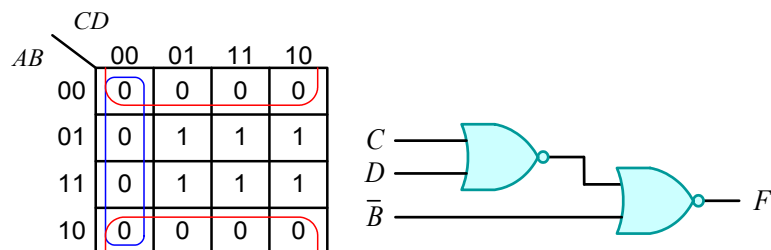
$$\textcircled{1} F(A,B,C,D) = A\overline{B} + ABD + AB\overline{D} + \overline{A}\overline{C}\overline{D} + \overline{A}\overline{B}\overline{C}$$

$$POS = (A + \overline{C})(A + B + \overline{D}) = \overline{\overline{(A + \overline{C})}(\overline{A + B + \overline{D}})} = \overline{(\overline{A + \overline{C}})(\overline{A + B + \overline{D}})}$$



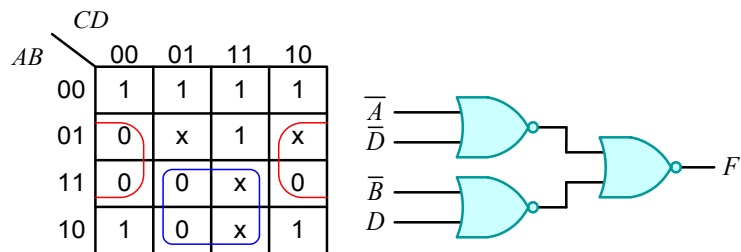
$$\textcircled{2} F(A,B,C,D) = BD + B\overline{C}\overline{D} + A\overline{B}\overline{C}\overline{D}$$

$$POS = B(C + D) = \overline{\overline{(B(C + D))}} = \overline{(\overline{B + \overline{C + D}})} = \overline{(\overline{B + \overline{C}})(\overline{B + \overline{D}})}$$



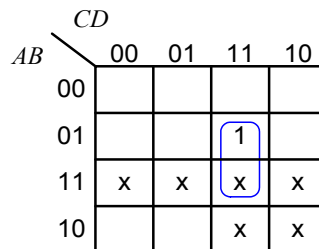
$$\textcircled{3} F(A,B,C,D) = \Sigma m(0,1,2,3,7,8,10) + \Sigma d(5,6,11,15)$$

$$F(A,B,C,D) = (\overline{A} + \overline{D})(\overline{B} + D) = \overline{\overline{(\overline{A} + \overline{D})}(\overline{\overline{B} + D})} = \overline{(\overline{A + D})(\overline{B + D})}$$



### 18. 논리식의 간략화

입출력 관계를 카르노 맵으로 그려서 정리하면  $Y = BCD$ 이다.



### 19. 스위치 회로망의 간략화

$N_1$		$N_2$		$F$
$A$	$B$	$C$	$D$	
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

①  $Minterm = \Sigma m(7,10,11,13,14,15)$

$$= \overline{A}BC\overline{D} + \overline{A}BCD + A\overline{B}C\overline{D} + A\overline{B}CD + AB\overline{C}\overline{D} + AB\overline{C}D + ABC\overline{D} + ABCD$$

②  $Maxterm = \Pi M(0,1,2,3,4,5,6,8,9,12)$

$$= (A+B+C+D)(A+B+C+\overline{D})(A+B+\overline{C}+D)(A+B+\overline{C}+\overline{D})(A+\overline{B}+C+D)(A+\overline{B}+C+\overline{D})(A+\overline{B}+\overline{C}+D)(A+\overline{B}+\overline{C}+\overline{D})$$