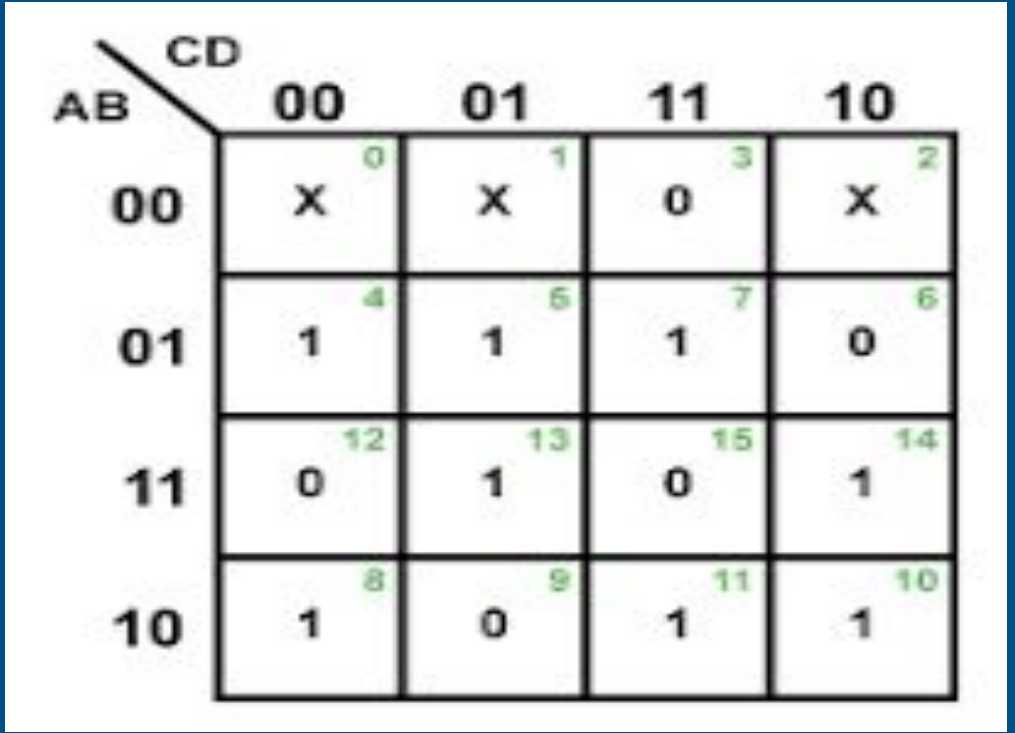
Logical Simplification

Karnaugh Map

Chapter 5



AB \ CD	00	01	11	10
00	X (0)	X (1)	0 (3)	X (2)
01	1 (4)	1 (5)	1 (7)	0 (6)
11	0 (12)	1 (13)	0 (15)	1 (14)
10	1 (8)	0 (9)	1 (11)	1 (10)

Karnaugh map(K-map)

The K-map is a systematic way of simplifying Boolean expressions. With the help of the K-map method, we can find the simplest POS and SOP expression, which is known as the minimum expression. The K-map provides a cookbook for simplification.

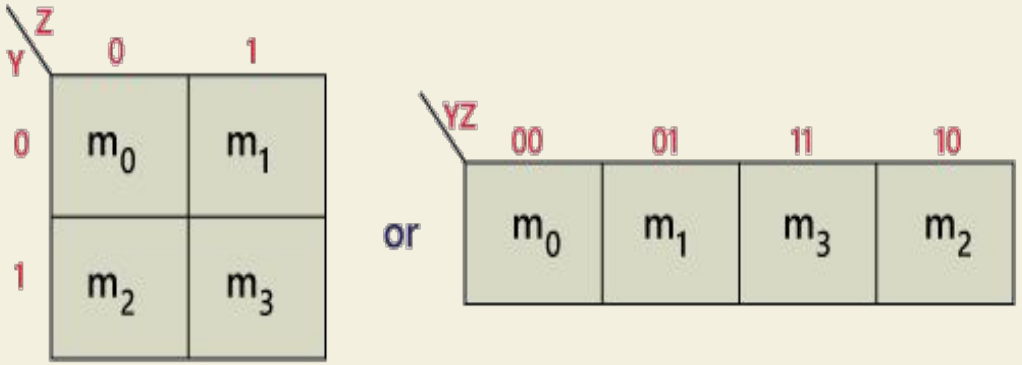
The K-map method is used for expressions containing 2, 3, 4, and 5 variables. For a higher number of variables, there is another method used for simplification called the Quine-McClusky method. In K-map, the number of cells is similar to the total number of variable input combinations. For example, if the number of variables is three, the number of cells is $2^3=8$, and if the number of variables is four, the number of cells is 2^4. The K-map takes the SOP and POS forms. The K-map grid is filled using 0's and 1's. The K-map is solved by making groups. There are the following steps used to solve the expressions using K-map:

Karnaugh map(K-map)

1. First, we find the K-map as per the number of variables.
2. Find the maxterm and minterm in the given expression.
3. Fill cells of K-map for SOP with 1 respective to the minterms.
4. Fill cells of the block for POS with 0 respective to the maxterm.
5. Next, we create rectangular groups that contain total terms in the power of two like 2, 4, 8, ... and try to cover as many elements as we can in one group.
6. With the help of these groups, we find the product terms and sum them up for the SOP form.

2 variable k-map

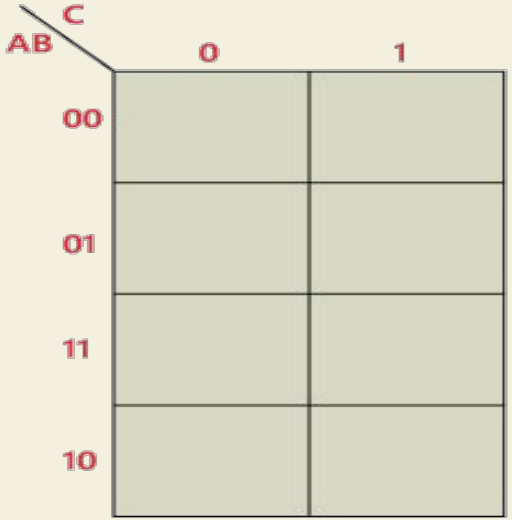
There is a total of 4 variables in a 2-variable K-map. There are two variables in the 2-variable K-map. The following figure shows the structure of the 2-variable K-map:

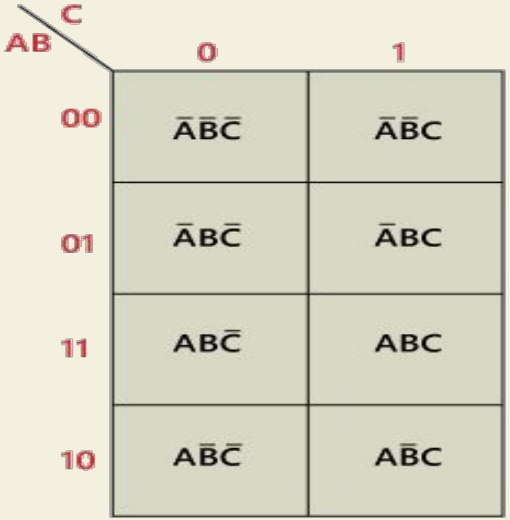


- In the above figure, there is only one possibility of grouping four adjacent minterms.
- The possible combinations of grouping 2 adjacent minterms are {(m0, m1), (m2, m3), (m0, m2) and (m1, m3)}.

3 variable k-map

The 3-variable K-map is represented as an array of eight cells. In this case, we used A, B, and C for the variable. We can use any letter for the names of the variables. The binary values of variables A and B are along the left side, and the values of C are across the top. The value of the given cell is the binary values of A and B at left side in the same row combined with the value of C at the top in the same column. For example, the cell in the upper left corner has a binary value of 000, and the cell in the lower right corner has a binary value of 101.





4 variable k-map

The 4-variable K-map is represented as an array of 16 cells. Binary values of A and B are along the left side, and the values of C and D are across the top. The value of the given cell is the binary values of A and B at left side in the same row combined with the binary values of C and D at the top in the same column. For example, the cell in the upper right corner has a binary value of 0010, and the cell in the lower right corner has a binary value of 1010