Logic design

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First stage

(Lecture 8)

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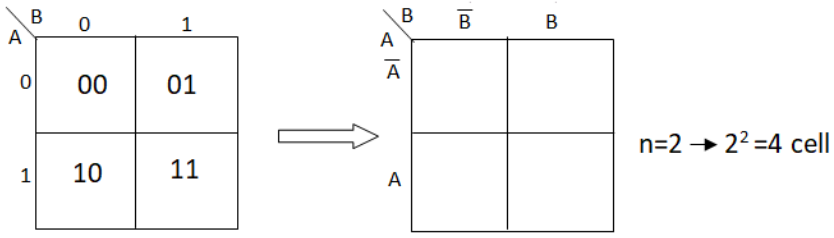
Chapter three

-Karnaugh map-

Karnaugh map simplification (k-map) :

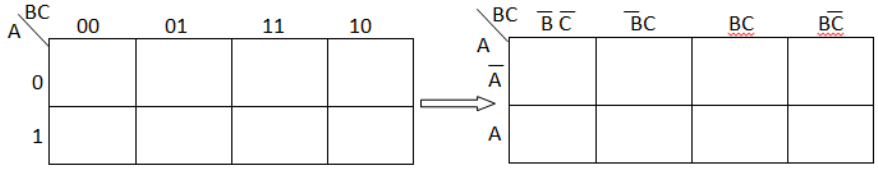
It is an important method to simplify or minimize a Boolean expression . It is composed of number of adjacent "cells" . Each cell corresponds to a T.T. row , therefore there must be 2^n
Cells in the k-map (where n=no. of input variables) .

For two input variables (A&B) :



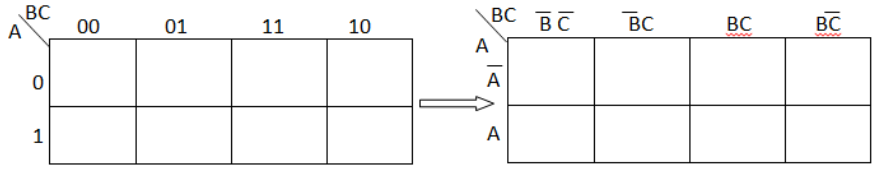
n=2 → 2^2 =4 cell

For three input variables (A,B,C) :



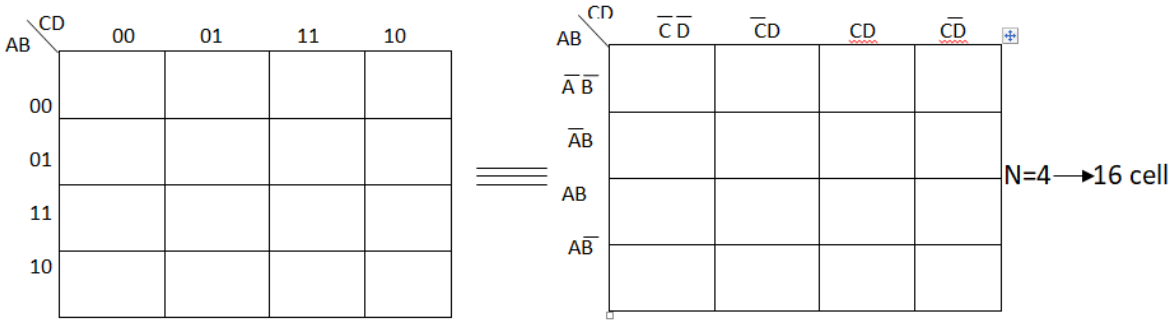
N=3 8 cell

For three input variables (A,B,C) :



N=3 8 cell

For four input variables (A,B,C,D) :



N=4⟶16 cell

The first step in the minimization method is to implement the T.T. to the K-map.
1's and 0's in the output of the T.T. is placed in the cells corresponding to the input variables of the T.T.

EX:

AB	Z
00	0
01	0
10	1
11	1

A \ B	0	1
0	0	0
1	1	1

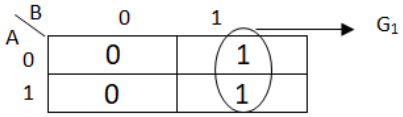
Ex:

ABC	Z
000	0
001	1
010	0
011	0
100	0
101	0
110	1
111	1

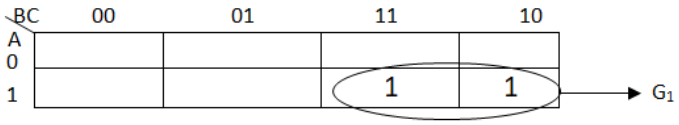
A \ BC	00	01	11	10
0	0	1	0	0
1	0	0	1	1

Adjacent cells :

The adjacent cells on k- map are those that differ by only one variable (only one variable changes from 0 to 1 or 1 to 0)

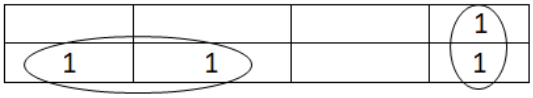


$G_1 = B$

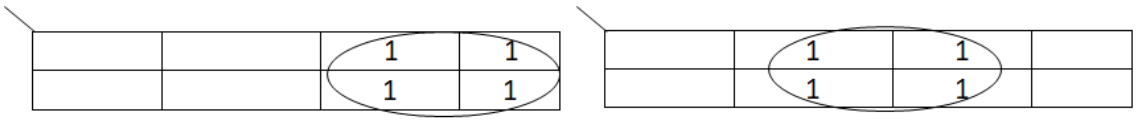


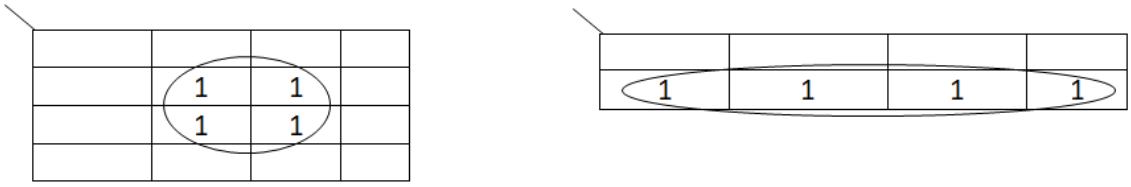
$G_1 = AB$

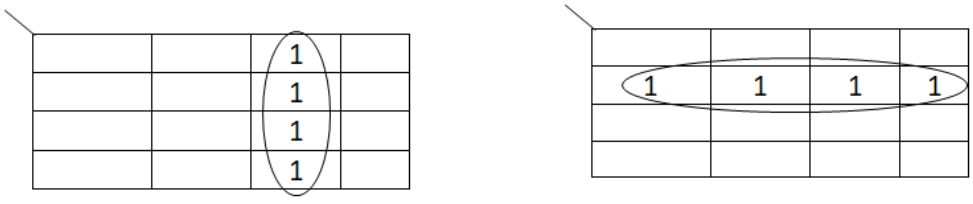
If more than one pair exist on k-map , we can OR the simplified products to get the final Boolean exp.



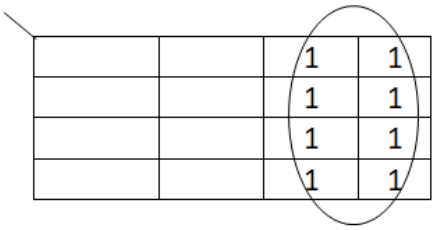
A quad is a group of four 1's that are horizontally or vertically adjacent . two variables are eliminated in the quad group.

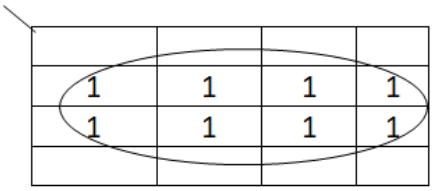






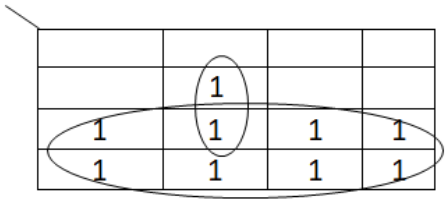
Octet is group of eight 1's that are horizontally or vertically adjacent , so three variables can be eliminated .

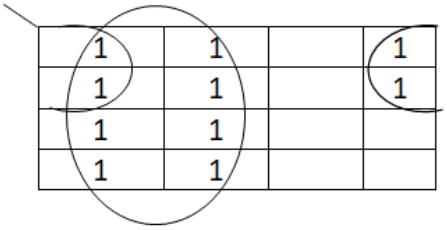




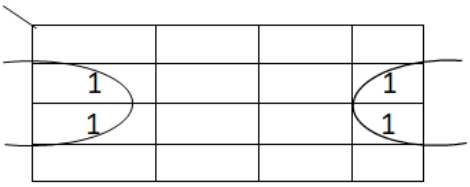
Over lapping :

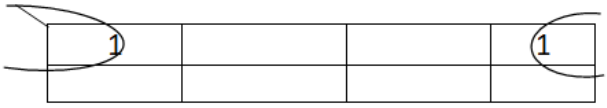
The same (1) can be used for more than one group





Rolling :





Summary of k-map method :

1-Implement the T.T. to k-map

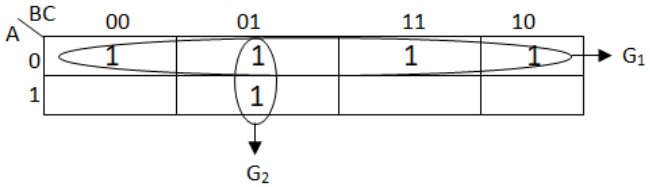
2-Encircle the octet , quads and pairs . Remember to roll and overlap to get the largest possible group.

3- If any isolated 1's , encircle each .

4-Write the Boolean exp. By ORing the products corresponding to the encircle groups.

EX: simplify the following function using k-map

$F(A,B,C) = \sum (0,1,2,3,5)$

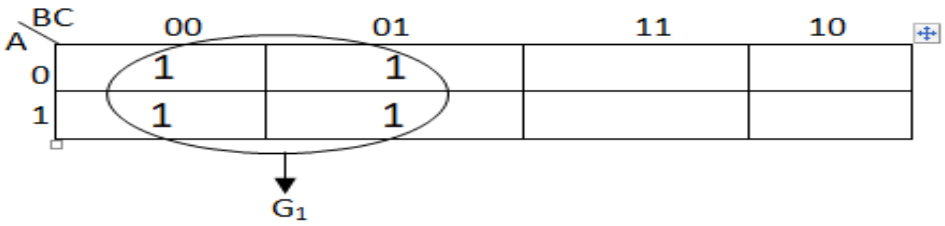


$F = G_1 + G_2$

$= \overline{A} + \overline{B}C$

EX: Simplify the following function using k-map

$F(ABC) = \sum m_0, m_1, m_4, m_5$

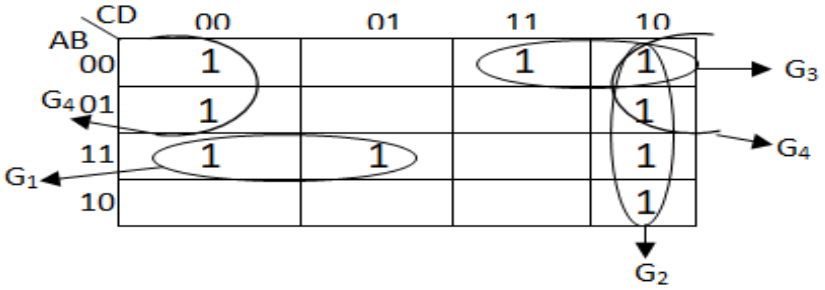


$F = G_1$

$= \overline{B}$

EX: Simplify the following function using k-map :

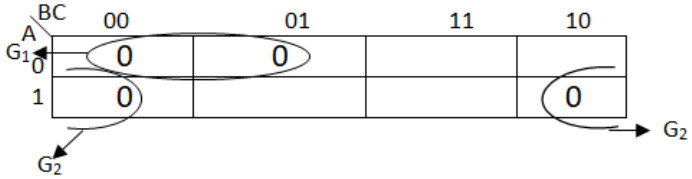
$F(ABCD) = \sum (0,2,3,4,6,10,12,13,14)$



$F = G_1 + G_2 + G_3 + G_4$

EX: Find the simplified output in PS method using k-map for the following function :

$F = (ABC) = \pi (0,1,4,6)$

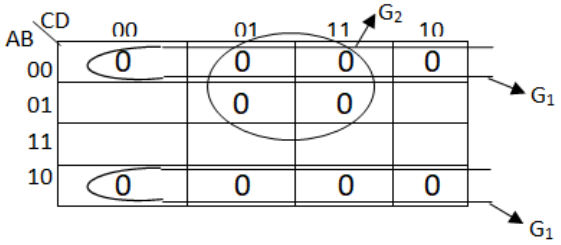


$F = G_1.G_2$

$= (A+B)(\overline{A}+C)$

EX: Simplify the following using k-map :

$F(ABCD) = \pi(0,1,2,3,5,7,8,9,10,11)$



$F = G_1 . G_2$

$= B(A+\overline{D})$

Don't care condition :

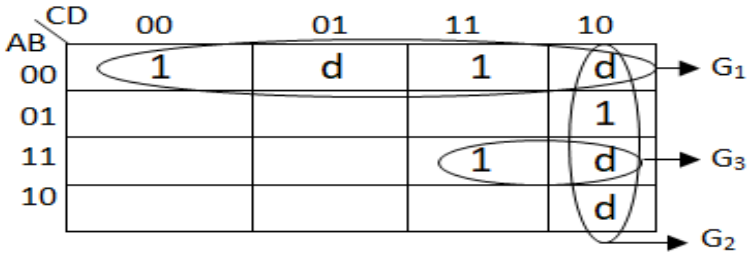
Some logic ccts. can be designed so that there are certain input conditions for which there are no specified output levels , because these input conditions will never occur.

It is necessary to specify the output for these conditions by either (0) or (1) in order to produce the simplest output exp.

EX: Simplify the following using k-map.

$F(ABCD) = \sum(0,3,6,15)$

dcc = 1,2,10,14



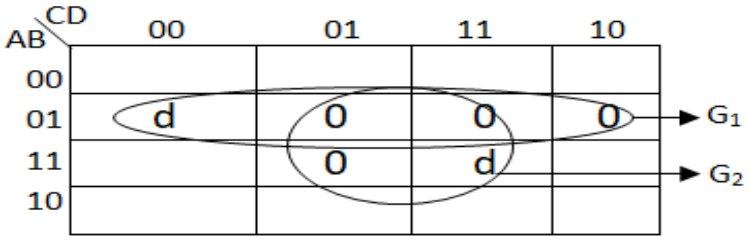
$F = G_1 + G_2 + G_3$

$= \overline{A}\,\overline{B} + C\overline{D} + ABC$

EX: Simplify the following function using k-map :

$F(ABCD) = \pi(5,6,7,13)$

dcc = (4,15)



$F = G_1 . G_2$

$= (A+\overline{B})\,(\overline{B}+\overline{D})$

H.W.: Simplify the following using PS and SP method by k-map :

$F(ABCD) = \pi(2,3,6,7,13)$

dcc = (0,4,8,9,10,12,14)