SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECB201 – DIGITAL SYSTEMS DESIGN

II YEAR/ III SEMESTER

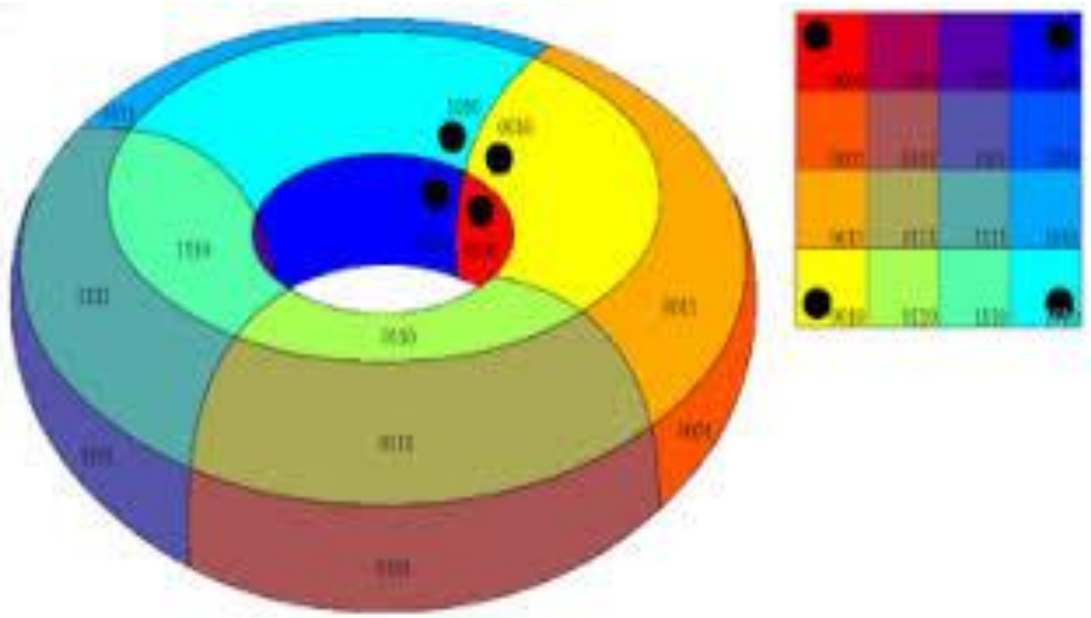
UNIT 1 – BOOLEAN THEOREMS AND LOGIC REDUCTION

TOPIC - KARNAUGH MAP MINIMIZATION

WHY KARNAUGH MAP MINIMIZATION?

- K-map simplification technique is simpler and less error-prone compared to the method of solving the logical expressions using Boolean laws.

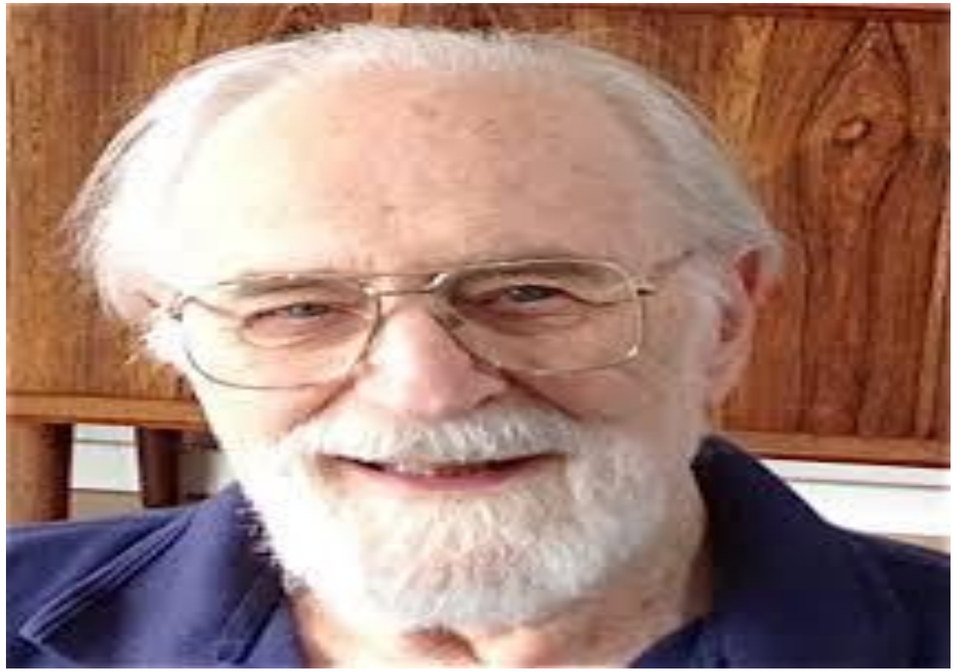
- Its main purpose is to simplify Boolean algebraic expressions.



KARNAUGH MAP

- KARNAUGH MAP is also named as K map

- K map was introduced by Dr. Maurice karnaugh in the year 1953

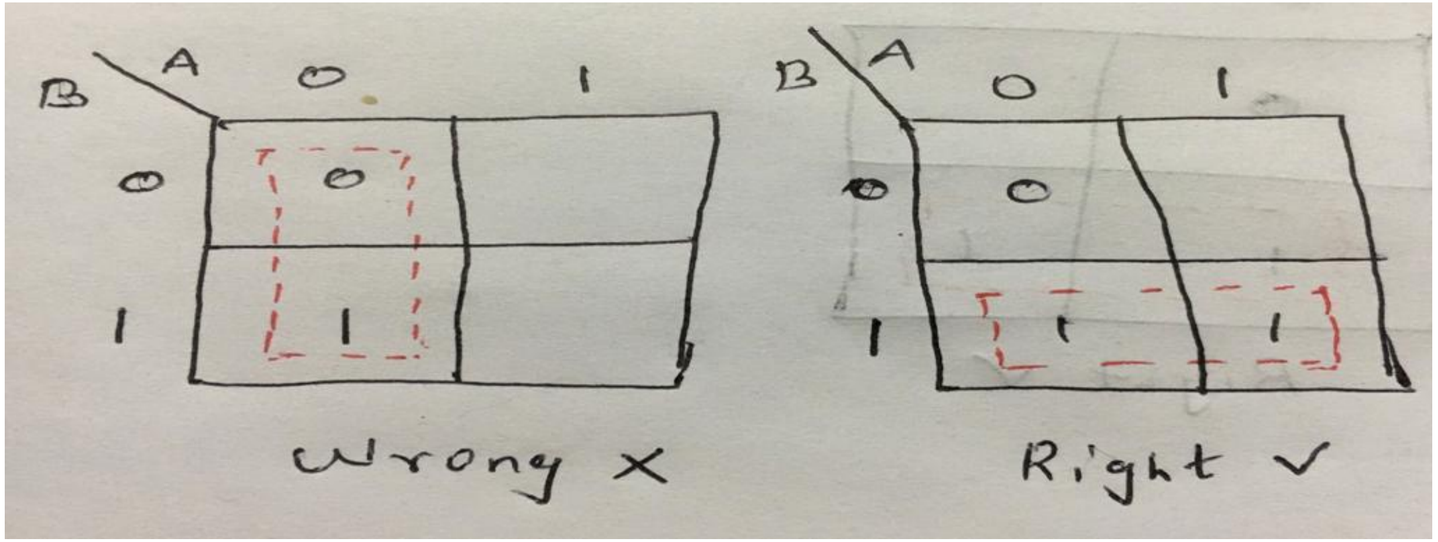


KARNAUGH MAP - Rules

- Karnaugh map is a pictorial method of grouping together expressions with common factors and then eliminating unwanted variables.

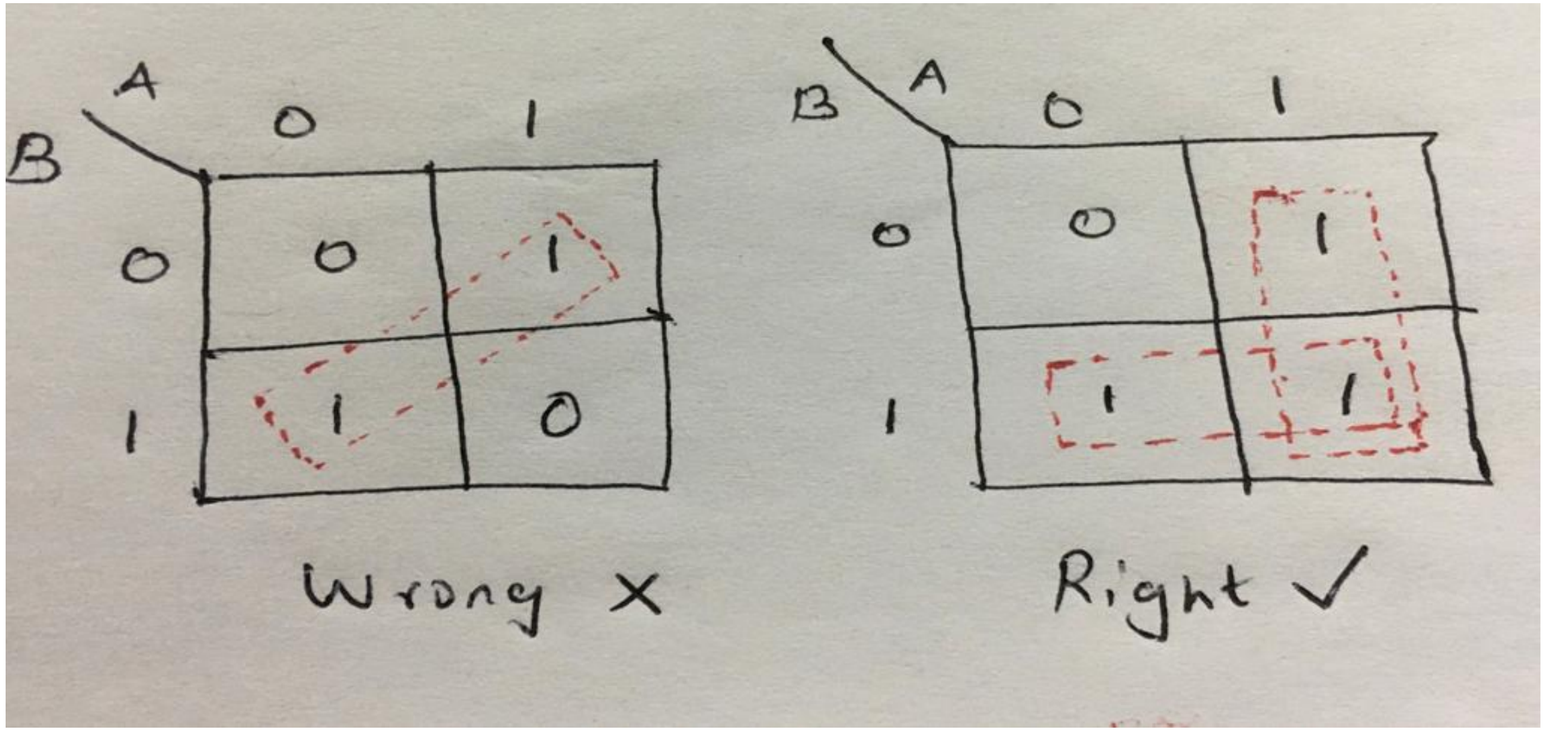
- Karnaugh map uses the following rules for the simplification of expressions by *grouping* together adjacent cells containing *ones* .

1. Groups may not include any cell containing a zero



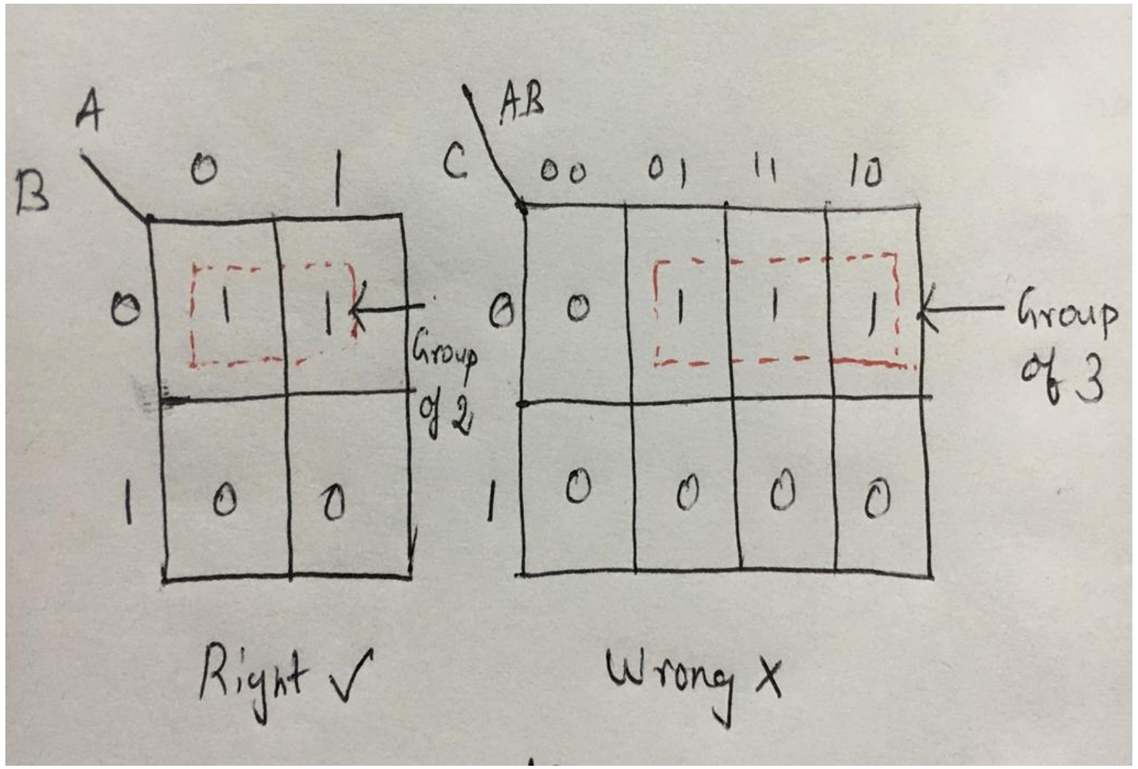
KARNAUGH MAP - Rules

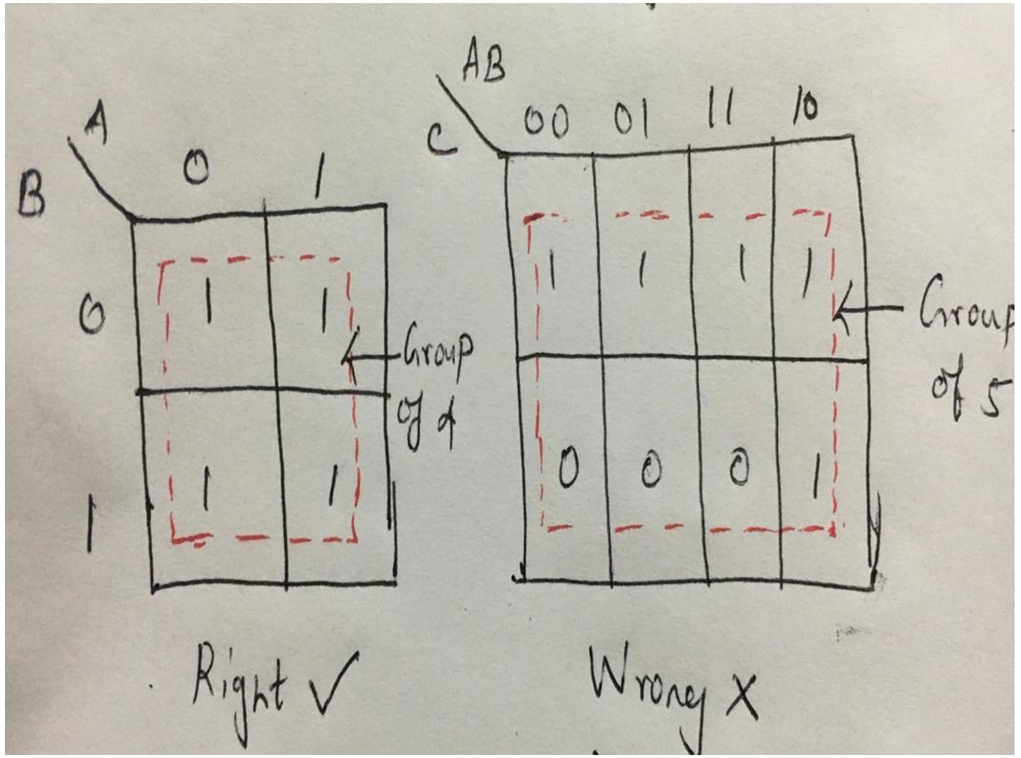
2. Groups may be horizontal or vertical, but not diagonal.



KARNAUGH MAP - Rules

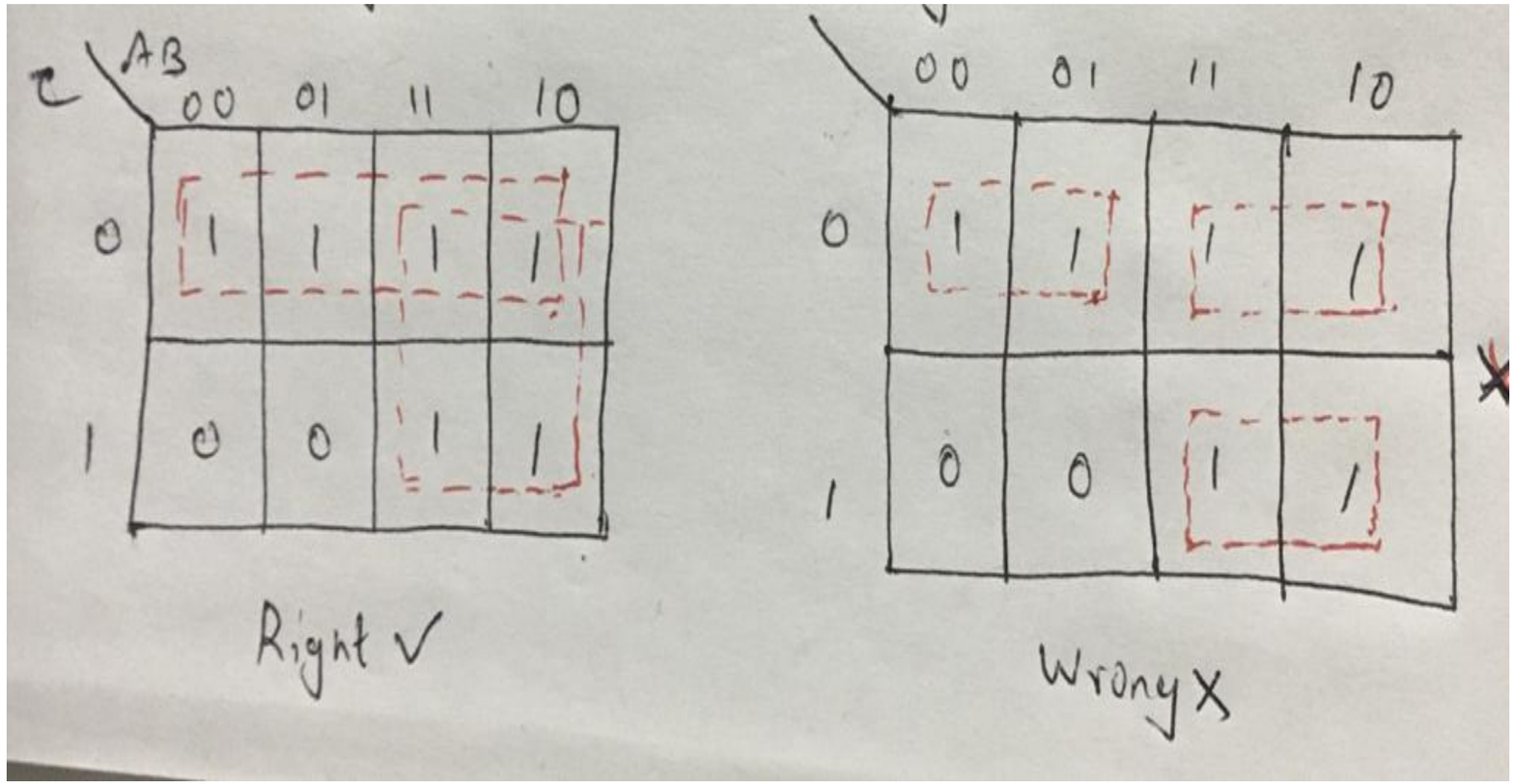
3. **Groups must contain 1, 2, 4, 8, or in general 2^n cells. If n = 1, a group will contain two 1's since $2^1 = 2$. If n = 2, a group will contain four 1's since $2^2 = 4$.**





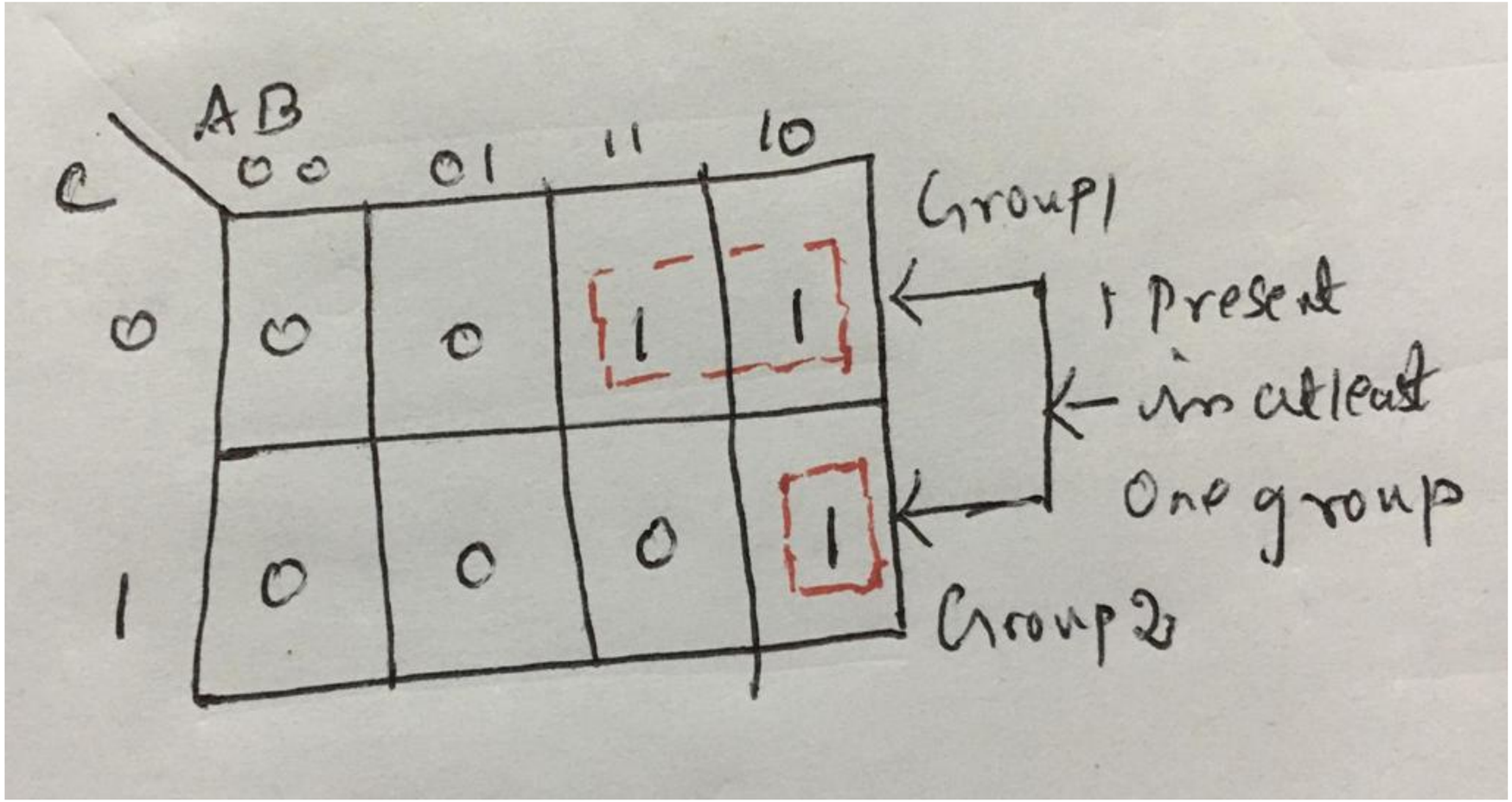
KARNAUGH MAP - Rules

4. Each group should be as large as possible.



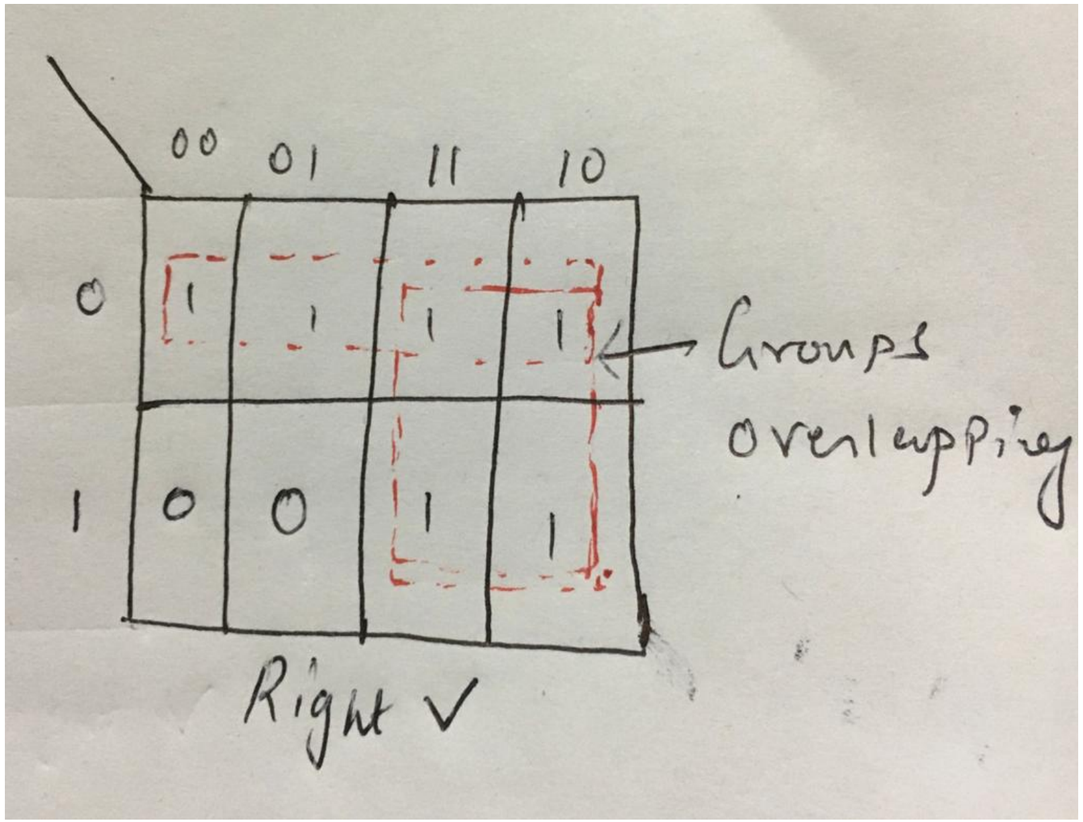
KARNAUGH MAP - Rules

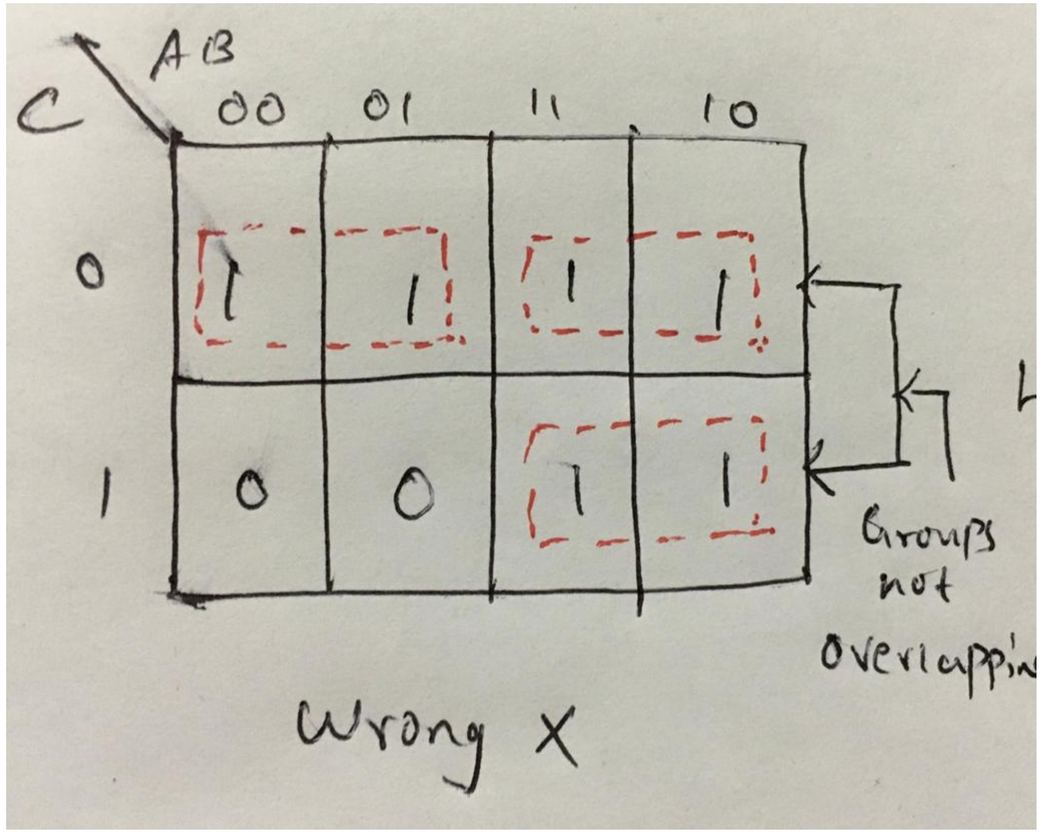
5. Each cell containing a *one* must be in at least one group.



KARNAUGH MAP - Rules

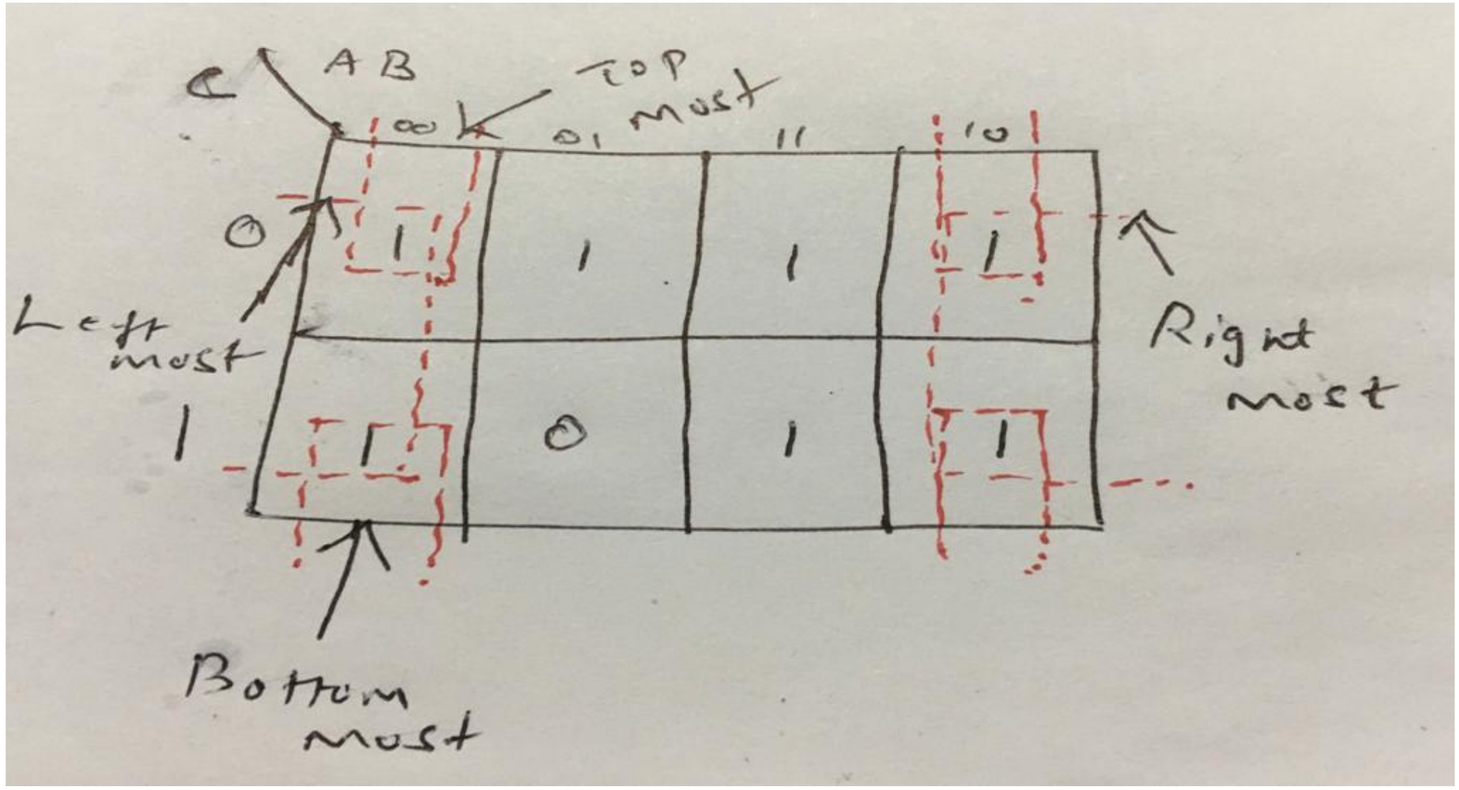
6. Groups may overlap.





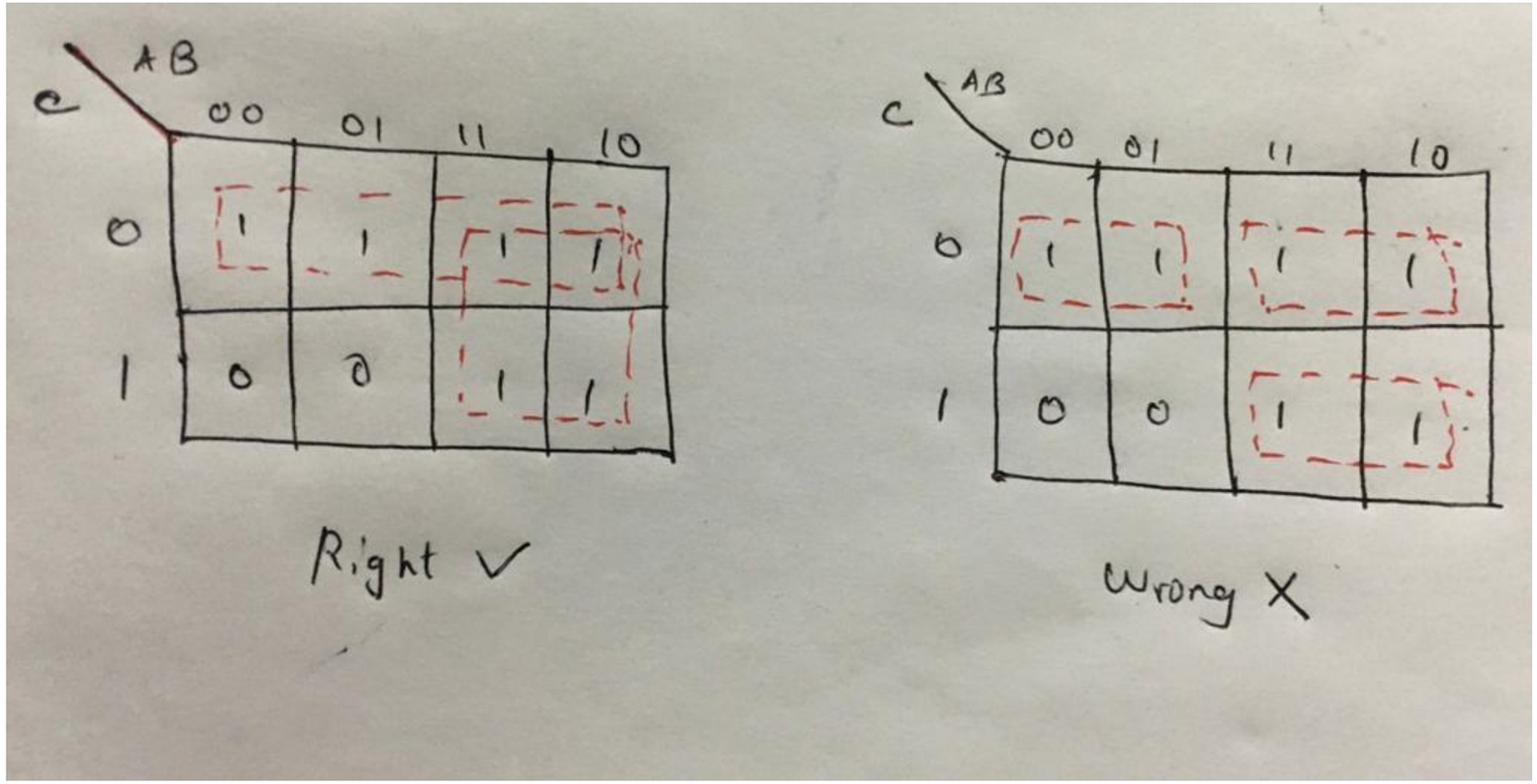
KARNAUGH MAP - Rules

7. Groups may wrap around the table. The leftmost cell in a row may be grouped with the rightmost cell and the top cell in a column may be grouped with the bottom cell



KARNAUGH MAP - Rules

8. There should be as few groups as possible, as long as this does not contradict any of the previous rules



KARNAUGH MAP-RULES-SUMMARY

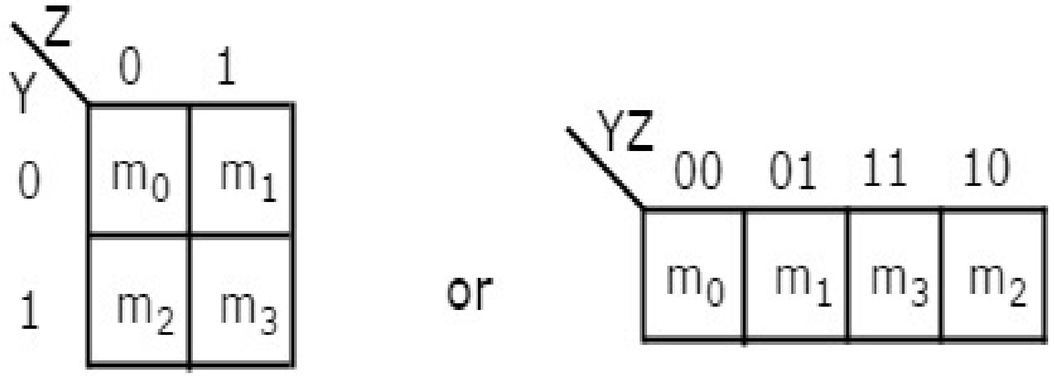
- No zeros allowed.
- No diagonals.
- Only power of 2 number of cells in each group.
- Groups should be as large as possible.
- Every one must be in at least one group.
- Overlapping allowed.
- Wrap around allowed.
- Fewest number of groups possible.

KARNAUGH MAP – Types of Variables

- Karnaugh Map is most suitable for Minimizing Boolean expressions of
  - 2 Variable
  - 3 Variable
  - 4 Variable
  - 5Variable

KARNAUGH MAP – 2 Variable

- The number of cells in 2 variable K-map is four, since the number of variables is two.
- There is only one possibility of grouping 4 adjacent min terms.
- The possible combinations of grouping 2 adjacent min terms are {(m_0, m_1), (m_2, m_3), (m_0, m_2) and (m_1, m_3)}.



KARNAUGH MAP – 3 Variable

- The number of cells in 3 variable K-map is eight, since the number of variables is three.

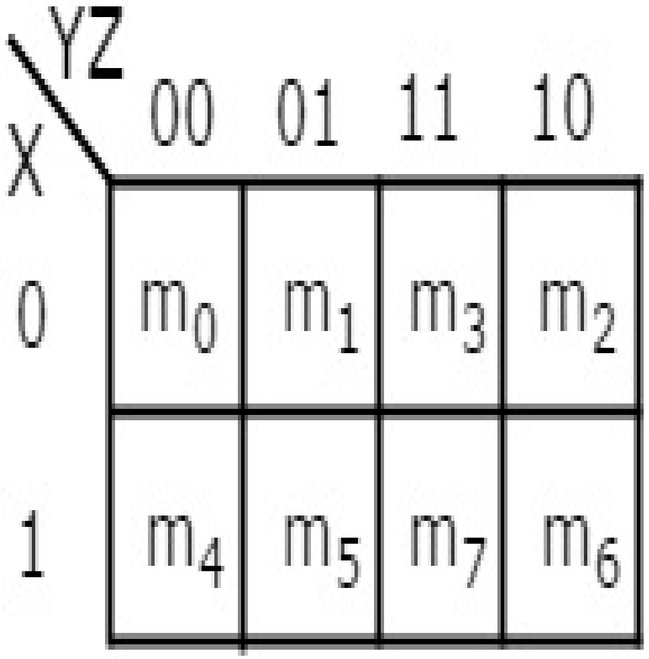
- There is only one possibility of grouping 8 adjacent min terms.

- The possible combinations of grouping 4 adjacent min terms are {(m_0, m_1, m_3, m_2), (m_4, m_5, m_7, m_6), (m_0, m_1, m_4, m_5), (m_1, m_3, m_5, m_7), (m_3, m_2, m_7, m_6) and (m_2, m_0, m_6, m_4)}.

- The possible combinations of grouping 2 adjacent min terms are {(m_0, m_1), (m_1, m_3), (m_3, m_2), (m_2, m_0), (m_4, m_5), (m_5, m_7), (m_7, m_6), (m_6, m_4), (m_0, m_4), (m_1, m_5), (m_3, m_7) and (m_2, m_6)}.

- If x=0, then 3 variable K-map becomes 2 variable K-map.

KARNAUGH MAP – 3 Variable



KARNAUGH MAP – 4 Variable

- The number of cells in 4 variable K-map is sixteen, since the number of variables is four.

WX \ YZ	00	01	11	10
00	m_0	m_1	m_3	m_2
01	m_4	m_5	m_7	m_6
11	m_{12}	m_{13}	m_{15}	m_{14}
10	m_8	m_9	m_{11}	m_{10}

KARNAUGH MAP – 4 Variable

- There is only one possibility of grouping 16 adjacent min terms.

- Let R_1, R_2, R_3 and R_4 represents the min terms of first row, second row, third row and fourth row respectively. Similarly, C_1, C_2, C_3 and C_4 represents the min terms of first column, second column, third column and fourth column respectively. The possible combinations of grouping 8 adjacent min terms are {(R_1, R_2), (R_2, R_3), (R_3, R_4), (R_4, R_1), (C_1, C_2), (C_2, C_3), (C_3, C_4), (C_4, C_1)}.

- If w=0, then 4 variable K-map becomes 3 variable K-map

KARNAUGH MAP – 5 Variable

 The number of cells in 5 variable K-map is thirty-two, since the number of variables is 5.

V=0

WX \ YZ	00	01	11	10
00	m_0	m_1	m_3	m_2
01	m_4	m_5	m_7	m_6
11	m_{12}	m_{13}	m_{15}	m_{14}
10	m_8	m_9	m_{11}	m_{10}

V=1

WX \ YZ	00	01	11	10
00	m_{16}	m_{17}	m_{19}	m_{18}
01	m_{20}	m_{21}	m_{23}	m_{22}
11	m_{28}	m_{29}	m_{31}	m_{30}
10	m_{24}	m_{25}	m_{27}	m_{26}

KARNAUGH MAP – 5 Variable

- There is only one possibility of grouping 32 adjacent min terms.
- There are two possibilities of grouping 16 adjacent min terms. i.e., grouping of min terms from m_0 to m_{15} and m_{16} to m_{31}.
- If v=0, then 5 variable K-map becomes 4 variable K-map.

ASSESSMENTS

1. Who introduced k map?
2. A K map is an abstract form of _____ diagram organized as a matrix of squares.
   a) Venn Diagram
   b) Cycle Diagram
   c) Block diagram
   d) Triangular Diagram
3. There are _____ cells in a 4-variable K-map.
4. Summarize the rules of k map.
5. Plot a 4 variable k map

THANK YOU