

1) Simplify the Boolean function.

$$F(x, y, z) = \sum (2, 3, 4, 5).$$

3 variable  
k-map

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

$$\bar{x}yz + \bar{x}y\bar{z} = \bar{x}y(z + \bar{z}) = \bar{x}y.$$

$$x\bar{y}\bar{z} + x\bar{y}z = x\bar{y}(\bar{z} + z) = x\bar{y}.$$

$$\Rightarrow \bar{x}y + x\bar{y} //$$

Karnaugh Map:

A Karnaugh map is similar to a truth table because it presents all of the possible values of input variables and the resulting o/p for each value.

The map method presented here provides a simple, straight forward procedure for minimizing Boolean functions. This method may be regarded as a pictorial form of a truth table. The map method is known as Karnaugh map or k-map.

The Karnaugh map identifies all of the cases for a given set of input variables where groups of minterms may contain redundant variables of the form of  $x + x' = 1$ . When these groups are identified, the redundant variables can be eliminated, resulting in a simplified o/p function.

2-variable k-map:

$$F(x, y) = \sum (0, 1, 3).$$

x \ y	0	1
0	1	1
1		1

$$x \quad \bar{x}\bar{y} + \bar{x}y \Rightarrow \bar{x}(\bar{y} + y) = \bar{x}(1).$$

$$\bar{x}y + xy = y(\bar{x} + x) = y = \bar{x} + y //$$

Three Variable K-Map:

$$F(x, y, z) = \sum (2, 3, 4, 5)$$

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

$$\begin{aligned} & \bar{x}y\bar{z} + \bar{x}yz \\ & \bar{x}y(\bar{z} + z) \\ & = \bar{x}y \end{aligned}$$

$$\begin{aligned} & x\bar{y}\bar{z} + x\bar{y}z \\ & = x\bar{y}(\bar{z} + z) = x\bar{y} \end{aligned}$$

$$\Rightarrow \bar{x}y + x\bar{y}$$

xy \ z	0	1
00	0	1
01	0	1
11	1	0
10	1	0

xy \ z	0	1
00	0	0
01	1	1
11	0	0
10	1	1

$$\bar{x}y\bar{z} + \bar{x}yz$$

$$\begin{aligned} & \bar{x}y\bar{z} + \bar{x}yz \\ & = \bar{x}y(\bar{z} + z) \\ & = \bar{x}y \end{aligned}$$

$$\begin{aligned} & x\bar{y}\bar{z} + x\bar{y}z = x\bar{y}(\bar{z} + z) \\ & = x\bar{y} \\ & = x\bar{y} + \bar{x}y \end{aligned}$$

Simplify using the Boolean func.

$$2) F(x, y, z) = \sum (3, 4, 6, 7)$$

xy \ z	00	01	11	10
0	0	0	1	0
1	1	0	1	1

$$\textcircled{1} \quad \bar{x}yz + \bar{x}y\bar{z} = yz(x + \bar{x}) = yz$$

$$\textcircled{2} \quad x\bar{y}\bar{z} + x\bar{y}z = x\bar{z}(x\bar{y} + y) = x\bar{z}$$

$$\Rightarrow yz + x\bar{z}$$

$$xy\bar{z} + x\bar{y}\bar{z} = x\bar{z}(y + \bar{y})$$

$$\Rightarrow x\bar{z}$$

3) Map the following std sop expression on a karnaugh map.

$$\bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$$

$\bar{A}\bar{B}C$	00	01	11	10
00		1		1
1			1	1

① →  $\bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C}$   
 =  $\bar{B}\bar{C}(\bar{A} + A)$   
 =  $\bar{B}\bar{C}$

② →  $ABC + A\bar{B}\bar{C}$   
 =  $AB(C + \bar{C})$   
 =  $AB$   
 =  $AB + \bar{B}\bar{C}$  „

4- Variable K-Map:-

4) Simplify the Boolean function.

$$F(x,y,z) = \sum(0,2,4,5,6)$$

5).  $F = A'C + A'B + A'B'C + BC$

$$\begin{aligned} &\Rightarrow A'C(B+B') + A'B(C+C') + A'B'C + BC(A+A') \\ &= \underline{A'BC} + A'B'C + \underline{A'BC} + A'BC' + A'B'C + ABC + A'\underline{BC} \\ &= A'BC + A'B'C + A'BC' + A'B'C + ABC \end{aligned}$$

$$011 \quad 001 \quad 010 \quad 101 \quad 111$$

$A \setminus BC$	00	01	11	10
0		1	1	1
01		1	1	

① →  $C + \bar{A}B$

3) Simplify the following 4-variable eqn.

$$K = f(w, x, y, z) = \Sigma(0, 1, 4, 5, 9, 11, 13, 15)$$

wx \ yz	00	01	11	10
00	1 0	1 1	3	2
01	1 4	1 5	7	6
11	12	1 13	1 15	14
10	8	1 9	1 11	10

$$\overline{y}z + \overline{w}y + \overline{w}z$$

wx \ yz	00	01	11	10
00	1 0	1 1	3	2
01	1 4	1 5	7	6
11	12	1 13	1 15	14
10	8	1 9	1 11	10

$$\overline{w}xy + \overline{w}z$$

4)  $Y = f(a, b, c) = \Sigma(0, 4, 5)$

8) Simplify the following 3 variable eqn

$$G = f(x, y, z) = \Sigma (0, 2, 3, 4, 5, 7)$$

9)  $L = f(a, b, c, d) = \Sigma (0, 2, 5, 7, 8, 10, 13, 15)$

10) Simplify the following eqn

$$P = f(x, s, t, u) = \Sigma (1, 3, 4, 6, 7, 11, 12, 14)$$

Five - Variable K - Map:

1) Five variable K - Map for

$$T = f(a,b,c,d,e) = \Sigma(0, 2, 8, 10, 16, 18, 24, 26)$$

bc \ de	00	01	11	10
00	1 0	1	3	2 1
01	4	5	7	6
11	12	13	15	14
10	8 1	9	11	10 1

a = 0

bc \ de	00	01	11	10
00	16 1	17	19	18 1
01	20	21	23	22
11	28	29	31	30
10	24 1	25	27	26 1

a = 1

$$\overline{c} \overline{e}$$

2) Five - Variable K - map for R = f(v,w,x,y,z)

$$= \Sigma(5, 7, 13, 15, 21, 23, 29, 31)$$

v = 0

v = 1

wx \ yz	00	01	11	10
00	0	1	3	2
01	4	1 5	1 7	6
11	12	1 13	1 15	14
10	8	9	11	10

wx \ yz	00	01	11	10
00	16	17	19	18
01	20	1 21	1 23	22
11	28	1 29	1 31	30
10	24	25	27	26

$$R = xz$$

Don't Care Conditions:

$$F(w, x, y, z) = \Sigma(1, 3, 7, 11, 15)$$

$$d(w, x, y, z) = \Sigma(0, 2, 5)$$

wx \ yz	00	01	11	10
00	X <sub>0</sub>	1	1	X <sub>2</sub>
01	4	X <sub>5</sub>	1	6
11	12	13	1	14
10	8	9	1	10

→ Q<sub>1</sub> (points to row 00)

→ Q<sub>2</sub> (points to row 11)

$$Q_1 = \bar{w}\bar{x}$$

$$F = \bar{w}\bar{x} + yz$$

$$Q_2 = yz$$

$$2) A = f(w, x, y, z) = \Sigma(5, 6, 7, 8, 9) + \Sigma d(10, 11, 12, 13, 14, 15)$$

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

1)  $\pi_m(1, 7)$

2)  $F(A, B, C, D) = \sum m(1, 3, 4, 5, 9, 11, 14, 15)$

$Z(A, B, C, D) = \prod M(0, 2, 6, 7, 8, 10, 12, 13)$

AB \ CD	00	01	11	10
00	0	1	3	2
01	4	5	7	6
11	13	15	11	14
10	12	10	11	10

$P_1$  (circled 1, 3, 7, 5)  
 $P_2$  (circled 13, 15, 11, 9)  
 $Q_0$  (circled 12, 10, 11, 10)  
 $Q_1$  (circled 1, 3, 7, 5)  
 $Q_2$  (circled 13, 15, 11, 9)

$Q_1 = (B + D)$

$P_1 = (\bar{C} + A + \bar{B})$

$P_2 = (\bar{A} + \bar{B} + C)$

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

3) Use K map to minimize the following exp.

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

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

Std pos.

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

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

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



$$Q_1 = \bar{C} + \bar{D}$$

$$\Rightarrow \bar{C} + \bar{D}$$

$$P_1 = A + B + D$$

$$P_2 = \bar{A} + B + C$$

AB \ CD	$\bar{C} + \bar{D}$	$\bar{C} + \bar{D}$	$\bar{C} + \bar{D}$	$\bar{C} + \bar{D}$
	00	01	11	10
A+B 00	1			1
A+B 01	0			
A+B 11	0			
A+B 10	1	1		

The table shows the truth table for the function  $Q_1 = \bar{C} + \bar{D}$ . The rows are labeled with the sum of variables  $A+B$  and the columns with the sum of variables  $C+D$ . The values in the cells are 1 or 0. The first row (A+B=00) has 1s in the first and fourth columns. The fourth row (A+B=10) has 1s in the first and second columns. The other cells are empty.

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

$$4) (\bar{A} + \bar{B} + C + D) (A + \bar{B} + C + D) (A + B + C + D)$$