



# FACULTY OF ENGINEERING & TECHNOLOGY

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# BOOLEAN ALGEBRA

## Canonical form of Boolean Expression (Standard form)

- In standard SOP and POS each term of Boolean expression must contain all the literals (with and without bar) that has been used in Boolean expression.
- If the above condition is satisfied by the Boolean expression, that expression is called Canonical form of Boolean expression.
- In Boolean expression  $AB+AC$ , the literal  $C$  is not in the 1st term  $AB$  and  $B$  is not in 2nd term  $AC$ . That is why  $AB+AC$  is not a Canonical SOP.

e.g. Convert  $AB+AC$  in Canonical SOP (Standard SOP).

Sol.

$$\begin{aligned} & AB + AC \\ &= AB(C+C') + AC(B+B') \\ &= ABC+ABC'+ABC+AB'C \\ &= ABC+ABC'+AB'C \end{aligned}$$



## Minterm & Maxterm:

- Each term of Canonical Sum of Products (SOP) is called Minterm. In other words minterm is a product of all the literals (with or without bar) within the Boolean expression.
- '1' means the variable is "Not Complemented" and '0' means the variable is "Complemented".
- Each term of Canonical Products of Sum (POS) is called Maxterm. In other words maxterm is a sum of all the literals (with or without bar) within the Boolean expression.
- '0' means the variable is "Not Complemented" and '1' means the variable is "Complemented".

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## Minterms & Maxterms for 2 variables (Derivation of Boolean function from Truth Table)

<b>x</b>	<b>y</b>	<b>Index</b>	<b>Minterm</b>	<b>Maxterm</b>
0	0	0	$m_0 = x' y'$	$M_0 = x + y$
0	1	1	$m_1 = x' y$	$M_1 = x + y'$
1	0	2	$m_2 = x y'$	$M_2 = x' + y$
1	1	3	$m_3 = x y$	$M_3 = x' + y'$

- The minterm  $m_i$  should evaluate to 1 for each combination of x and y.
- The maxterm is the complement of the minterm

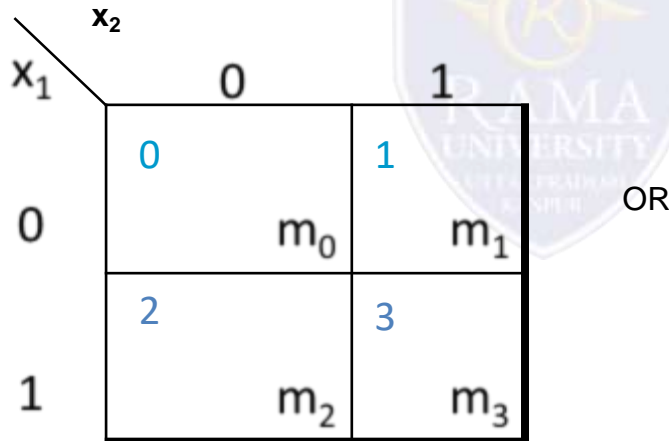
# BOOLEAN ALGEBRA

## Karnaugh map (K – map)

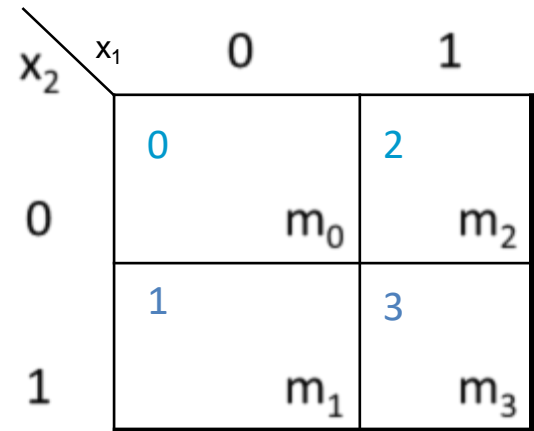
Boolean functions can be simplified using the Boolean theorems but This method of simplification is not used in practice due to reduced expression is not minimal & unique. For that reason Karnaugh map (K – map) method is used most frequently.

- It is used when output is 0,1 & x(don't care).
- In K-Map gray code representation is used.
- K-maps are graphical representations of Boolean functions.
- It's similar to truth table; instead of being organized (i/p & o/p) into columns and rows, the K-map is an array of cells in which each cell represents a binary value of the input variables.
- K-maps can be used for expressions with 2, 3, 4, and 5 variables.

## Two-Variable Map



OR



- ordering of variables is IMPORTANT for  $f(x_1, x_2)$ ..
- Cell 0 represents  $x_1'x_2'$ ; Cell 1 represents  $x_1'x_2$ ; etc. If a minterm is present in the function, then a 1 is placed in the corresponding cell.

## 2-Variable Map -- Example

- $f(x_1, x_2) = x_1'x_2' + x_1'x_2 + x_1x_2'$   
 $= m_0 + m_1 + m_2$   
 $= x_1' + x_2'$

- 1s placed in K-map for specified minterms  $m_0, m_1, m_2$
- Grouping of 1s allows simplification
- What (simpler) function is represented by each dashed rectangle?
  - $- x_1' = m_0 + m_1$
  - $- x_2' = m_0 + m_2$
- Here  $m_0$  covered twice

