

E-content of MSc Semester II Electronics – Unit 4

KARNAUGH MAP

By:-

Dr. Surabhi Prasad

Professor & Head

Department of Physics

Patna University

Karnaugh Map (K-map) -

The K-map is a graphical representation that provides a systematic method for simplifying the Boolean Expression.

Two-variable K-map

For n variable K-map 2^n cells are required. Therefore for 2-variable K-map $2^2 = 4$ cells will be required.

	B	0	1
A	0	00	01
	1	10	11

	B	\bar{B}	B
A	\bar{A}	$\bar{A}\bar{B}$	$\bar{A}B$
	A	$A\bar{B}$	AB

	B		
A		0	1
		2	3

Three variable K-map cells are required
 3 variable K map $2^3 = 8$ cells are required

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

	C	0	1
AB	00	0	1
	01	2	3
	11	6	7
	10	4	5

Four variable K-map

$2^4 = 16$ cells are required

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

Q Plot the Boolean expression

$$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} \quad \text{-SOP form}$$

$$Y = m_4 + m_{10} + m_6 + m_1$$

$$Y = \sum m(4, 6, 10, 13)$$

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

Grouping of cells for simplification

→ Adjacent cells which have 1's can be grouped together in 2's Power

i.e. $2^0 = 1$

$2^1 = 2$ adjacent cell can be grouped (Pair)

$2^2 = 4$ "

8

16

(Quad)
(Octet)

	CD	$\bar{C}\bar{D}$	$\bar{C}D$	$C\bar{D}$	CD	$\bar{C}\bar{D}$	$\bar{C}D$	$C\bar{D}$
AB	1				1			
$\bar{A}\bar{B}$	1							
$\bar{A}B$			1	1				
AB			1	1				
$\bar{A}\bar{B}$					1			

$(\bar{A}\bar{B} + \bar{A}B) \cdot \bar{C}\bar{D}$
 $A(\bar{B} + B) \cdot \bar{C}\bar{D}$
 $\bar{A}\bar{C}\bar{D} + B\bar{C}\bar{D}$
 $A\bar{B}\bar{D}$

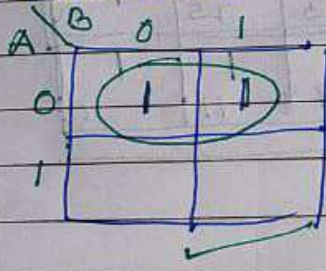
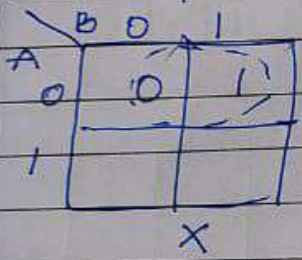
$F = \bar{A}\bar{B}\bar{D} + B\bar{C}\bar{D} + A\bar{B}\bar{D}$

$F = \bar{C} + \bar{D}$

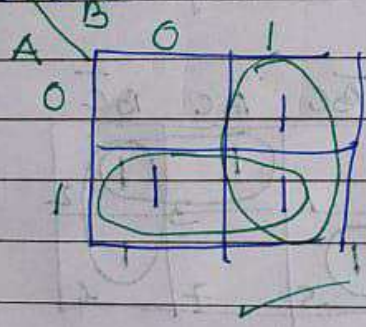
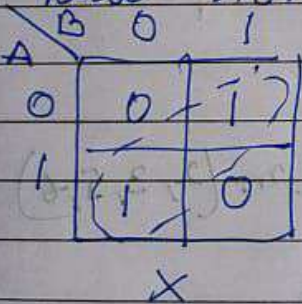
$F = \bar{A}\bar{C}\bar{D} + B\bar{C}\bar{D} + A\bar{B}\bar{D}$

Rules followed for K-map simplification

1. Groups do not include any cell containing a zero



2. Groups may be horizontal or vertical but not diagonal



- 3. Groups must contain 1, 2, 4, 8 or 2^n cells
- 4. Each group should be as large as possible

Q Simplify the following expression using K-map

$$F(ABCD) = \sum m(4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15)$$

Solⁿ :-

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

$F = B + A$

Simplify $F(ABC) = \bar{A}BC + B\bar{C} + A\bar{B}\bar{C} + A\bar{B}C$ in SOP form and POS form

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
\bar{A}	0	1	3	2
A	4	5	7	6

$F = \sum m(2, 3, 5, 6)$

POS

$F = B\bar{C} + \bar{A}B + A\bar{B}\bar{C}$
SOP form.

$F = \prod M(0, 1, 4, 7)$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
\bar{A}	0	1	3	2
A	4	5	7	6

$F = \bar{B}\bar{C} + \bar{A}\bar{B} + A\bar{B}C$

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

	BC	B+C	B+C	$\overline{B+C}$	$(\overline{B+C})$
A	0	1	1	0	0
\overline{A}	0	0	1	1	0

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

8) Obtain Reduce Express with for

$$F(A, B, C, D) = \sum m(0, 1, 2, 5, 7, 8, 9, 10, 13, 15)$$

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

$$F = BD + \overline{C}D + \overline{B}\overline{D}$$

————— X —————