

School of Computing Science and Engineering

Course Code : BSCP3005

Course Name: Digital System and Application

Canonical Forms

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- Minterms and Maxterms
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Minterms

Minterms are AND terms with every variable present in either true or complemented form.

Given that each binary variable may appear normal (e.g., x) or complemented (e.g., \bar{x}), there are 2^n minterms for n variables.

Example: Two variables (X and Y) produce $2 \times 2 = 4$ combinations:

(both normal)

(X normal, Y complemented)

(X complemented, Y normal)

(both complemented)

Thus there are four minterms of two variables.

Maxterms

Maxterms are OR terms with every variable in true or complemented form.

Given that each binary variable may appear normal (e.g., x) or complemented (e.g., \bar{x}), there are 2^n maxterms for n variables.

Example: Two variables (X and Y) produce $2 \times 2 = 4$ combinations:

(both normal)

(x normal, y complemented)

(x complemented, y normal)

(both complemented)

Minterms & Maxterms for 2 variables

Two variable minterms and maxterms.

x	y	Index	Minterm	Maxterm
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

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Minterms & Maxterms for 3 variables

x	y	z	Index	Minterm	Maxterm
0	0	0	0	$m_0 = \bar{x} \bar{y} \bar{z}$	$M_0 = x + y + z$
0	0	1	1	$m_1 = \bar{x} \bar{y} z$	$M_1 = x + y + \bar{z}$
0	1	0	2	$m_2 = \bar{x} y \bar{z}$	$M_2 = x + \bar{y} + z$
0	1	1	3	$m_3 = \bar{x} y z$	$M_3 = x + \bar{y} + \bar{z}$
1	0	0	4	$m_4 = x \bar{y} \bar{z}$	$M_4 = \bar{x} + y + z$
1	0	1	5	$m_5 = x \bar{y} z$	$M_5 = \bar{x} + y + \bar{z}$
1	1	0	6	$m_6 = x y \bar{z}$	$M_6 = \bar{x} + \bar{y} + z$
1	1	1	7	$m_7 = x y z$	$M_7 = \bar{x} + \bar{y} + \bar{z}$

Maxterm M_i is the complement of minterm m_i $M_i = \overline{m_i}$ and $m_i = \overline{M_i}$

Purpose of the Index

Minterms and Maxterms are designated with an index

The index number corresponds to a binary pattern

The index for the minterm or maxterm, expressed as a binary number, is used to determine whether the variable is shown in the true or complemented form

For Minterms:

'1' means the variable is "Not Complemented" and

'0' means the variable is "Complemented".

For Maxterms:

'0' means the variable is "Not Complemented" and

'1' means the variable is "Complemented".

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Standard Order

All variables should be present in a minterm or maxterm and should be listed in the same order (usually alphabetically)

Example: For variables a, b, c:

Maxterms $(a + b + c)$, $(a + b + c)$ are in standard order

However, $(b + a + c)$ is NOT in standard order

$(a + c)$ does NOT contain all variables

Minterms $(a b c)$ and $(a b c)$ are in standard order

However, $(b a c)$ is not in standard order

$(a c)$ does not contain all variables

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References:

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