BEE Experiments Record.

11. REDUCTION OF BOOLEAN EXPRESSION USING K-MAP.

☆ PRE - LAB QUESTIONS ⟹

① Write the Distributive property of Boolean Algebra.

→ The Distributive property of Boolean Algebra is as follows:

- $A(B+C) = AB + AC$

② Write down the De-Morgan's law.

→ The De-Morgan's laws are as follows:

1) $\overline{A+B} = \overline{A} \cdot \overline{B}$

2) $\overline{A \cdot B} = \overline{A} + \overline{B}$

③ What do you mean by don't care conditions in K-Map or truth table?

→ 1) One of the very significant and useful concept in simplifying the output expression using K-Map is the concept of "Don't Cares".

2) The "Don't Care" condition allows us to replace the empty cell of a K-Map to form a grouping of the variables which is larger than that of forming groups with don't cares.

④ How many cells are in 4 and 5 variable K-Map?

→ 1) Any Boolean expression or function comprising of 5-variables can be solved using 5 variable K-Map. Such a 5-variable K-Map contains $2^5 = 32$ cells.

2) Any Boolean expression or function comprising of 4-variables can be solved using 4 variable K-Map. Such a 4 variable K-Map contains $2^4 = 16$ cells.

⑤ State the difference between SOP and POS.

→

	BASIS FOR COMPARISON	SUM OF PRODUCT (SOP)	PRODUCT OF SUM (POS)
1.	Expands to	Sum of Product	Product of Sum
2.	Basic	Form of representation of boolean expression incorporating min terms.	Technique of generating a boolean expression involving max terms.
3.	Expression includes	Product terms are taken where the input set produces a value 1.	Only Sum terms which generate a value 0.
4.	Method	1 represents the variable and 0 is the complement of it.	0 represents the variable and 1 is complement of the variable.
5.	Obtained through	Adding corresponding product terms.	Multiplying relevant sum terms.

★ AIM ⟹

To simplify and verify the Boolean expression using K-map.

★ APPARATUS REQUIRED ⟹

Logic trainer kit, Logic gates / ICs, wires.

☆ DIAGRAM ⟹

1) Karnaugh Map (K-Map) of 4 variables.

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

☆ OBSERVATIONS ⟹

· The given expression is:

$y = \pi M(0, 2, 3, 4, 8, 10, 14)$

$y(A, B, C, D)$.

→ Simplification using 4 variable K-Map:

AB \ CD	CD	CD̄	C̄D̄	C̄D
	00	01	11	10
AB 00	0 (0)	1	0 (3)	0 (2)
AB̄ 01	0 (4)	5	7	6
ĀB̄ 11	12	13	15	0 (14)
ĀB 10	0 (8)	9	11	0 (10)

So, $y = (A + C + D) \cdot (\bar{A} + \bar{C} + D) \cdot (B + D) \cdot (A + B + \bar{C})$

☆ TABULAR COLUMN ⟹

A (8)	B (4)	C (2)	D (1)	$(A+B+\bar{C})$	$(A+C+D)$	$(\bar{A}+\bar{C}+D)$	$(B+D)$	y
0	0	0	0	1	0	1	0	0
0	0	0	1	1	1	1	1	1
0	0	1	0	0	1	1	0	0
0	0	1	1	0	1	1	1	0
0	1	0	0	1	0	1	1	0

0	1	0	1	1	1	1	1	1
0	1	1	0	1	1	1	1	1
0	1	1	1	1	1	1	1	1
1	0	0	0	1	1	1	0	0
1	0	0	1	1	1	1	1	1
1	0	1	0	1	1	0	0	0
1	0	1	1	1	1	1	1	1
1	1	0	0	1	1	1	1	1
1	1	0	1	1	1	1	1	1
1	1	1	0	1	1	0	1	0
1	1	1	1	1	1	1	1	1

☆ RESULT ⟹

Thus, simplification and verification of the Boolean expression using K-Map is done.

☆ POST-LAB QUESTIONS ⟹

① Simplify the expression: $F = AB + A\overline{B}$

→ as, $F = AB + A\overline{B}$

$= A(B + \overline{B})$ ..... as $(AB + AC = A[B + C])$

$= A(1)$ ..... as $(A + \overline{A} = 1)$

$= A$

② Give the merits and demerits of K-map.

→ The merits of K-map are as follows:

1) Easy and convenient to implement.
2) Data representation is simplified.
3) Reduces the cost and quantity of logic gates.
4) Less number of steps when compared to algebraic minimization technique.

The demerits of K-map are as follows:

1) Complexity of K-map simplification process increases with increase in number of variables.
2) The minimum expression obtained might not be unique.
3) Care must be taken to field in every cell with the relevant theory/entry such as (0, 1) or don't care terms.

③ What is the difference between K-Map and Quine-McCluskey?

→ 1) Unlike a Karnaugh map (K-Map), the Quine-McCluskey method uses tables, which provide simple pattern recognitions.
2) Quine-McCluskey method is a tabular method that has an advantage over Karnaugh maps when a large number of inputs are present.
3) The Quine-McCluskey method does not require pattern recognition.

④ Give steps for reducing two variable expression using K-Map?

→ STEP : 1

1) Firstly, we define the given expression in its canonical form.
2) Next, we create the K-Map by entering 1 to each product-term into the K-Map cell and fill the remaining cells with zero.

STEP : 2

1) Next, we form the groups by considering each one in the K-Map.

2) Notice that each group should have the largest number of 'ones'. A group cannot contain an empty cell or cell that contains 0.

3) In a group, there is a total of 2^n number of ones. Here; $n = 0, 1, 2, \ldots\ldots, n$.

4) We group the number of ones in decreasing order. First, we have to try to make the group of eight, then for four, after that two and lastly for 1.

5) In horizontally or vertically manner, the groups of ones are formed in the shape of rectangle, and square. We cannot perform the diagonal grouping in K-Map.

6) The elements in one group can also be used in different groups only when the size of the group is increased.

7) The elements located at the edges of the table are considered to be adjacent. So, we can group these elements.

8) We can consider the 'don't care condition' only when they aid in increasing the group-size. Otherwise 'don't care' elements are discarded.

STEP : 3

1) In the next step, we find the Boolean expression for each group. By looking at the common variables in cell-labelling, we define the groups in terms of input variables.

STEP : 4

1) Lastly, we find the boolean expression for the output. To find the simplified boolean expression in the SOP form, we combine the product-terms of all individual groups.