

Digital Design

Lecture 8: Five Variable K-map



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

Innovate

achieve

1

lead

5- Variable K -Map

The structure of such a K-Map for SOP expression is given below :

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

P=0

F(P,Q,R,S,T)

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

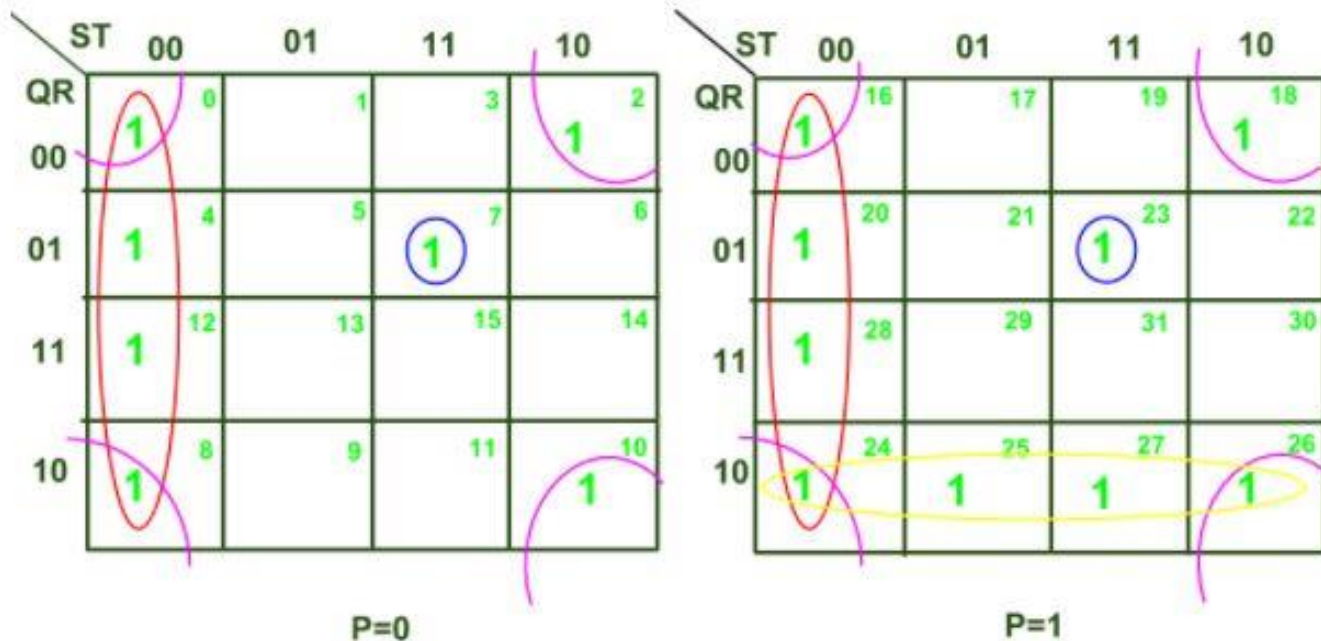
P=1

Minimization of Boolean Expression by 5 Variable K-Map (SOP form)

I. Solving SOP function -

For clear understanding, let us solve the example of SOP function minimization of 5 Variable K-Map using the following expression :

$$\sum m(0, 2, 4, 7, 8, 10, 12, 16, 18, 20, 23, 24, 25, 26, 27, 28)$$



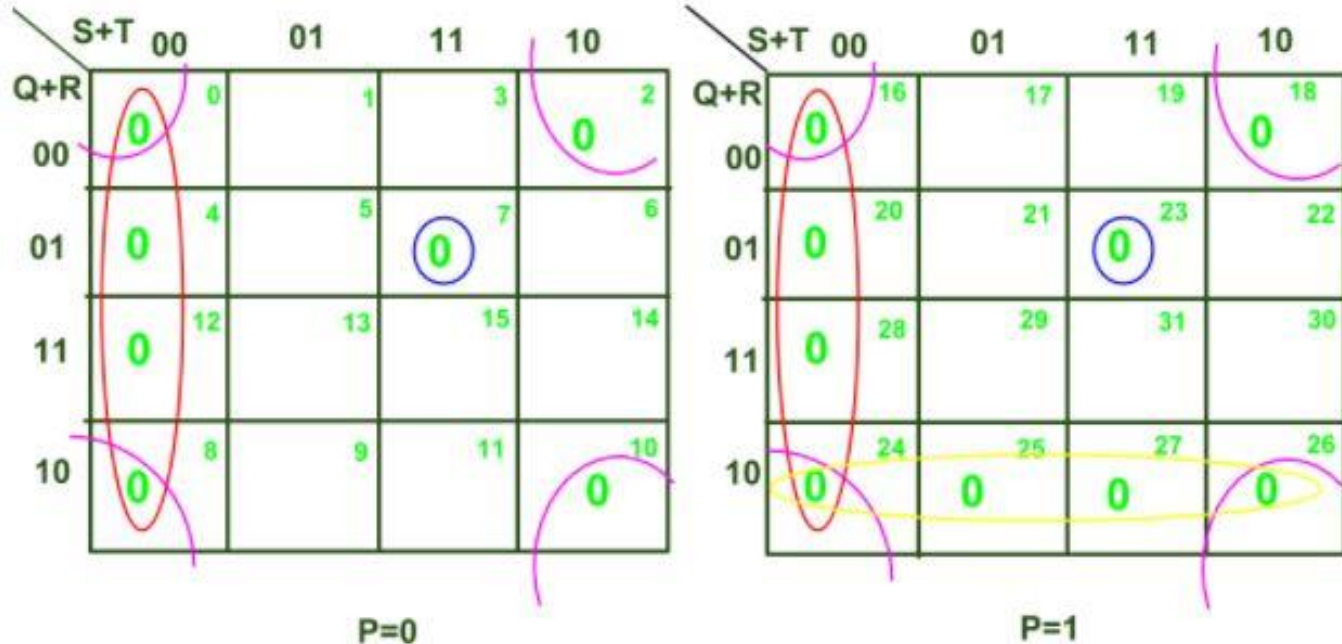
$$F(PQRST) = S'T' + Q'RST + PQR' + R'T'$$

Minimization of Boolean Expression by 5 Variable K-Map (POS form)

II. Solving POS function -

Now, let us solve the example of POS function minimization of 5 Variable K-Map using the following expression :

$$\prod M(0, 2, 4, 7, 8, 10, 12, 16, 18, 20, 23, 24, 25, 26, 27, 28)$$



$$f(PQRST) = (S+T) \cdot (R+T) \cdot (Q+R'+S'+T') \cdot (P'+Q'+R)$$

Five Variable K-map

A \ B		CDE							
		000	001	011	010	110	111	101	100
0	0								
0	1								
1	1								
1	0								

5-variable Karnaugh map (Gray code)



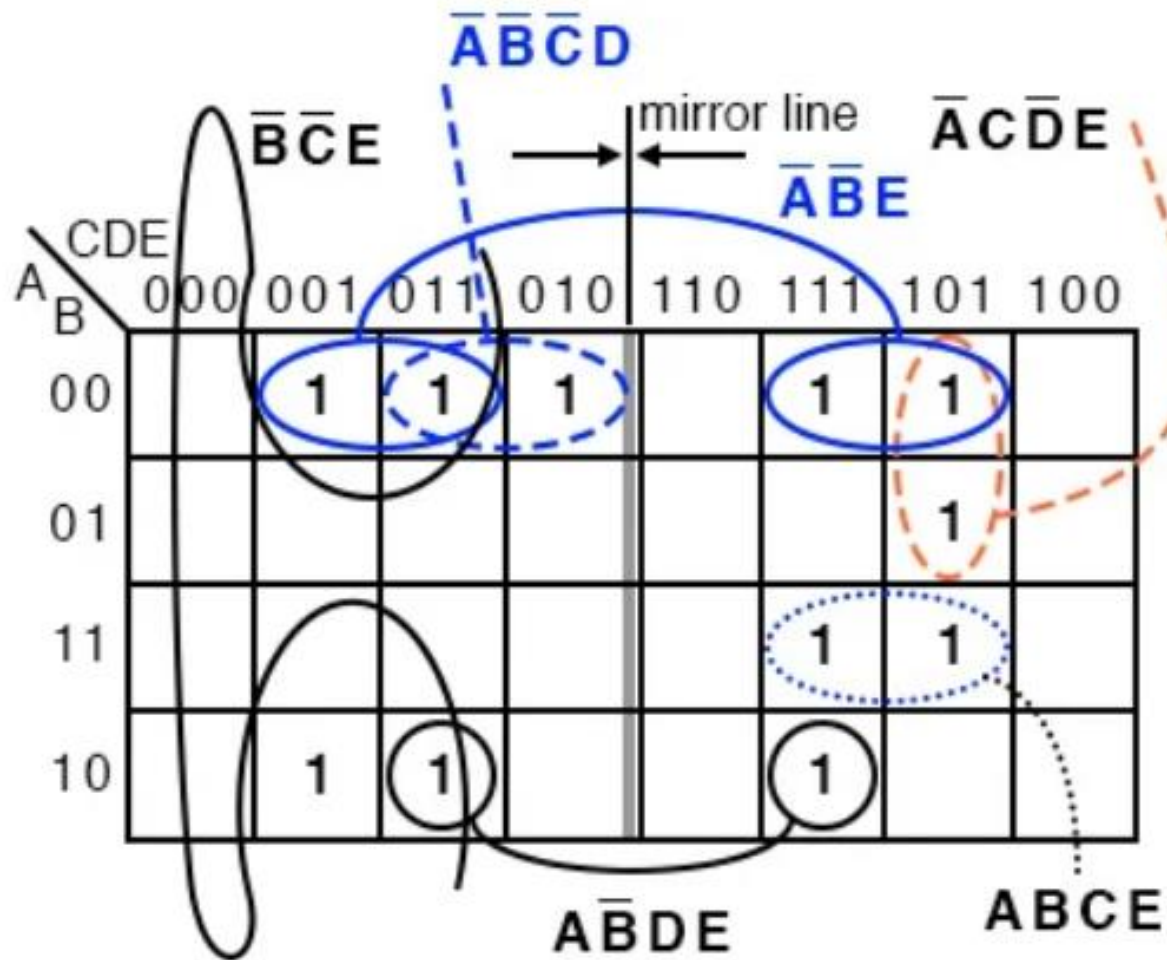
$$F(A, B, C, D, E) = \sum(0, 2, 4, 6, 9, 11, 13, 15, 17, 21, 25, 27, 29, 31)$$

		CDE							
		000	001	011	010	110	111	101	100
A	00	1			1	1			1
	01		1	1			1	1	
	11		1	1			1	1	
	10		1					1	

The table includes several annotations:

- A bracket labeled 'C' spans the columns for CDE values 110, 111, 101, and 100.
- A bracket labeled 'B' spans the rows for AB values 01 and 11.
- A bracket labeled 'D' spans the columns for CDE values 011 and 010.
- Two brackets labeled 'E' span the columns for CDE values 001 and 011, and 101 and 100 respectively.

$$BE + AD'E + A'B'E'$$

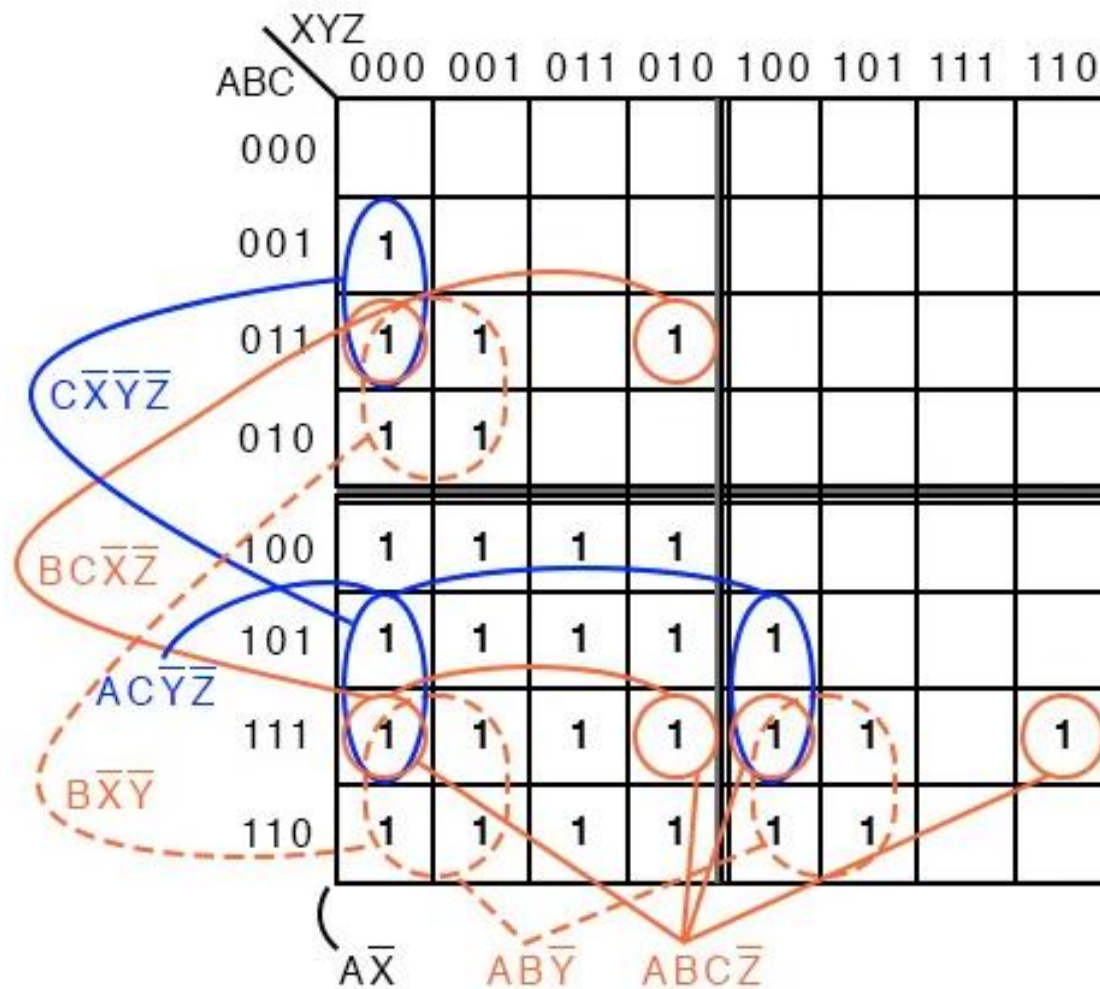


5-variable Karnaugh map (Gray code)

Overlay Version of the K-map

A \ B		CDE							
		000	001	011	010	100	101	111	110
0	00								
	01								
	11								
	10								

5-variable Karnaugh map (overlay)



$$\text{Out} = \overline{A}\overline{X} + \overline{A}\overline{B}\overline{Y} + \overline{B}\overline{X}\overline{Y} + \overline{A}\overline{B}\overline{C}\overline{Z} + \overline{A}\overline{C}\overline{Y}\overline{Z} + \overline{B}\overline{C}\overline{X}\overline{Z} + \overline{C}\overline{X}\overline{Y}\overline{Z}$$

6 - variable Karnaugh map (overlay)



Complements

Decimal	S.M.	1's comp.	2's comp.
7	0111	0111	0111
6	0110	0110	0110
5	0101	0101	0101
4	0100	0100	0100
3	0011	0011	0011
2	0010	0010	0010
1	0001	0001	0001
0	0000	0000	0000
-0	1000	1111	—
-1	1001	1110	1111
-2	1010	1101	1110
-3	1011	1100	1101
-4	1100	1011	1100
-5	1101	1010	1011
-6	1110	1001	1010
-7	1111	1000	1001
-8	—	—	1000

Advantages of 2's Complement

- **Two Zeros**
- **No End-around-carry-bit addition**

Add 4 & -7

$$\begin{array}{r} 0100 \\ \underline{1001} \\ 1101 \end{array}$$

Add 4 & -3

$$\begin{array}{r} 0100 \\ \underline{1101} \\ 1\ 0001 \end{array}$$

Complements

Overflow in 2's Complement

Add 4 & -3

$$\begin{array}{r} 0100 \\ \underline{1101} \\ 1\ 0001 \end{array}$$

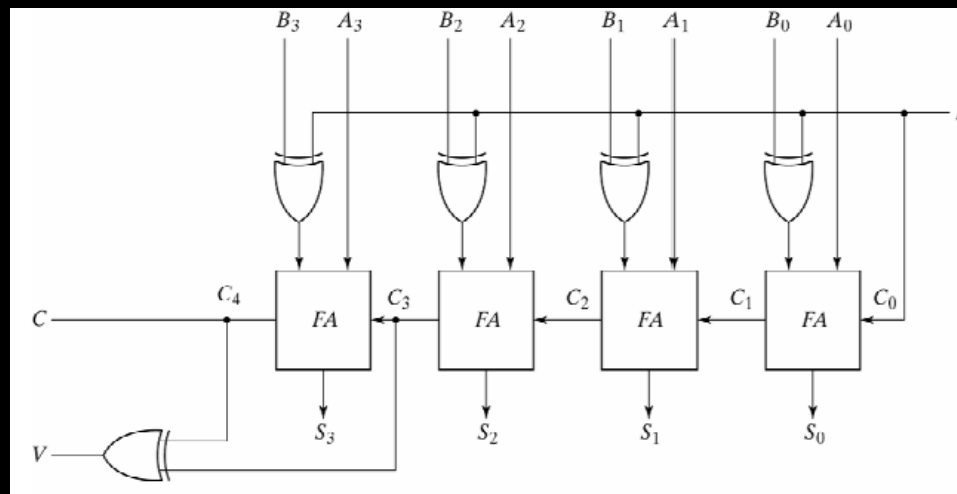
Add -4 & -5

$$\begin{array}{r} 1100 \\ \underline{1011} \\ 1\ 0111 \end{array}$$

Add -8 & 4

$$\begin{array}{r} 1000 \\ \underline{0100} \\ 1100 \end{array}$$

Add 4 & 4

$$\begin{array}{r} 0100 \\ \underline{0100} \\ 1000 \end{array}$$




Thank You