SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE NAME : 19EC306 – Digital Circuits

II YEAR / III SEMESTER

Unit I- MINIMIZATION TECHNIQUES AND LOGIC GATES

Topic : Minterm – Maxterm - Sum of Products (SOP) – Product of Sums (POS)

Minterm and Maxterm

We will get four Boolean product terms by combining two variables x and y with logical AND operation. These Boolean product terms are called as **min terms** or **standard product terms**. The min terms are x'y', x'y, xy' and xy.
Similarly, we will get four Boolean sum terms by combining two variables x and y with logical OR operation. These Boolean sum terms are called as **Max terms** or **standard sum terms**. The Max terms are x + y, x + y', x' + y and x' + y'.

The following table shows the representation of min terms and MAX terms for 2 variables.

x	y	Min terms	Max terms
0	0	$m_0=x'y'$	$M_0=x + y$
0	1	$m_1=x'y$	$M_1=x + y'$
1	0	$m_2=xy'$	$M_2=x' + y$
1	1	$m_3=xy$	$M_3=x' + y'$

Canonical SoP and PoS forms

A truth table consists of a set of inputs and outputs. If there are ‘n’ input variables, then there will be 2^n possible combinations with zeros and ones. So the value of each output variable depends on the combination of input variables. So, each output variable will have ‘1’ for some combination of input variables and ‘0’ for some other combination of input variables.

Therefore, we can express each output variable in following two ways.

- Canonical SoP form
- Canonical PoS form

Canonical SoP form

Canonical SoP form means Canonical Sum of Products form. In this form, each product term contains all literals. So, these product terms are nothing but the min terms. Hence, canonical SoP form is also called as **sum of min terms** form.

First, identify the min terms for which, the output variable is one and then do the logical OR of those min terms in order to get the Boolean expression *function*

corresponding to that output variable. This Boolean function will be in the form of sum of min terms.

Follow the same procedure for other output variables also, if there is more than one output variable.

Example

Consider the following **truth table**.

Inputs		Output	
p	q	r	f
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Here, the output *f* is '1' for four combinations of inputs. The corresponding min terms are p'qr, pq'r, pqr', pqr. By doing logical OR of these four min terms, we will get the Boolean function of output *f*.

Therefore, the Boolean function of output is, f = p'qr + pq'r + pqr' + pqr. This is the **canonical SoP form** of output, f. We can also represent this function in following two notations.

$$f = m_3 + m_5 + m_6 + m_7$$

$$f = \sum m(3, 5, 6, 7)$$

In one equation, we represented the function as sum of respective min terms. In other equation, we used the symbol for summation of those min terms.

Canonical PoS form

Canonical PoS form means Canonical Product of Sums form. In this form, each sum term contains all literals. So, these sum terms are nothing but the Max terms. Hence, canonical PoS form is also called as **product of Max terms** form.

First, identify the Max terms for which, the output variable is zero and then do the logical AND of those Max terms in order to get the Boolean expression *function* corresponding to that output variable. This Boolean function will be in the form of product of Max terms.

Follow the same procedure for other output variables also, if there is more than one output variable.

Example

Consider the same truth table of previous example. Here, the output *f* is '0' for four combinations of inputs. The corresponding Max terms are p + q + r, p + q + r', p + q' + r, p' + q + r. By doing logical AND of these four Max terms, we will get the Boolean function of output *f*.

Therefore, the Boolean function of output is, f = $p+q+r \cdot p+q+r' \cdot p+q'+r \cdot p'+q+r$. This is the **canonical PoS form** of output, f. We can also represent this function in following two notations.

$$f = M_0 . M_1 . M_2 . M_4$$

$$f = \prod M\,(0, 1, 2, 4)$$

In one equation, we represented the function as product of respective Max terms. In other equation, we used the symbol for multiplication of those Max terms.

The Boolean function, f = *p+q+r .p+q+r'.p+q'+r.p'+q+r*
is the dual of the Boolean function, f = p'qr + pq'r + pqr' + pqr.
Therefore, both canonical SoP and canonical PoS forms are **Dual** to each other. Functionally, these two forms are same. Based on the requirement, we can use one of these two forms.

Any Query????

Thank you……