DIGITAL ELECTRONICS:

SUM OF PRODUCT IN BOOLEAN ALGEBRA

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SUM OF PRODUCTS IN BOOLEAN ALGEBRA

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BOOLEAN EXPRESSION

- In Digital Electronics any logic circuit's output is the function of digital inputs.

- The relation between input and output can be represented using logic table or Boolean expressions.

This Boolean expression can be represented in two forms.

- Sum of Product (SOP)
- Product of Sum (POS)

The Sum of Product Form

- In sum of product form of expression, we perform **logical OR** operations on **different product terms**.

$$A.B + A.\overline{B}.C + A.B$$

product product product

sum sum

Canonical & Non-Canonical forms

The SOP form can be in either:

(i) Non-canonical form.

(ii) Canonical form

Non-Canonical SOP Form

In this form each product term between may or may not contain all the variables of the function.

Examples:

$$F(A,B,C) = A + \bar{B}.C + A.C$$

Canonical form

Canonical SOP Form

In canonical SOP form each product term contains all the variables of the function, where variables in each product term can be in true form or complemented form.

Examples:

$$F(A,B) = \bar{A}.B + A.\bar{B}$$

The product terms are called as **Minterms**

SOP

- With ‘n’ inputs namely X, Y, Z ,we get 2^n combinations.
- Here number of inputs are three and so 8 combinations

X	Y	Z	Minterms
0	0	0	X’Y’Z’ = m0
0	0	1	X’Y’Z = m1
0	1	0	X’Y Z’ = m2
0	1	1	X’YZ = m3
1	0	0	XY’Z’= m4
1	0	1	XY’Z = m5
1	1	0	XYZ’ = m6
1	1	1	XYZ = m7

Canonical Sum of Products

Find the Canonical Sum of Products:

X	Y	Z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

Canonical Sum of Products

Find the Canonical Sum of Products:

X	Y	Z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

For the table, the **canonical SOP form** is:

$$F = \sum (m1, m2, m3, m5)$$

By expanding the above summation we can get the following function.

$$F = m1 + m2 + m3 + m5, m3, m5)$$

By substituting the minterms in the above equation we can get the below expression

$$F = X'Y'Z + X'YZ' + X'YZ + XY'Z$$

Non- Canonical Sum of Products

Find the Non- Canonical Sum of Products:

In the non-canonical sum of product form, the product terms are simplified.

$F = X'Y'Z + X'YZ' + X'YZ + XY'Z$

$F = X'Y'Z + X'Y\,(Z'+Z) + XY'Z$

$F = X'Y'Z + X'Y\,(1) + XY'Z$ [W.K.T $Z'+Z = 1$]

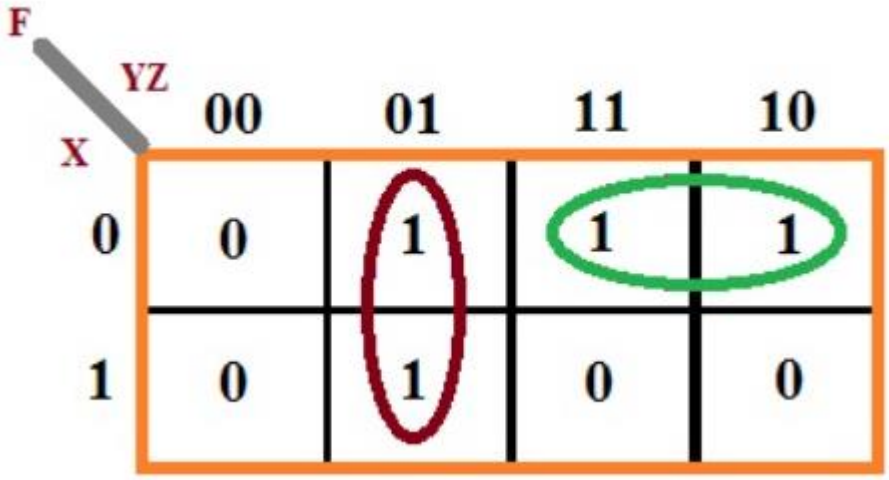
$F = X'Y'Z + X'Y + XY'Z$

Minimal Sum of Products

Find the Minimal Sum of Products:

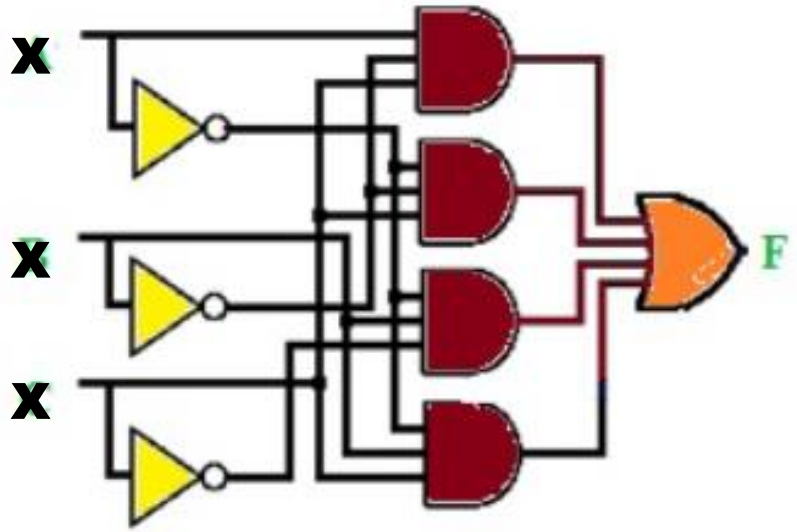
- It is simply done by using **K-map (Karnaugh map)**.

X	Y	Z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0



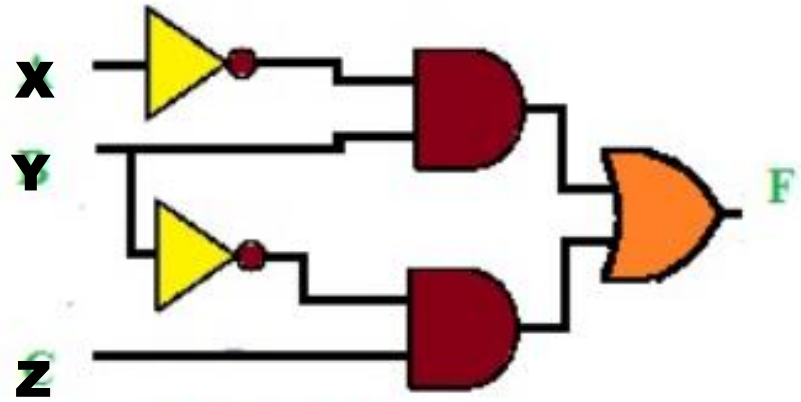
$F = Y'Z + X'Y$

Schematic Design of Sum of Product



Canonical Form

$F = X'Y'Z + X'Y + XY'Z$



Minimal Form

$F = Y'Z + X'Y$

Assessment

1. What is a minterm?

2. Mention the difference between Canonical and Non-Canonical SOP?


Thank
you