# Digital Logic Design:

→ Introduction
→ Number System
→ Digital Logic Gates (Symbol, Definition, Truth table)

- AND:-

  Its an electronic gate which is true when all the inputs are true.

- OR:

  True when one of the input is true.

→ Boolean Algebra.
→ Combinational Circuit (Adders / Subtractors, Mux / demux, Coder / Decoder)
(when you changed the input, the output is changed)
→ Sequential Circuit (Flipflops, Registers → Memory, Counters)
(Changes output based on input and previous outputs).

# Number System:-

Weighted | Not weighted

- → Decimal
- → Binary
- → HexaDecimal
- → Octal

Symbols:- Digits.

Total digits are 10

0, 1, 2, 3, 4, 5, 6, 7, 8, 9

DLD Lecture: 4

| Decimal | (2) Binary | (8) Octal | (5) Pedal | (16) HexaDecimal |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |
| 2 | 10 | 2 | 2 | 2 |
| 3 | 11 | 3 | 3 | 3 |
| 4 | 100 | 4 | 4 | 4 |
| 5 | 101 | 5 | 10 | 5 |
| 6 | 110 | 6 | 11 | 6 |
| 7 | 111 | 7 | 12 | 7 |
| 8 | 1000 | 10 | 13 | 8 |
| 9 | 1001 | 11 | 14 | 9 |
| 10 | 1010 | 12 | 20 | A |
| 11 | 1011 | 13 | 21 | B |
| 12 | 1100 | 14 | 22 | C |
| 13 | 1101 | 15 | 23 | D |
| 14 | 1110 | 16 | 24 | E |
| 15 | 1111 | 17 | 30 | F |
| 16 | 10000 | 20 | 31 | 1A |
| 17 | 10001 | 21 | 32 | 1B |
| 18 | 10010 | 22 | 33 | 1C |
| 19 | 10011 | 23 | 34 | 1D |
| 20 | 10100 | 24 | 40 | 1E |
| 21 | 10101 | 25 | 41 | 1F |
| 22 | 10110 | 26 | 42 | 2A |
| 23 | 10111 | 27 | 43 | 2B |
| 24 | 11000 | 30 | 44 | 2C |
| 25 | 11001 | 31 | 50 | 2D |
| 26 | 11010 | 32 | 51 | 2E |
| 27 | 11011 | 33 | 52 | 2F |

| Decimal | Binary | Octal | Pedal | HexaDecimal |
| --- | --- | --- | --- | --- |
| 28 | 11100 | 34 | 53 | 3A |
| 29 | 11101 | 35 | 54 | 3B |
| 30 | 11110 | 36 | 60 | 3C |
| 31 | 11111 | 37 | 61 | 3D |
| 32 | 100000 | 40 | 62 | 3E |
| 33 | 100001 | 41 | 63 | 3F |
| 34 | 10010 | 42 | 64 | 4A |
| 35 | 100011 | 43 | 70 | 4B |
| 36 | 100100 | 44 | 71 | 4C |
| 37 | 100101 | 45 | 72 | 4D |
| 38 | 100110 | 46 | 73 | 4E |
| 39 | 100111 | 47 | 74 | 4F |
| 40 | 101000 | 50 | 80 | 5A. |

| | |
|---|---|
| 2 | 5473 |
| 2 | 2736 - 1 |
| 2 | 1368 - 0 |
| 2 | 684 - 0 |
| 2 | 342 - 0 |
| 2 | 171 - 0 |
| 2 | 85 - 1 |
| 2 | 42 - 1 |
| 2 | 21 - 0 |
| 2 | 10 - 1 |
| 2 | 5 - 0 |
| 2 | 2 - 1 |
| | 1 - 0 |

$(1010101100001)_2$

$$(5473)_{10} = 4096 + 1024 + 256 + 64 + 32 + 1$$
$$= 2^{12} + 2^{10} + 2^{8} + 2^{6} + 2^{5} + 2^{0}$$
$$= 1010101100001$$

| $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^{9}$ | $2^{8}$ | $2^{7}$ | $2^{6}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ | $2^{2}$ | $2^{1}$ | $2^{0}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

| $2^{20}$ | $2^{19}$ | $2^{18}$ | $2^{17}$ | $2^{16}$ | $2^{15}$ |
|---|---|---|---|---|---|
| 1048576 | 524288 | 262144 | 131072 | 65536 | 32768 |

| | (2) Binary | (5) Pedal | (8) Octal | (16) Hexa Decimal |
|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 |
| 1 | 2 | 5 | 8 | 16 |
| 2 | 4 | 25 | 64 | 256 |
| 3 | 8 | 125 | 512 | 4096 |
| 4 | 16 | 625 | 4096 | 65536 |
| 5 | 32 | 3125 | 32768 | 1048576 |
| 6 | 64 | 15625 | 262144 | 16777216 |
| 7 | 128 | 78125 | 2097152 | 268435456 |
| 8 | 256 | 390625 | 16777216 | 4294967296 |
| 9 | 512 | 1953125 | 134217728 | |
| 10 | 1024 | 9765625 | 1073741824 | |
| 11 | 2048 | 48828125 | 8589934592 | |
| 12 | 4096 | 244140625 | | |
| 13 | 8192 | 1220703125 | | |
| 14 | 16384 | 6103515625 | | |
| 15 | 32768 | | | |
| 16 | 65536 | | | |
| 17 | 131072 | | | |
| 18 | 262144 | | | |
| 19 | 524288 | | | |
| 20 | 1048576 | | | |
| 21 | 2097152 | | | |
| 22 | 4194304 | | | |
| 23 | 8388608 | | | |
| 24 | 16777216 | | | |
| 25 | 33554432 | | | |

DLD lectures

$\rightarrow (1234)_{10} = (\quad)_2$

~~512 + 256 + 128 + 64 + 32 + 16 +~~

$1024 + 128 + 64 + 16 + 2$

$2^{10} + 2^7 + 2^6 + 2^4 + 2^1$

$(10011010010)_2$

$\rightarrow (1234)_{10} = (\quad)_5$

$625 + 125 + 25 + 5 + 1$

$? \times 5^4 + ? \times 5^3 + ? \times 5^2 + ? \times 5^1 + ? \times 5^0$

$\rightarrow (1234)_{10} = (\quad)_8$

$512 + 64 + 8 + 1$

$? \times 8^3 + ? \times 8^2 + ? \times 8^1 + ? \times 8^0$

$2 \times 8^3 + 3 \times 8^2 + 2 \times 8^1 + 2 \times 8^0$

$= (2322)_8$

$\rightarrow (1234)_{10} = (\quad)_{16}$

$256 + 16 + 1$

$? \times 16^2 + ? \times 16^1 + ? \times 16^0$

$4 \times 16^2 + D \times 16^1 + 2 \times 16^0$

$(4D2)_{16}$

→ BCD (Binary Coded Decimal):

Binary Coded Digits.

25863.

0010 0101 1000 0110 0011

When answer is invalid or carry is generated.

$$
\begin{array}{r}
{}^{1}1\dot{0}\dot{0}1 \\
{}^{1}\ 0111 \\
\hline
\underbrace{1}\underbrace{0000} \\
0110 \\
\hline
\underbrace{0001}_{1}\,\underbrace{0110}_{6}
\end{array}
$$

→ GRAY CODE:-

0000 → 0
0001 → 1
0011 → 2
0010 → 3
0110 → 4
0111 → 5
0101 → 6
0100 → 7
1100 → 8

## → ASCII :-

(American Standard Code for Information Interchange).

Hanzala.

Hani.

48 61 6E 69 2E

100 1000

1100001

1101110

## Assignment # 1.

→ What is BCD? How to convert BCD to Binary and Binary to BCD.

→ What is gray code? How to convert BCD to gray and Gray to BCD.

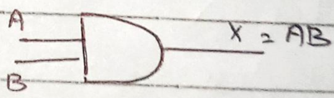
→ Write down your name and registration number in ASCII?

MSB
(Most Significant Bit)
LSB
(Least Significant Bit)

```
  1101   1101
+ 0011   0011
 ------------
 10001   0000
```

```
  1000        8
-   11       -3
 -----      ----
  0111        5
```

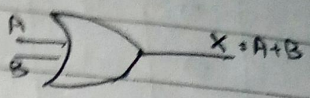
**AND :-**




| A | B | AND |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

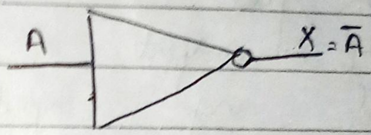
OR:-

| A | B | OR |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |



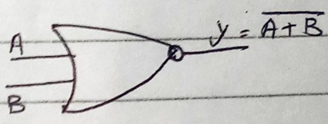

NOT:-

| Input | output |
|---|---|
| 0 | 1 |
| 1 | 0 |



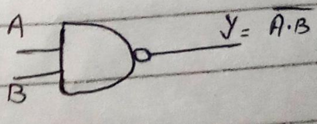

NOR:-

| A | B | NOR |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |



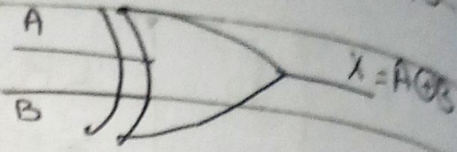

NAND:-

| A | B | NAND |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |



## XOR:-

$A\bar{B} + \bar{A}B$




| A | B | XOR |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

OR gate is an electronic circuit the output of which is high if any input is high

# XOR ~~Gat~~ Table

| A | B | Output |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

## BCD to Gray.

MSB $\qquad\qquad\qquad\qquad$ LSB

0 $\quad$ 1 $\quad$ 1 $\quad$ 1 $\quad$ ← 7.

$0 \oplus 1 \quad 1 \oplus 1 \quad 1 \oplus 1$

0 $\quad$ 1 $\quad$ 0 $\quad$ 0

## Gray to BCD.

MSB $\qquad\qquad\qquad\qquad$ LSB

0 $\quad$ 1 $\quad$ 0 $\quad$ 0

$0 \oplus 1 \quad 1 \oplus 0 \quad 1 \oplus 0$

0 $\quad$ 1 $\quad$ 1 $\quad$ 1

## BCD to Gray

MSB              LSB      2

$0 \quad 0 \quad 1 \quad 0$

$\quad\; 0 \oplus 0 \quad 0 \oplus 1 \quad 1 \oplus 0$

$0 \quad 0 \quad 1 \quad 1$

## Gray to BCD

MSB              LSB.

$0 \quad 0 \quad 1 \quad 1$

$\quad\; 0 \oplus 0 \quad 0 \oplus 1 \quad 1 \oplus 1$

$0 \quad 0 \quad 1 \quad 0$

# Expressions

DLD
Lecture:

Not :-

$$X = \bar{A}$$

OR :-

$$X = \sum_{i=1}^{N} A_i = A_1 + A_2 + A_3 + \cdots$$

$$X = A + B$$

AND :-

$$X = \prod_{i=1}^{N} A_i = A_1 + A_2 + A_3 + \cdots$$

XOR :-

$$X = A \oplus B$$

$$A\bar{B} + \bar{A}B$$

NOR :-

NAND :-

$A\bar{B} + \bar{A}B$.

| A | B | $\bar{A}$ | $\bar{B}$ | $A\bar{B}$ | $\bar{A}B$ | $A\bar{B}+\bar{A}B$ |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 |

→ **Boolean Algebra :-**

**Logical Expressions**

| | |
|---|---|
| $A + A = A$ | $A + B = B + A$ |
| $A + 0 = A$ | $AB = BA$ |
| $A \cdot A = A$ | $A(B+C) = AB + AC$ |
| $A \cdot 1 = A$ | $(A+B)+C = A + (B+C)$ |
| $A \cdot 0 = 0$ | |

| A+ | A | $X = A + A = A$ |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |

| A | $X = A + 0 = A$ |
|---|---|
| 0 | $0 + 0 = 0$ |
| 1 | $1 + 0 = 1$ |

| A | A | $X = A \cdot A = A$ |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |

| A | 1 | $X = A \cdot 1 = A$ |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 1 | 1 |

## Logic Gates:-

Logic Gates is an electronic circuit whose output is true/high when some conditions at the input are satisfied.

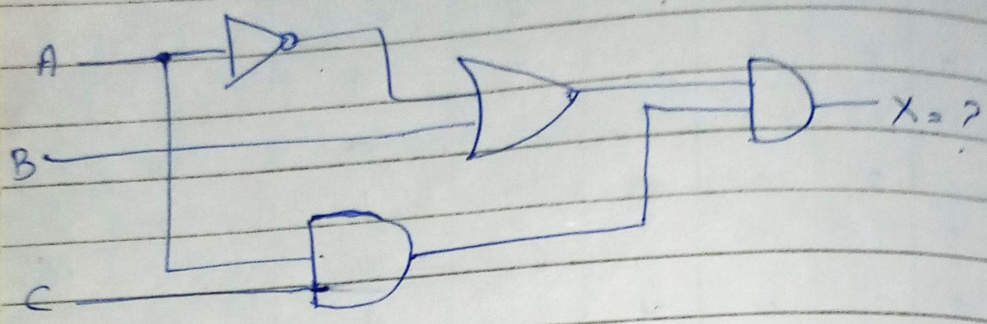
| A | 0 | $X = A \cdot 0 = 0$ |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |

| A | B | C | B+C | $X = A(B+C)$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |

# DLD Lecture :- 9

OR = +

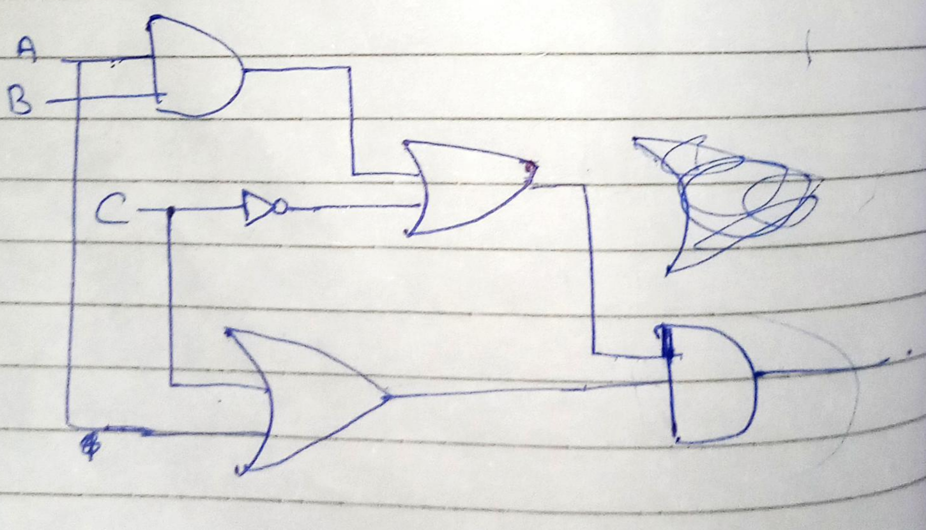
And = *




$$X = (\bar{A} \vee B) \wedge (\bar{A} \wedge C)$$

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

$\rightarrow$ $(AB + \bar{C})(A + C)$



$\rightarrow (\bar{A}+B)AC = AC(\bar{A}+B)$

$AC\bar{A} + ACB = CA\bar{A} + ACB$

$A\bar{A}C + ACB = 0 + ACB$

$0 + ACB = 0 + ACB$

$\rightarrow X = (AB+\bar{C})(A+C)$

$ABA + ABC + \bar{C}A + \bar{C}C$

$BAA + ABC + \bar{C}A + \bar{C}C$

$B(A) + ABC + \bar{C}A + 0$

$BA + ABC + \bar{C}A$

$AB + ABC + \bar{C}A$

$AB(1+C) + A\bar{C}$

$1+C = 1$ $\quad AB(1) + A\bar{C}$

$AB \cdot 1 = AB$ $\quad AB + A\bar{C}$

$A(B+\bar{C})$

# Theorems

$A \cdot A = A$

$B \cdot B = B$

$\rightarrow \quad x + x = x$

$x + x = (x + x) \cdot 1$

$= (x + x) \cdot (x + \bar{x})$

$= \overset{A}{x x} + \overset{B}{x \bar{x}} + \overset{A}{x x} + \overset{B}{x \bar{x}}$

$\because x + \bar{x} = 1$

$= \underset{A}{x x} + \underset{B}{x \bar{x}}$

$A + A = A$

$A \cdot \bar{A} = 0$

$= x + 0$

$= x$

$\rightarrow \quad x(x + y)$

$x x + x y$

$= x + x y$

$1 + y = 1$

$= x(1 + y)$

$x \cdot 1 = x$

$= x(1)$

$= x$

$\rightarrow \quad x + x y = x(1 + y)$

$= x \cdot 1$

$= x$

$\rightarrow \quad x(x' + y)$

$x x' + x y$

$x \cdot x' = 0$

$0 + x y$

$= x y$

$\rightarrow \quad xy + x'z + yz.$

$xy + yz + x'z.$

$y.(x+z) + x'z$

$\rightarrow \quad xy + x'z + yz \cdot 1$

$= xy + x'z + yz(x+\bar{x})$

$= xy + x'z + xyz + x'yz.$

$= xy + xyz + x'z + x'yz.$

$= xy(1+z) + x'z(1+y)$

$= xy + x'z.$

→ Standart form:-

$$xy + x'z + yz.$$

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

$$= xyz + xyz' + x'yz + x'y'z + xyz + x'yz.$$

$$X = xyz + x'yz + xyz' + x'y'z$$

$$X = \underset{1}{xyz} + \underset{1}{x'yz} + \underset{1}{xyz'} + \underset{1}{x'y'z}$$

if $x=1$, $y=1$, $z=1$ — if $x=0$, $y=1$, $z=1$ — if $x=1$, $y=1$, $z=0$. — if $x=0$, $y=0$, $z=1$

| x | y | z | X |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

$\rightarrow F = A + B'C$

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

$= A(BC + BC' + B'C + B'C') + AB'C + A'B'C$

$= ABC + ABC' + AB'C + AB'C' + AB'C + A'B'C$

$= ABC + ABC' + AB'C + AB'C' + A'B'C$

1 1 1 1 1.

| if $A=1$ | if $A=1$ | if $A=1$ | if $A=1$ | if $A=0$ |
|---|---|---|---|---|
| $B=1$ | $B=1$ | $B=0$ | $B=0$ | $B=0$ |
| $C=1$ | $C=0$ | $C=1$ | $C=0$ | $C=1$. |

| A | B | C | X |
|---|---|---|---|
| 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 |

$F = x + y'z$

$x(y+y')(z+z') + (x+x')y'z$

$x(yz + yz' + y'z + y'z') + xy'z + x'y'z$

$xyz + xyz' + xy'z + xy'z' + xy'z + x'y'z$

$xyz + xyz' + xy'z + xy'z' + x'y'z$

| if $x=1$ | if $x=1$ | if $x=1$ | if $x=1$ | if $x=0$ |
|---|---|---|---|---|
| $y=1$ | $y=1$ | $y=0$ | $y=0$ | $y=0$ |
| $z=1$ | $z=0$ | $z=1$ | $z=0$ | $z=1$ |

| x | y | z | X |
|---|---|---|---|
| 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 |

→ **Minterm:-**

Two binary variables x and y combined with an AND operation.

Four possible combination:-

$x'y'$, $x'y$, $xy'$, $xy$.

Each of these four AND terms is called a minterm.

| x | y | F |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

Minterm

Sum of product.

**Maxterm:-**

Each variable are performed in OR operation

| x | y | F |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

Maxterm

Product of sum.

# Minterm / Maxterm

$x'y'z' + xy'z + xyz' + xyz$

| X | Y | Z | F |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

Max

Min

$= (x+y+z') \cdot (x+y'+z) \cdot (x+y'+z') \cdot$

$(x'+y+z')$

Min $x'=0$, $x=1$

$\rightarrow F = x'y'z' + x'y'z + x'yz + xy'z' + xyz$

| | x | y | z | F |
|---|---|---|---|---|
| ✓ | 0 | 0 | 0 | 1 |
| ✓ | 0 | 0 | 1 | 1 |
| | 0 | 1 | 0 | 0 |
| ✓ | 0 | 1 | 1 | 1 |
| ✓ | 1 | 0 | 0 | 1 |
| | 1 | 0 | 1 | 0 |
| | 1 | 1 | 0 | 0 |
| ✓ | 1 | 1 | 1 | 1 |

Minterm

Maxterm

$$F = (x + y' + z) \cdot (x' + y + z') \cdot (x' + y' + z)$$

Each minterm is obtained from the AND term of the n variables, with each variable being primed if the corresponding bit of the pimary number is a zero (0) and unprimed if a 1.

Each maxterm is obtained from OR Term of the n variables, with each variable being unprimed if the correspond bit is a (0) and primed if a (1)

# DLD Lecture

| | | | MinTerms | | MaxTerms | |
|---|---|---|---|---|---|---|
| x | y | z | Term | Designation | Term | Designation |
| 0 | 0 | 0 | $x'y'z'$ | $m_0$ | $x+y+z$ | $M_0$ |
| 0 | 0 | 1 | $x'y'z$ | $m_1$ | $x+y+z'$ | $M_1$ |
| 0 | 1 | 0 | $x'yz'$ | $m_2$ | $x+y'+z$ | $M_2$ |
| 0 | 1 | 1 | $x'yz$ | $m_3$ | $x+y'+z'$ | $M_3$ |
| 1 | 0 | 0 | $xy'z'$ | $m_4$ | $x'+y+z$ | $M_4$ |
| 1 | 0 | 1 | $xy'z$ | $m_5$ | $x'+y+z'$ | $M_5$ |
| 1 | 1 | 0 | $xyz'$ | $m_6$ | $x'+y'+z$ | $M_6$ |
| 1 | 1 | 1 | $xyz$ | $m_7$ | $x'+y'+z'$ | $M_7$. |

$M_5 = w'+x'+y'+z' = 1111$

$2^4 = 16$

$F = x'y'z + xyz' + xyz$

$F = x'y'z + xy(z + z')$

$F = x'y'z + xy(1)$

$F = x'y'z + xy$

$F = x'y'z + xy(z \cdot z')$

$F = x'y'z + xyz + xyz'$

---

$F = x'y'z + xyz' + xyz$

$= m1 + m6 + m7 = \Sigma(1, 6, 7)$

# DLD lecture

$F = \Sigma(3, 7, 9, 12, 14, 15)$.

$F_{sop} = m3, m7, m9, m12, m14, m15$ (Minterm)

$w, x, y, z$ (4 variables)

$F_{pos} = \Pi(0, 1, 2, 4, 5, 6, 8, 10, 11, 13)$.

$F_{pos} = M_0, M_1, M_2, M_4, M_5, M_6, M_8, M_{10}, M_{11}, M_{13}$

(Maxteem)

## → Mapping :-

Making a table of cells

No. of ~~variables~~ Cells = table = $2^n$

n is the number of variables.

$n = 2$

00, 01, 10, 11

| x \ n | 0 | 1 |
|---|---|---|
| 0 | 00 | 01 |
| 1 | 10 | 11 |

Cells = $2^3 = 8$.

| x \ yz | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 000 | 001 | 011 | 010 |
| 1 | 100 | 101 | 111 | 110 |

Followed by Gray Code

One bit change at a time.

| | |
|---|---|
| 0 → 000 | 000 → 0 |
| 1 → 001 | 001 → 1 |
| 2 → 010 | 011 3 |
| 3 → 011 | 010 2 |
| 4 → 100 | 110 6 |
| 5 → 101 | 100 4 |
| 6 → 110 | 101 5 |
| 7 → 111 | 111 7 |

$F = \Sigma(0, 3, 4, 5, 7)$

$m_0, m_3, m_4, m_5, m_7$ (Minterm)

| x | y | z | F | |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | $m_0$ |
| 0 | 0 | 1 | 0 | $m_1$ |
| 0 | 1 | 0 | 0 | $m_2$ |
| 0 | 1 | 1 | 1 | $m_3$ |
| 1 | 0 | 0 | 1 | $m_4$ |
| 1 | 0 | 1 | 1 | $m_5$ |
| 1 | 1 | 0 | 0 | $m_6$ |
| 1 | 1 | 1 | 1 | $m_7$ |

| xy \ z | 0 | 1 |
|---|---|---|
| 00 | 1 | 0 |
| 01 | 0 | 1 |
| 11 | 0 | 1 |
| 10 | 1 | 1 |

$y'z' + yz + xz$

$F = x'y'z' + x'yz + xy'z' + xy'z + xyz$

$F = \Sigma(0,3,4,5,7)$

| x \ yz | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |

2,4,

$F = y'z' + yz + xz$

| x \ yz | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 |

$F = (x' + z)$

000
001
010

1. $F = \Sigma(0, 2, 4, 5, 6, 7)$.

$F = m0, m2, m4, m5, m6, m7$

| x | y | z | F | |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | m0 |
| 0 | 0 | 1 | 0 | m1 |
| 0 | 1 | 0 | 1 | m2 |
| 0 | 1 | 1 | 0 | m3 |
| 1 | 0 | 0 | 1 | m4 |
| 1 | 0 | 1 | 1 | m5 |
| 1 | 1 | 0 | 1 | m6 |
| 1 | 1 | 1 | 1 | m7 |

**Boolean Expression:-**

$= x'y'z' + x'yz' + xy'z' + xy'z + xyz' + xyz$

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

$= x'z'(1) + xy'(1) + xy(1)$

$= x'z' + xy' + xy$

$= x'z' + x(y+y')$

$= x'z' + x(1)$

$= x'z' + x$

# K- Mapping :-

| xy \ z | 0 | 1 |
|---|---|---|
| 00 | 1 | 0 |
| 01 | 1 | 0 |
| 11 | 1 | 1 |
| 10 | 1 | 1 |

$= z' + x$

| X | Y | Z | $\bar{X}$ | $\bar{Z}$ | $\bar{X}\bar{Z}$ | $\bar{X}z' +$ |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 |

| $\bar{Z} + X$ |
|---|
| 1 |
| 0 |
| 1 |
| 0 |
| 1 |
| 1 |
| 1 |
| 1 |