DIGITAL ELECTRONICS:
K-MAP

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BOOLEAN EXPRESSION REDUCTION USING K-MAP

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K-MAP

The complexity of the digital logic gates that implement a Boolean function is directly related to the complexity of the algebraic expression from which the function is implemented.

A map method 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 also known as the **Karnaugh map or K-map.**

K-MAP

K-map can take two forms:

Sum of product (SOP)
Product of Sum (POS)

Steps to Solve Expression using K-map

- Select the K-map according to the number of variables.

- Identify minterms or maxterms as given in the problem.

- For SOP put 1's in blocks of K-map respective to the minterms (0's elsewhere).

- For POS put 0's in blocks of K-map respective to the max terms (1's elsewhere).

- Make rectangular groups containing total terms in power of two like 2,4,8 (except 1) and try to cover as many elements as you can in one group.

- From the groups made in step 5 find the product terms and sum them up for SOP form.

SOP FORM K-MAP

1. K-map of 3 variables

BC \ A	B'C' 00	B'C 01	BC 11	BC' 10
A' 0	A'B'C' (0)	A'B'C (1)	A'BC (3)	A'BC' (2)
A 1	AB'C' (4)	AB'C (5)	ABC (7)	ABC' (6)

SOP(MINTERMS)

8 Blocks = 1
4 Blocks = 1 variable term
2 Blocks = 2 variable term
1 Block = 3 variable term

K-map for 4 variables

K-map of 4 variables with don't care

Minimize the following 4-variable Boolean expression in SOP form using K-map.

$$f(A, B, C, D) = \sum m(0, 1, 4, 5, 6, 10, 13) + d(2, 3)$$

Solution

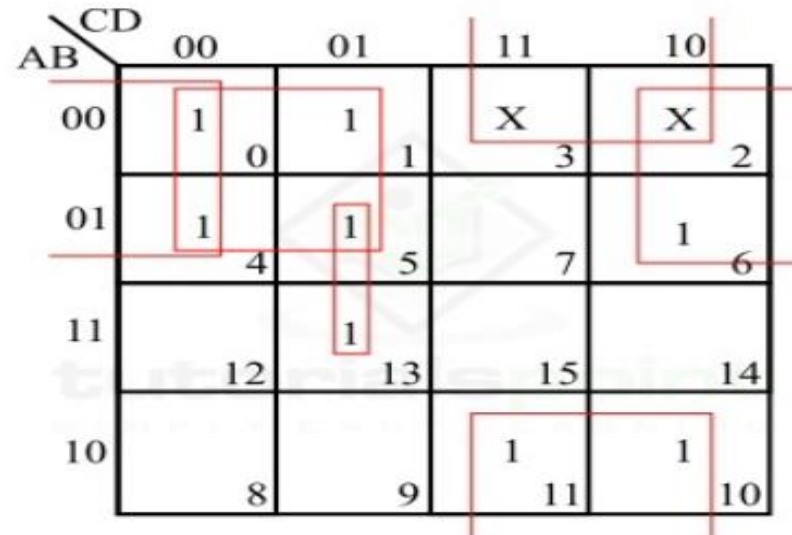The SOP K-map representation of the given Boolean function is shown in Figure 1.

Figure 1 - SOP K-Map

Therefore, the minimal Boolean expression is,

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

Problem

Minimize the following 4-variable Boolean expression in POS form using K map.

$$f(A, B, C, D) = \prod M(1, 5, 6, 12, 13, 14) + d(2, 4)$$

Solution

The POS K-map representation of the given Boolean function is shown in Figure-2.

Figure 2 - POS K-Map

Therefore, the minimal Boolean expression is,

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

Assessment

1. What is the necessity of K-Map?

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2. Mention few methods used to minimize Boolean Expression?

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