ELECTRONIC PRINCIPLES AND DEVICES

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Unit-3 Digital Electronics

Boolean Functions, Canonical and Standard Form

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Boolean Functions, Canonical and Standard Form

❖ Boolean function described by an algebraic expression consists of **binary variables, the constants 0 and 1, and the logic operation symbols**.

❖ Boolean function is **evaluated to logic-1 or logic-0** for a given value of the binary variables.

❖ Boolean function can be represented in a **truth table**.

❖ A Boolean function can be implemented as **digital circuit**,
Which is constructed by using logic gates.

❖ Example: F = X + Y'Z

F = 1 if X = 1 or if Y = 0 and Z = 1

F = 0 Otherwise

Boolean Functions, Canonical and Standard Form

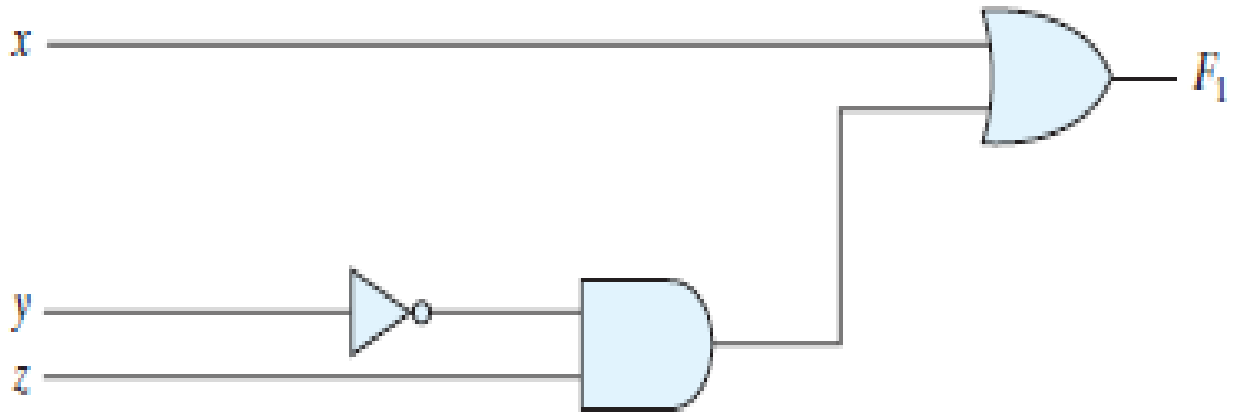
❖ Example: $F_1 = x + y'z$

❖ F_1 contains either 0 or 1 for each of these combinations. The table shows that the function is equal to 1 when x = 1 or when yz = 01 and is equal to 0 otherwise.

Truth Table:

x	y	z	F_1
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Gate Level Implementation:



Reference: "Digital Design with an Introduction to Verilog HDL" M Morris Mano, Michale D Ciletti

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Boolean Functions, Canonical and Standard Form

❖ Simplify and realize the given Boolean function using basic gates

$F_2 = x'y'z + x'yz + xy'$.....(1)

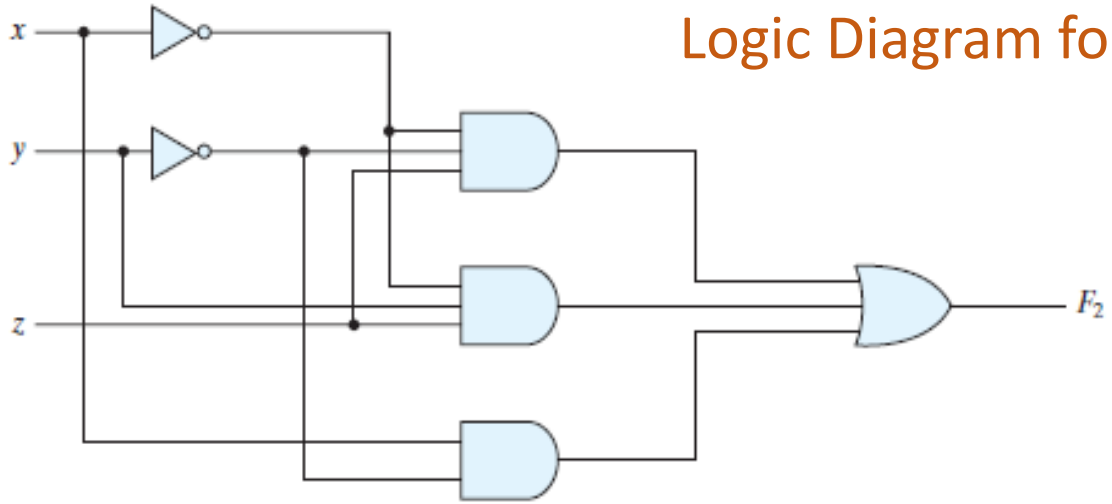
$F_2 = x'z\,(y' + y) + xy'$

$F_2 = x'z + xy'$.....(2)

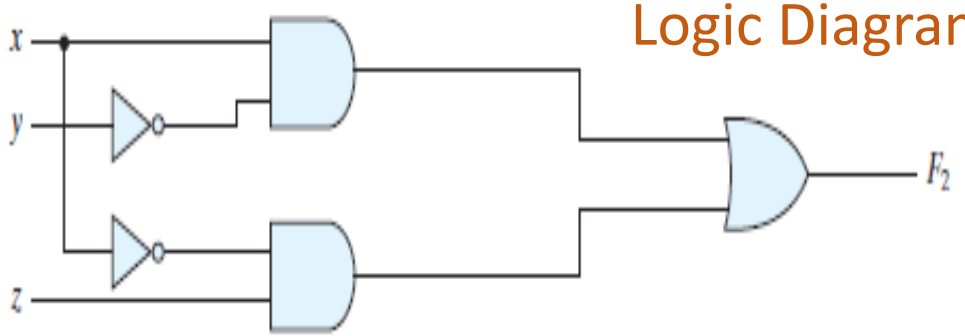
Truth Table

x	y	z	F_2
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

Logic Diagram for eq.1



Logic Diagram for eq.2



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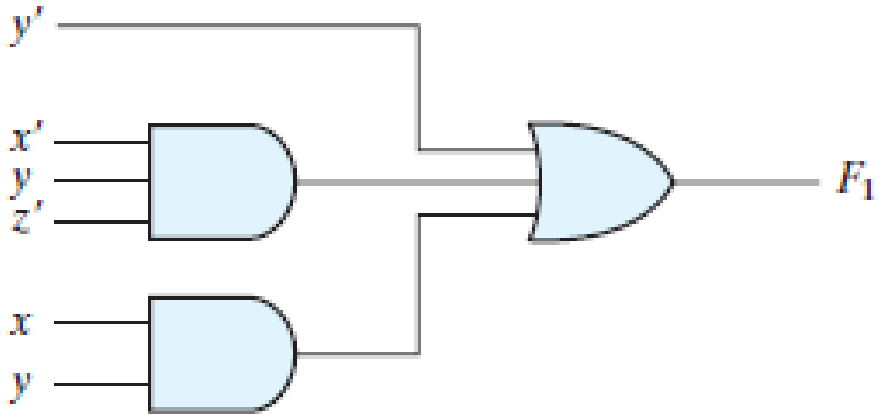
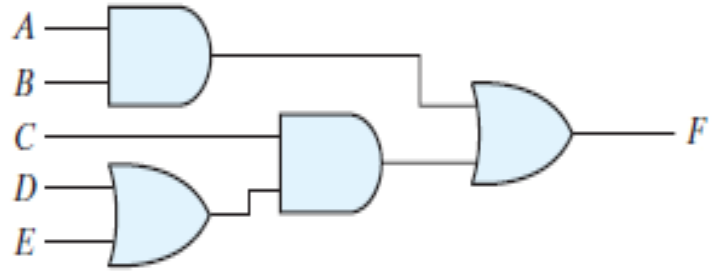
Boolean Functions, Canonical and Standard Form

❖ Sum of Products: (SOP)

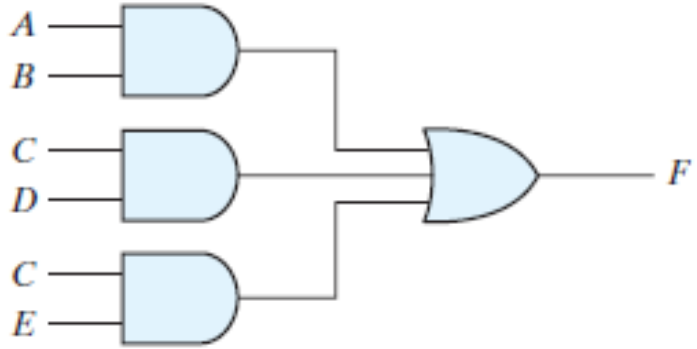
- The sum of products is a Boolean expression containing **AND** terms, called **product terms,** with one or more literals each. The **sum** denotes the **OR**ing of these terms.
- Two- Level Logic implementation of SOP

❖ Example 1 : $F_1 = y' + xy + x'yz'$





Example 2:
F = AB + C (D+E)



F = AB + CD + CE

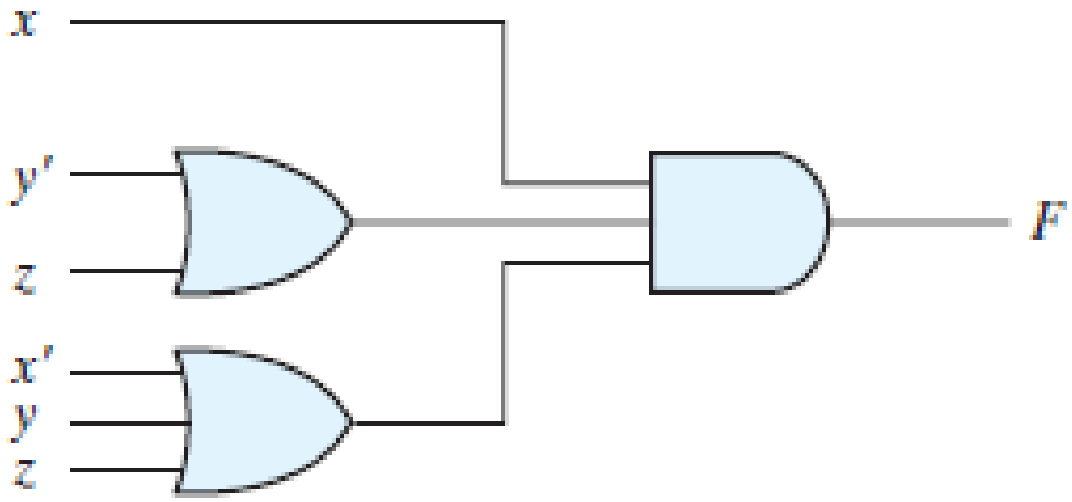
Reference: "Digital Design with an Introduction to Verilog HDL" M Morris Mano, Michale D Ciletti

❖ Product Of Sum: POS

➢ A product of sum (POS) is a Boolean expression containing OR terms, called sum terms. Each term may have any number of literals. The product denotes the ANDing of these terms

➢ Example 1 :

F = x.(y’ + z).(x’ + y + z)



➢ Example 2: Y = (A+B). (C+D)

Boolean Functions, Canonical and Standard Form

❖ Canonical SOP Form:

- Each product term contains all the literals of that function either in true or complement form
- **Example:** F(x,y,z) = xyz + x'y'z + x'yz' +x'y'z'
- Each product term is called as **minterm**
- For three variable function: Truth Table

			Minterms	
x	y	z	Term	Designation
0	0	0	$x'y'z'$	m_0
0	0	1	$x'y'z$	m_1
0	1	0	$x'yz'$	m_2
0	1	1	$x'yz$	m_3
1	0	0	$xy'z'$	m_4
1	0	1	$xy'z$	m_5
1	1	0	xyz'	m_6
1	1	1	xyz	m_7

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Boolean Functions, Canonical and Standard Form

❖ Consider the function: f1 and f2 in the truth table

x	y	z	Function f_1	Function f_2
0	0	0	0	0
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

❖ Canonical SOP Form for f1

f1 = x'y'z + xy'z' + xyz = m1 + m4 + m7

❖ Canonical SOP Form for f2

f2 = x'yz + xy'z + xyz' + xyz = m3 + m5 + m6 + m7

Boolean Functions, Canonical and Standard Form

❖ Canonical POS Form:

- Each sum term contains all the literals of that function either in true or complement form
- **Example:** F(x, y, z) = (x +y+z) (x'+y'+z) (x'+y+z')
- Each sum term is called as **Maxterm**
- For three variable function: Truth Table

			Maxterms	
x	y	z	Term	Designation
0	0	0	$x + y + z$	M_0
0	0	1	$x + y + z'$	M_1
0	1	0	$x + y' + z$	M_2
0	1	1	$x + y' + z'$	M_3
1	0	0	$x' + y + z$	M_4
1	0	1	$x' + y + z'$	M_5
1	1	0	$x' + y' + z$	M_6
1	1	1	$x' + y' + z'$	M_7

Boolean Functions, Canonical and Standard Form

❖ Consider the function: f1 and f2 in the truth table

x	y	z	Function f_1	Function f_2
0	0	0	0	0
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

❖ Canonical POS Form for f1

f1 = (x + y + z)(x + y' + z)(x + y' + z')(x' + y + z')
(x' + y' + z)
= M0. M2 .M3 . M5 . M6

❖ Canonical POS Form for f2

f2 = (x + y + z)(x + y + z')(x + y' + z)(x' + y + z)
= M0. M1. M2. M4

Boolean Functions, Canonical and Standard Form

❖ Find the Minterms for the given expression: (Convert into canonical SOP Form)

F = A + BC

F = A.1.1 + BC.1

F = A. (B+B'). (C+C'). + BC.(A+A')

F = A. (BC + BC' +B'C +B'C') + ABC +A'BC

F = ABC + ABC' + AB'C + AB'C' + ABC + A'BC

F = ABC + ABC' + AB'C + AB'C' +A'BC

F = m7 + m6 +m5 + m4 + m3

F = Σ (3,4,5,6,7)

THANK YOU

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