


Combinational Logic Circuits

- most common type of digital logic circuit
- combination of logic gates

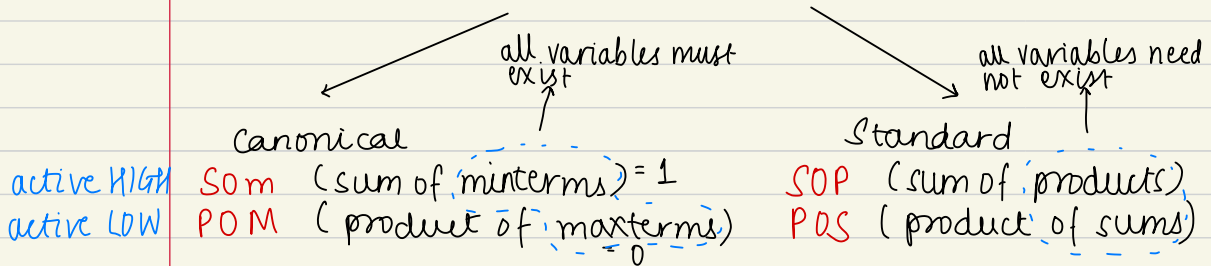
$$O(t) = f[I_1(t), I_2(t), I_3(t) \dots I_n(t)]$$

↑
O/P at any time t depends on the inputs at that time



- no memory characteristics (unlike sequential circuits)
- easier to analyse and design (— " —>)
- its f^n can be completely represented in a truth table
- boolean expression = boolean equation = logic f^n

forms of boolean exp.



key.

minterms : all combinations of input variables connected by an AND operator

maxterms : all possible combinations of a given set of boolean variables formed by using the OR operator

(more on next to next page)

- simplified exp from canonical forms lead to simpler logic circuits (standard form)
 ↑ combinational circuits minimisation
 - no of gates
 - no of inputs per gate

ex. $f(x, y, z) = xy z' + xy z + x' y' z + x y' z$
 $= xy + y' z \rightarrow \text{sum of products}$

neither SOP or POS

$$f = (xy)'z + xz'$$

$$f = xy(x' + z)'$$

(1)
 min term because minimum number of terms we need for logic - 1 o/p
 max term because max (all) number of terms needed for logic - 1 o/p

written in a way
that result is 1

result is 0

	X	Y	minterms	maxterms
dec 0	0	0	$x' \cdot y'$ m0	$x+y$ M0
dec 1	0	1	$x' \cdot y$ m1	$x+y'$ M1
dec 2	1	0	$x \cdot y'$ m2	$x' + y$ M2
dec 3	1	1	$x \cdot y$ m3	$x' + y'$ M3

→ clearly $m_i = \overline{M_i}$

→ n-inputs have 2^n min/max terms

4: a, b, c, d

$13_{10} = 1101_2$

$M_{13} = a' + b' + c + d'$

$2_{10} = 0010_2$

$m_2 = a'b'cd'$

→ for n-inputs for n ^{maxterms} minterms, only one ^{maxterm} minterm (for a certain set of inputs) gives one ^{zero} and it is order specific.

011

$xyz \rightarrow x'yz$ (m3)

$zyx' \rightarrow 110$ (m6)

inputs			Output F ✓				
X	Y	Z		min		max	
0	0	0	0	$x' \cdot y' \cdot z'$	m0	$x+y+z$	M0
0	0	1	1		m1	.	M1
0	1	0	1		m2	.	M2
0	1	1	0		m3		M3
1	0	0	1		m4	.	M4
1	0	1	0		m5		M5
1	1	0	0		m6		M6
1	1	1	1		m7		M7

$$\text{SDm} : (x'y'z) + x'yz' + xy'z' + xyz$$

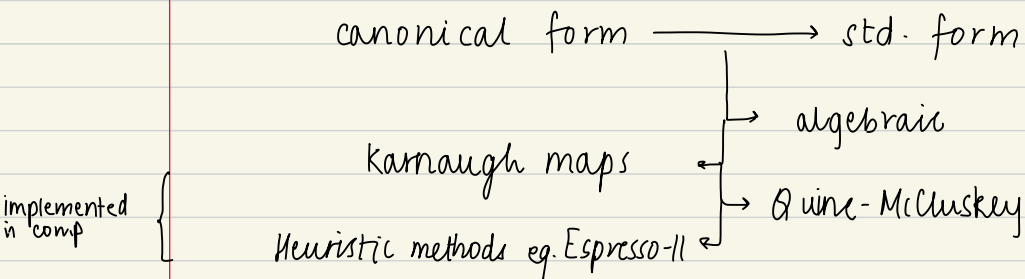
$$\sum_{xyz} (1, 2, 4, 7)$$

$$F(x, y, z) = \sum m(1, 2, 4, 7) = m1 + m2 + m4 + m7$$

$$\text{POM} : (x+y+z)(x+y'+z')(x'+y+z')(x'+y'+z)$$

$$\prod_{xyz} (0, 3, 5, 6)$$

$$F(x, y, z) = \prod M(0, 3, 5, 6) = M0 \cdot M3 \cdot M5 \cdot M6$$



$$Z = ABC + AB'(A'C')'$$

$$Z = ABC + AB'(A+C)$$

$$Z = ABC + AB' + AB'C$$

$$Z = A(C + AB')$$

$$Z = A(C + B')$$

$$X = (A' + B)(A + B + D)D'$$

$$X = (A' + B)(AD' + BD' + 0)$$

$$X = A'BD' + BAD' + BD'$$

$$X = BD' + BDA'$$

$$X = BD'$$

L7 practice problems

1. Construct the truth table for the following logic functions.

a. $F(X,Y,Z) = X'Y + X'Y'Z = X'YZ + X'YZ' + X'Y'Z = \sum m(1, 2, 3)$

b. $F(A,B,C,D) = ((A+B')' + C)' + D' = ((\overline{A+B'}) + C)' + D' = ((A+B')C' + D)' = \overline{(A+B')C' + D} = (A+B')C + D' = (A'B + C)D' = A'BCD' + A'BC'D' + CD'(AB + A'B + BA' + A'B')$

2. Write the canonical sum-of-minterm expression for output F in question 1(a).
3. Write the canonical product-of-maxterm expression for output F in question 1(b).
4. The following expressions are taken from lecture slides 5.23. Use algebraic manipulations to simplify each of them and obtain the minimum cost SOP (sum-of-product) expression.

Students are required to know and apply Boolean theorems but are not required to cite the name of the theorems used

a. $Z = ABC + AB'(A'C)'$

$X + XY = X$ $ABC + AB'(A+C)$
 $X + X'Y = X + Y$ $ABC + AB'(C + AB')$
 $ABC + AB'$
 $A(BC + B')$
 $A(B' + C) = AC + AB'$

b. $X = (A' + B)(A + B + D)D'$

$(A' + B)(AD' + BD')$
 $(A'BD' + BAD')$
 BD'