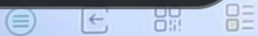


K-Map (Karnaugh Map)

- K Map is a graphical representation used for simplifying the Boolean expressions.
- For a Boolean expression consisting of n -variables, number of cells required in K Map = 2^n cells.
- K Map is based on Grey code(Unit distance code).
- K Map is based on three types of Input values(0, 1, don't care)



View key concept



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A B
0 0
[0 1]
1 0
1 1

00 01 11 10





$$f(A, B, C) \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix}$$

A	BC			
	00	01	11	10
0	000	001	011	010
1	100	101	111	110
	0	1	3	2
	4	5	7	6

AB \ CD		$\overline{C}\overline{D}$ 00	$\overline{C}D$ 01	$C\overline{D}$ 11	CD 10
$\overline{A}\overline{B}$	00	0	1	3	2
$\overline{A}B$	01	4	5	7	6
$A\overline{B}$	11	12	13	15	14
AB	10	8	9	11	10

F(A, B, C, D)

$$F(P, Q, R, S) = \underline{\Sigma m}(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$

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

$$F(P, Q, R, S) = \underline{\Sigma m}(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$

PQ \ RS		RS			
		00	01	11	10
00	0			X	
01	4				
11	12	X			X
10	8	X			X

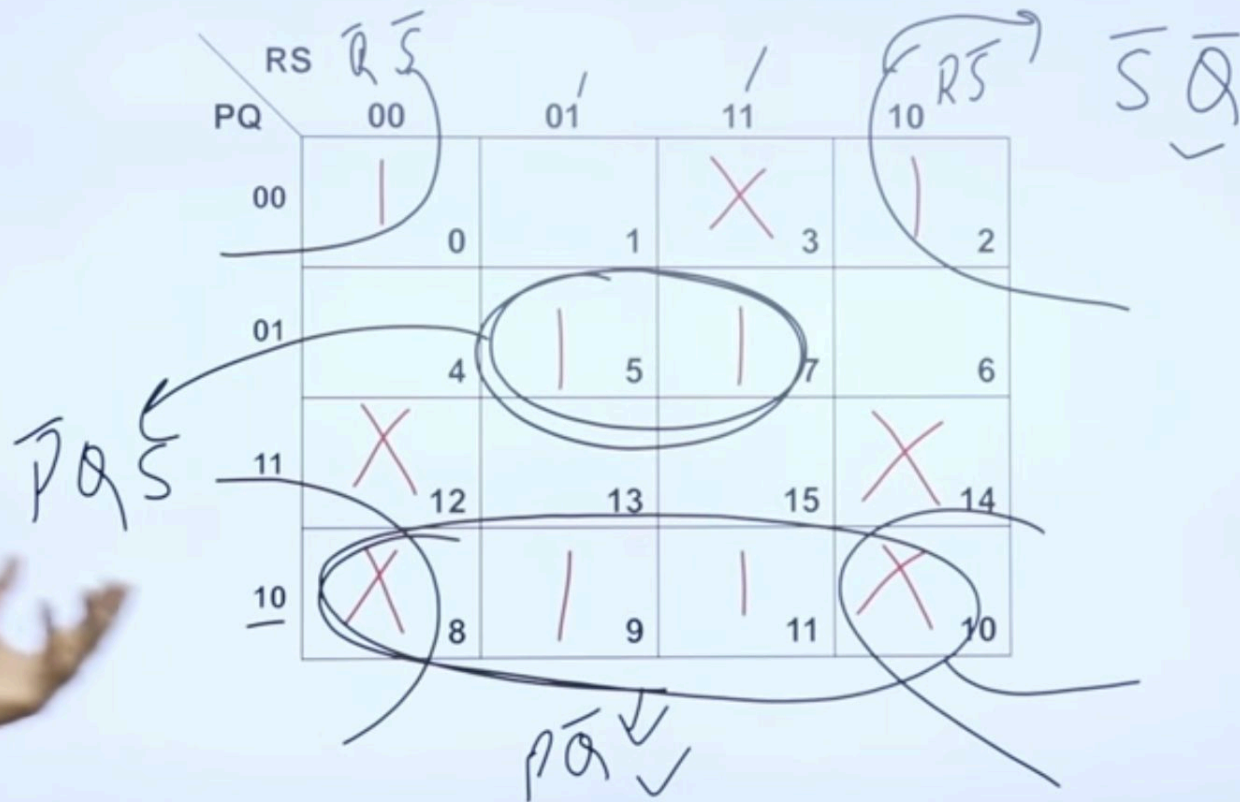
$$F(P, Q, R, S) = \underline{\Sigma m}(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$

RS		PQ			
PQ	RS	00	01	11	10
	00	1 0		X 3	1 2
	01		1 5	1 7	
	11	X 12			X 14
	10	X 8	1 9	1 11	X 10

$$F(P, Q, R, S) = \underline{\Sigma m}(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$

RS		PQ			
PQ	RS	00	01	11	10
	00	1 0		X 3	1 2
	01		1 5	1 7	
	11	X 12			X 14
	10	X 8	1 9	1 11	X 10

$$F(P, Q, R, S) = \sum m(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$



Two possibilities

Minterms, Maxterms
will be
given in question

$$\Sigma m(1, 2, 3, 5, 6, 7, 10)$$

$$\Pi M(1, 2, 4, 5)$$

Boolean Expression
will be
given in question

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

Q1. Simplify boolean function using K-map in SOP and POS forms and implement with gates.

$$\underline{f(A,B,C) = \sum m(0, 2, 3, 4, 5, 6)}$$

Note → $\sum m()$ Minterms → SOP → when $F=1$

So put 1 in KMap

TM → Maxterms → POS → when $F=0$

and implement with gates.

$$f(A,B,C) = \underline{\underline{\sum m(0,2,3,4,5,6)}}$$

Note → $\sum m()$ Minterms → SOP → when F=1

So put '1' in kMap

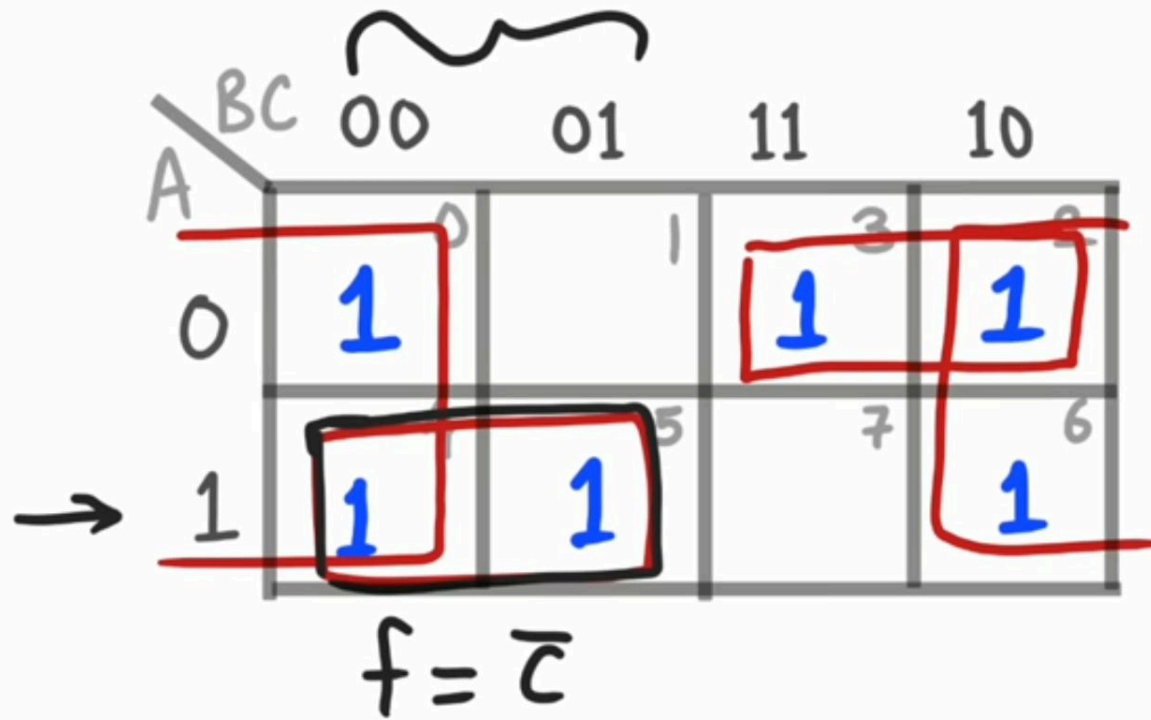
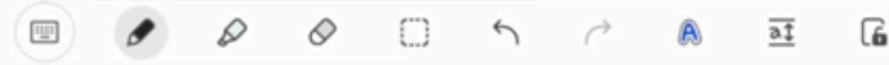
TTM → Maxterms → POS → When F=0

So put '0' in kMap

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

$$\Sigma m(0, 2, 3, 4, 5, 6)$$

$$\{$$



A	\bar{B}	C
1	0	0
0	0	1

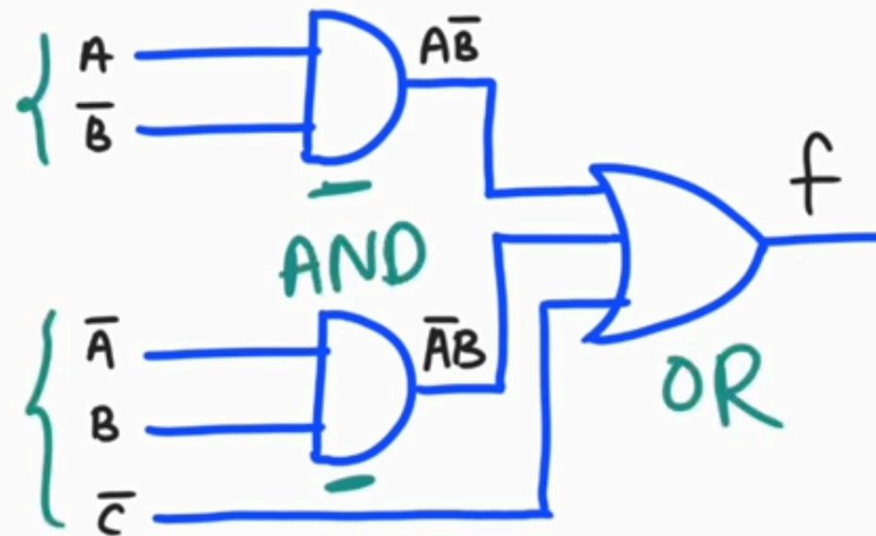


BC \ A	00	01	11	10
0	1		1	1
1	1	1		1

$$f = \bar{C} + A\bar{B} + \bar{A}B \checkmark$$

SOP

$$f = \bar{C} + \underline{A\bar{B}} + \underline{\bar{A}B}$$





A \ BC	00	01	11	10
0	0	1	3	2
1	4	5	7	6

0

0

$\pi M(1,7)$



A \ BC	00	01	11	10
0	0 1	1 0	3 1	2 1
1	4 1	5 1	7 0	6 1

$\pi M(1,7)$

A \ BC	00	01	11	10
	0	1	3	2
0	1	0	1	1
1	1	1	0	1

✓ $\Pi M(1,7)$

$$f = \bar{A}\bar{B}C + ABC \dots \dots \text{SOP}$$

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$A \rightarrow$

BC	00	01	11	10
0		0		
1			0	

$\Pi M(1,7)$

$$f = \bar{A}\bar{B}C + \underline{ABC} \dots \dots \text{SOP}$$

BC	00	01	11	10
A				
0	0	1	3	2
1	4	5	7	6

A →

✓ $f = \bar{A}\bar{B}C + \underline{ABC} \dots \dots \text{SOP}$

$f = (A+B+\bar{C}) \cdot (\bar{A} + \bar{B} + \bar{C}) \dots \dots \text{POS}$

$\Pi M(1,7)$

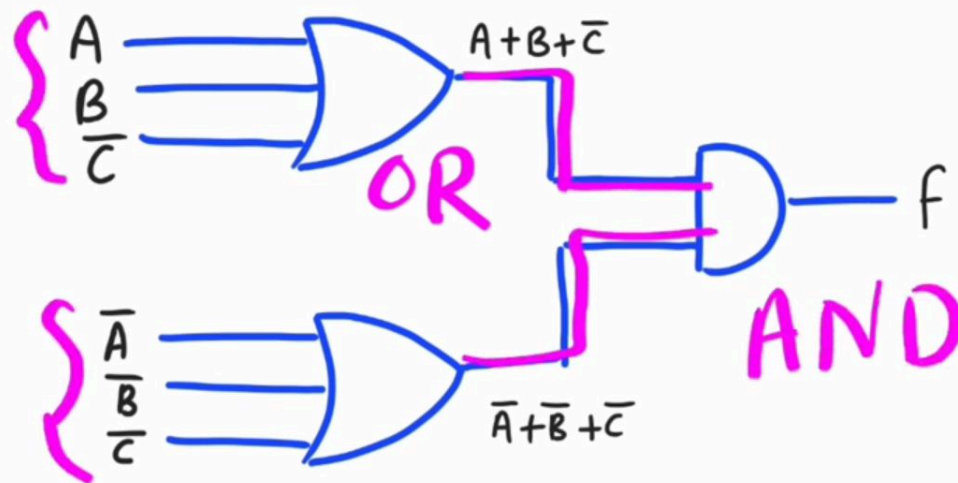
Note → for POS

1 → \bar{A}

0 → A



$$f = \underline{(A+B+\bar{C})} \cdot (\bar{A}+\bar{B}+\bar{C}) \dots \text{POS}$$





Q2. Simplify the following expression

1. SOP ✓

2. POS ✓

$$f(A, B, C, D) = \underline{A\bar{B}C + \bar{A}BC\bar{D} + AB\bar{C}D + ABC}$$





$$f(A, B, C, D) = \underline{A\bar{B}C} + \bar{A}BC\bar{D} + AB\bar{C}D + ABC$$

CD \ AB	$\bar{C}\bar{D}$	$\bar{C}D$	$C\bar{D}$	CD
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	4	5	7	6
AB	12	13	15	14
$A\bar{B}$	8	9	11	10



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

→

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	4	5	7	6
AB	12	13	15	14
$A\bar{B}$	8	9	11	10

Handwritten blue '1's are placed in the cells corresponding to minterms 1, 2, 6, and 10.



$$f(A,B,c,D) = \overline{A}\overline{B}C + \overline{A}BC\overline{D} + A\overline{B}C\overline{D} + ABC$$

↓

CD	$\overline{C}\overline{D}$	$\overline{C}D$	$C\overline{D}$	CD
$\overline{A}\overline{B}$	0	1	3	2
$\overline{A}B$	4	5	7	6 1
AB →	12	13	15	14
$A\overline{B}$	8	9	11 1	10 1

○



$$f(A, B, C, D) = \overline{A}\overline{B}C + \overline{A}BC\overline{D} + A\overline{B}C\overline{D} + ABC$$

→

AB \ CD	$\overline{C}\overline{D}$	$\overline{C}D$	$C\overline{D}$	CD
$\overline{A}\overline{B}$	0	1	3	2
$\overline{A}B$	4	5	7	6
AB	12	13	15	14
$A\overline{B}$	8	9	11	10

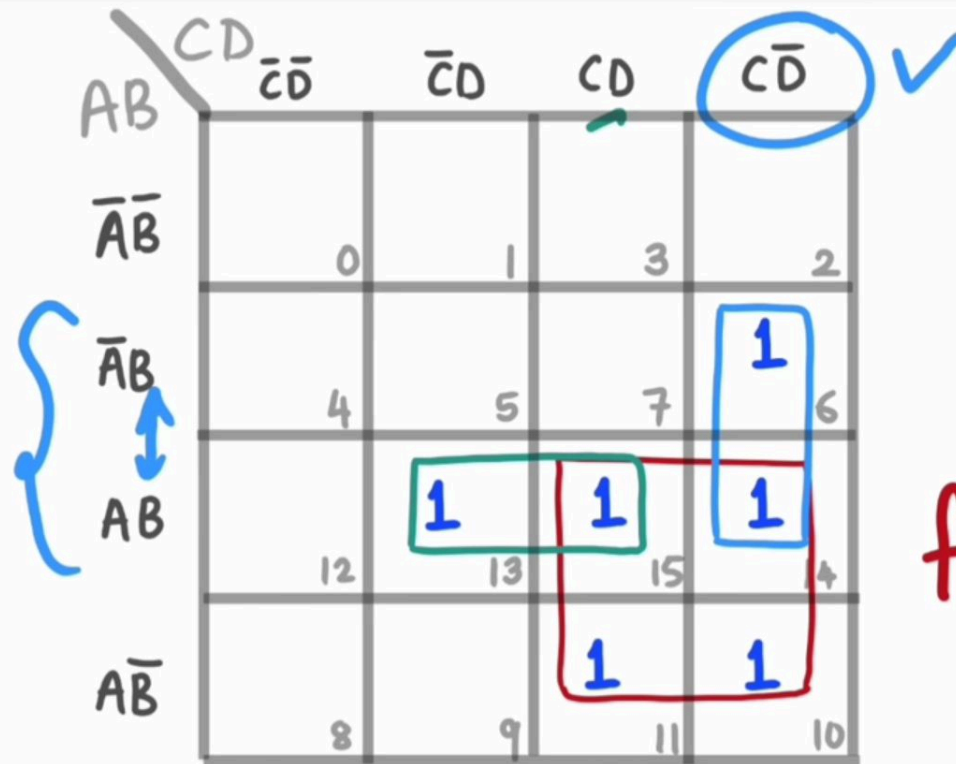
$$f(A, B, C, D) = A\bar{B}C + \bar{A}BC\bar{D} + AB\bar{C}D + ABC$$

Karnaugh map for $F(A,B,C,D) = A + B + C + D$. The map shows 1s in all cells except the top-left cell (0). Red boxes highlight the prime implicants: a 4-cell box for A , a 2x2 square for B , a 2x2 square for C , and a 2x2 square for D .

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$$f = AC + ABD + BC\bar{D}$$

SOP ✓

	CD			
	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	4	5	7	6
AB	12	13	15	14
$A\bar{B}$	8	9	11	10



	CD			
AB	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	4	5	7	6
AB	12	13	15	14
$A\bar{B}$	8	9	11	10

$$\bar{A}\bar{B} \rightarrow A+B$$

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	4	5	7	6
AB	12	13	15	14
$A\bar{B}$	8	9	11	10

Pos

$$\bar{A}\bar{B} \rightarrow A+B$$


		CD			
		$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
{	$\bar{A}\bar{B}$	0	1	3	2
	$\bar{A}B$	4	5	7	6
	AB	12	13	15	14
	$A\bar{B}$	8	9	11	10

$$\bar{A}\bar{C} \rightarrow A+C$$

		CD			
		$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
AB					
$\bar{A}\bar{B}$	0	1	3	2	
$\bar{A}B$	4	5	7	6	
AB	12	13	15	14	
$A\bar{B}$	8	9	11	10	

$$\bar{A}D \rightarrow A + \bar{D}$$

Karnaugh map for the function $F(A, B, C) = \sum(0, 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15)$. The map shows all 16 cells containing 1. A red box highlights the first column (C=0), and a blue circle highlights the top cell (A=0, B=0).

$$\overline{C}\overline{D} \rightarrow C+D$$

Hand-drawn Karnaugh map for a 4-variable function with variables A, B, C, and D. The map is a 4x4 grid with rows labeled AB, $\bar{A}\bar{B}$, $\bar{A}B$, AB and columns labeled $\bar{C}\bar{D}$, $\bar{C}D$, CD , $C\bar{D}$. The cells contain 0s and 1s. Two groups of 1s are circled in red: one group of two 1s in the first row (cells 0 and 1) and one group of two 1s in the last row (cells 8 and 9). A blue arrow points to the first row, and another blue arrow points to the last row. A blue bracket is above the first two columns.

$$\overline{B}\overline{C} \rightarrow B+C$$

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$$\bar{A}\bar{B} + \bar{A}\bar{C} + \bar{A}D + \bar{C}\bar{D} + \bar{B}\bar{C} \rightarrow \text{SOP}$$

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