Number system

1. Decimal number system:

0 - Level-1
1
2
3
4
5
6
7
8
9 - Level-10

$(\ \ )_{Base=10}$

$(\ \ )_{10} = (\ \ )_{D} = (\ \ )_{d}$

2. Binary number system:

0 - Level-1
1 - Level-2

$(\ \ )_{Base=2}$

$(\ \ )_{2} = (\ \ )_{B} = (\ \ )_{b}$

3. Hexa-decimal:

0
1
2
3
4
5
6
7
8
9
A
B
C
D
E
F

4. octal

0
1
2
3
4
5
6
7
~~8~~

Ex:- $(BOB)_H = (?)_{10}$

$$\begin{array}{ccc} B & O & B \\ 11 & & 11 \end{array}$$

$\Rightarrow 16^2 \times 11 + 16^1 \times 0 + 16^0 \times 11$

$\Rightarrow 256 \times 11 + 11$

$\Rightarrow 2,827$

Ex:- $(DAD)_H = (?)_8$

$$\begin{array}{ccc} D & A & D \\ 13 & 10 & 13 \end{array}$$

$\Rightarrow 16^2 \times 13 + 10 \times 16^1 + 16^0 \times 13$

$\Rightarrow 3,501$

~~Ex:-~~

NOTE:-

Decimal $\rightarrow$ other $\Rightarrow$ division

other $\rightarrow$ Decimal $\Rightarrow$ multiplication.

Ex:- $(1234)_{10} = (?)_2$ $\quad$ $(BAD.BED)_H = (?)_{8\&10}$ $\quad$ $(10111110)_2 = (?)_{10}$

$\boxed{(10111.1111)_{10} = (?)_8}$ $\quad$ $(DEAD)_H = (?)_8$ $\quad$ $(CODE.DCODE)_H = (?)_{10}$

1.
2 | 1234
2 | 617 - 0
2 | 308 - 1
2 | 154 - 0
2 | 77 - 0
2 | 38 - 1
2 | 19 - 0
2 | 9 - 1
2 | 4 - 0
2 | 2 - 0
1 - 1

$(1234)_{10} = (1001010010)_2$

$\underset{76543210}{(10111110)_2} \Rightarrow 2^7 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1$

$\Rightarrow (190)_{10}$

2.
$\underset{76543210}{(10111110)_2}$

$2^0 \times 0 + 2^1 \times 1 + 2^2 \times 1 + 2^3 \times 1 + 2^4 \times 1 + 2^5 \times 1 + 0 \times 2^6$
$+ 1 \times 2^7$

$\Rightarrow (190)_{10}$

3.

$(DEAD)_H = (?)_8$

Hexadecimal → Binary

$(1101\ 1110\ 1011\ 1101)_2$

Binary → octal.

$(001\ 101\ 111\ 010\ 111\ 101)_2$

$\Rightarrow (157275)_8$

$(CODE.DCODE)_H = (?)_{10}$

$CODE \Rightarrow 12 \times 16^3 + 0 \times 16^2 + 13 \times 16^1 + 14 \times 16^0$

$\Rightarrow 49374$

$DCODE \Rightarrow \frac{13}{16} + \frac{12}{16^2} + 0 + \frac{13}{16^4} + \frac{14}{16^5}$

$\Rightarrow$

$(03122006)_{10} = (?)_2$

```
2 | 3122006
2 | 1561003 - 0
2 | 780501  - 1
2 | 390250  - 1
  | 195125  - 0
```

$(03)_{10} = (?)_2$

```
2 | 3 - 1
2 | 1 - 1
```

$\Rightarrow (11)_2$

$(12)_{10} = (?)_2$

```
2 | 12 - 0
2 | 6  - 0
2 | 3  - 1
    1  - 1
```

$= (1100)_2$

.070704145

```
2 | 2006 - 0
2 | 1003 - 1
2 | 501  - 1
2 | 250  - 0
2 | 125  - 1
2 | 62   - 0
2 | 31   - 1
2 | 15   - 0
2 | 7
```

Ex 1:- $(3DE.EFC)_H = (?)_2$

16 2

2^4 — 2^1 : represented in 4 digits.

$(3)_H = (0011)_2$

$(D)_H = (1101)_2$

$(E)_H = (1110)_2$

$(F)_H = (1111)_2$

$(C)_H = (1100)_2$

$(0011\ 1101\ 1110\ .\ 1110\ 1111\ 1100)_2$

Ex 2:

$(\underline{1}\underline{1010}\underline{0111}.\underline{1100}\underline{1111}\underline{1})_2 = (?)_H$

$(0001)_2 = 1$

$(1010)_2 = 10$ A

$(0111)_2 = 7$

$(1100)_2 = 12$ C

$(1111)_2 = 15$ F

$(1000)_2 = 8$

1 10 7 12

$(1A7.CF8)_H$

Ex:
2

$(3AB.BA5)_{H} = (?)_8$

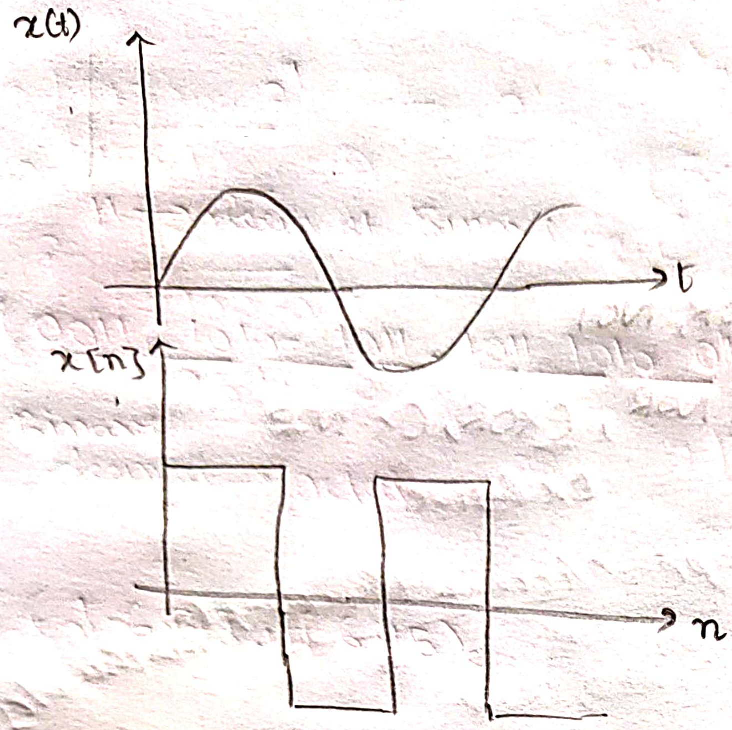
$2^4 - 2^3$

H → ~~decimal~~ Binary

$(\underline{0011}\ \underline{1010}\ \underline{1011}.\underline{1011}\ \underline{1010}\ \underline{0101})_2$

Binary
~~decimal~~ → Octal

$(1653.7645)_8$



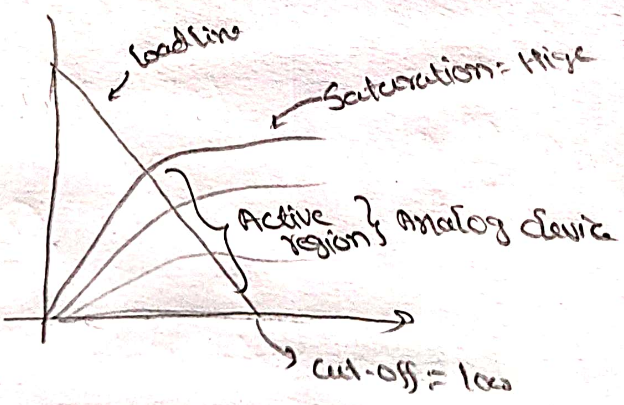
Analog signals

Digital signals.

- Digital signals with continous tyme : Digital circuits & Hardware Design
- Digital signals with discrete time : Digital signal Processing.
  design in optimum size.

Transistor in active region gives Analog signal
- Analog device.

High = 1
Low = 0
Binary N.S



Digital is not only binary

* interview ques.

Gates :- Basic components to make circuits.

Types

1. Basic Gates
2. Derived Gates

Basic gates : AND, OR, NOT

Derived gates : NAND, NOR, EXOR, EX-NOR

Exclusive

Boole - mapped human thinking to mathematics

AND, OR, NOT

AND

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

2^n → variables

→ No.s

* interview ques-

Gates: Basic components to make circuits.

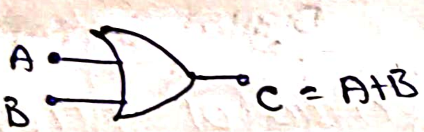
- **Types:**

  1. Basic Gates - OR, AND, NOT (universal gates)
  2. Derived Gates. - NAND, NOR, EX-OR, EX-NOR

     Exclusive

- **Basic gates:**

1. **OR Gate:** Performs addition.



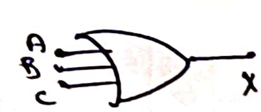
I/P		O/P
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

no. of possibilities ⇒ 4

NOTE:- No of possibilities = 2^x ← no. of variables

number system

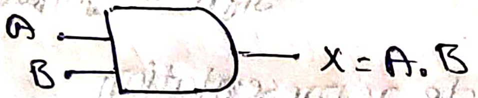
A	B	C	X
0	0	0	0
0	0	1	1
1	0	0	1
0	1	1	1
1	1	0	1
0	1	0	1
1	0	1	1
φ	1	1	1



* Boolean mapped human thinking to mathematics.

OR, AND, NOT

2. AND Gate: Perfoms multiplication



3. NOT Gate: inverts the signal

* Reducing Boolean Expressions:

- Look for identical terms, retain one such terms only and remove redundancy

  Ex:- $AB + AB + AB = AB$ ↳ Extra terms which are not necessary.

- Multiply all variables necessary to remove all parenthesis.

- Look for variable & its negation in the same term. It can than be dropped.

  Ex: $A.B.\bar{B} = 0$

- Look for pair of terms that are identical except for 1 variable which may be missing in one of the terms

  Ex: $AB\bar{C}\bar{D} + AB\bar{C} = AB\bar{C}$

- Look for pair of terms which are complement.

  Ex:- $AB\bar{C}\bar{D} + AB\bar{C}D = AB\bar{C}$

NOTE:- Sometimes, we have to add redondancy such channel encryption, sattilite communication.

Ex:

$$Y = A[B + \bar{C}(\overline{AB + A\bar{C}})]$$

$$Y = A[B + \bar{C}(\overline{AB} \cdot \overline{A\bar{C}})]$$

$$Y = A[B + \bar{C}((\bar{A} + \bar{B}) \cdot (\bar{A} + C))]$$

$$Y = A[B + \bar{C}[\bar{A} + \bar{B} + C]]$$

$$Y = A[B + \bar{C}\bar{A} + \bar{C}\bar{B} + \underbrace{\bar{C}C}_{0}]$$

$$Y = AB + \underbrace{A\bar{C}\bar{A}}_{0} + A\bar{C}\bar{B} = AB + A\bar{C}\bar{B}$$

$$\Rightarrow A[B + \bar{C}[\bar{A} + \underset{0}{\bar{A}}C + \bar{B}.\bar{A} + \bar{B}.\bar{C}]]$$

$$\Rightarrow A[B + \bar{C}\bar{A} + \bar{A}.\bar{B}.\bar{C} + \bar{A}.\bar{B})]$$

$$\Rightarrow AB + 0 + 0 + 0 = \underline{AB}$$

★ Reducing Boolean Expressions:

- Look for identical terms, retain one such terms only and remove redundancy ↳ extra terms which are not necessary.

  Ex:- $AB + AB + AB = AB$

- Multiply all variables necessary to remove all parenthesis.
- Look for variable & its negation in the same term. It can then be dropped.

  Ex: $A.B.\bar{B} = 0$

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NOTE:- sometimes, we have to add redundancy such channel encryption, sattilite communication.

Ex:

$$Y = A[B + \bar{C}\,\overline{(AB + A\bar{C})}]$$

$$Y = A[B + \bar{C}(\overline{AB} \cdot \overline{A\bar{C}})]$$

$$Y = A[B + \bar{C}((\bar{A} + \bar{B}) \cdot (\bar{A} + C))]$$

$$\Rightarrow A[B + \bar{C}[\bar{A} + \underset{0}{\bar{A}C} + \bar{B}.\bar{A} + \bar{B}.\bar{C}$$

$$\Rightarrow A[B + \bar{C}\bar{A} + \bar{A}.\bar{B}.\bar{C} + \bar{A}.\bar{B})]$$

$$\Rightarrow AB + 0 + 0 + 0 = \underline{\underline{AB}}$$

$$Y = A[B + \bar{C}[\bar{A} + \bar{B} + C]]$$

$$Y = A[B + \bar{C}\bar{A} + \bar{C}\bar{B} + \underbrace{\bar{C}C}_{0}]$$

$$Y = AB + \underbrace{A\bar{C}\bar{A}}_{0} + A\bar{C}\bar{B} = AB + A\bar{C}\bar{B}$$

★ 2's Complement

-2 -1 0 1 2 3

15 → 1 1 1 1

(+)15 → $0\ \underbrace{1111}_{\text{magnitude}}$

(−)15 → $1\ \underbrace{1111}_{\text{magnitude}}$

} This is called as sign-Magnitude representation

→ 2's Complement

1's Complement : Interchange '0' & '1'

2's Complement : 1's complement + '1'

Eg: 1's complement

$11101010 \xrightarrow{1's} 00010101$

Determine 1's Complement of $(51)_d$ in Binary

$0110011 \xrightarrow{1's} 1001100$

+1

$(1001101)_B$

$(-51)_d$

2	51	1
2	25	1
2	12	0
2	6	0
2	3	1
2	1	1
	0	

$7 \rightarrow 0111 \xrightarrow{1's} 1000$

+1

$(1001)_B \longrightarrow (-7)$

$8 \rightarrow 1000 \longrightarrow 0111$

+1

$1000 \longrightarrow (-8)$

0000	$\rightarrow 0$
0001	$\rightarrow 1$
0010	$\rightarrow 2$
0011	$\rightarrow 3$
0100	$\rightarrow 4$
0101	$\rightarrow 5$
0110	$\rightarrow 6 \rightarrow (2^{n}-1)$
0111	$\rightarrow 7 \rightarrow -2^{n}$
8 → 1000	$\rightarrow -8$
1001	$\rightarrow -7$
1010	$\rightarrow -6$
1011	$\rightarrow -5$
1100	$\rightarrow -4$
1101	$\rightarrow -3$
1110	$\rightarrow -2$
1111	$\rightarrow -1$

• $5-4=?$

$$\begin{array}{lr} (+5) & 0101 \\ +(-4) & 1100 \\ \hline & \boxed{1}\ \underbrace{0001}_{1} \end{array}$$

$\downarrow$ Overflow ignore

• $4-5=?$

$$\begin{array}{lr} (+4) & 0100 \\ +(-5) & 1011 \\ \hline & 1111 \end{array}$$

• $(-3)+(-2)=?$

$$\begin{array}{lr} (-3) & 1101 \\ (-2) & 1110 \\ \hline & \boxed{1}\ \underbrace{1011}_{-5} \end{array}$$

$\downarrow$ overflow

★ **Positive Logic**

+5V → logic '1'
0V → logic '0'

★ **Negative Logic**

+5V → logic '0'
0V → logic '1'

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Boolean Algebra

- Axioms or Laws of Boolean Algeba

$$\left.\begin{aligned} 0.0 &= 0 \\ 0.1 &= 0 \\ 1.0 &= 0 \\ 1.1 &= 1 \end{aligned}\right\} \text{AND}$$

$$\left.\begin{aligned} 0+0 &= 0 \\ 0+1 &= 1 \\ 1+0 &= 1 \\ 1+1 &= 1 \end{aligned}\right\} \text{OR}$$

$$\left.\begin{aligned} \bar{0} &= 1 \\ \bar{1} &= 0 \end{aligned}\right\} \text{NOT}$$

- Laws
  - $\bar{\bar{A}} = A$
  - $0.A = 0$
  - $1.A = A$
  - $A.A = A$
  - $A.\bar{A} = 0$

- OR Laws
  - $A+0 = A$
  - $A+1 = 1$
  - $A+A = A$
  - $A+\bar{A} = 1$

- $A(B+C) = AB + AC$
- $\boxed{A + \bar{A}B = A+B}$

↓ Proof

$\Rightarrow A.1 + \bar{A}B$ $\quad\therefore 1 = 1+B$

$\Rightarrow A.(1+B) + \bar{A}B$

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

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

$\Rightarrow A+B$

- $A(\bar{A}+B) = AB$

★ Concensus Theorem –

$$AB + \bar{A}C + BC = AB + \bar{A}C$$

→ Proof of Consensus theorem

$$AB + \bar{A}C + BC = AB + \bar{A}C$$

L.H.S ⇒

⇒ $AB + \bar{A}C + BC[A + \bar{A}]$ ∴ $A + \bar{A} = 1$

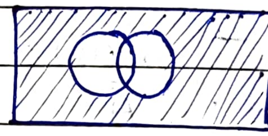
⇒ $AB + \bar{A}C + ABC + \bar{A}BC$

⇒ $AB(1+C) + \bar{A}C(1+B)$ (∴ $1+C$ or $1+B = 1$)

⇒ $AB + \bar{A}C$

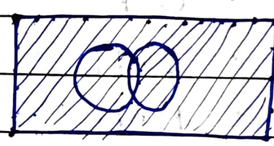
☆ De Morgan's Theorem

- $\overline{A+B} = \bar{A} \cdot \bar{B}$



NOR = Bubbled AND

- $\overline{A \cdot B} = \bar{A} + \bar{B}$



NAND = Bubbled OR

Ques ① $F = \overline{AB} + A$

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

$F = [A + \bar{A}] + \bar{B} = 1 + \bar{B} = 1$

② $F = \overline{(\bar{A} + B)} + AB$

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

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

$= A.1$

$F = A$

③ $F = \overline{(A + \overline{BC})}$

$F = \bar{A} \cdot (\overline{\overline{BC}})$

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

$F = \bar{A}B + \bar{A}C$

$F = \bar{A}B + \bar{A} + \bar{C}$

$F = \bar{A}(B+1) + \bar{C}$

$F = \bar{A} + \bar{C}$

$F = \bar{A} \cdot (\overline{\overline{BC}})$

$F = \bar{A}.BC$

④ $F = (\overline{A+B}) \cdot (\bar{A} + B)$

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

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

$F = \bar{A} \cdot \bar{B} \cdot \bar{A} + \bar{A} \cdot \bar{B} \cdot B$ $\quad \therefore \bar{B} \cdot B = 0$

$F = \bar{A}\bar{B}$

⑤ $F = (\overline{AB + C}) + \bar{C}$

$= (\overline{A \cdot B}) \cdot \bar{C} + \bar{C}$

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

$= \bar{A} \cdot \bar{C} + \bar{B} \cdot \bar{C} + \bar{C}$

$= \bar{A} \cdot \bar{C} + \bar{C}(\bar{B} + 1)$

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

$= \bar{C}$

⑥ $F = (\overline{A + BC}) + A\bar{B}$

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

$F = \bar{A}\bar{B} + \bar{A}\bar{C} + A\bar{B}$

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

$F = \bar{B} + \bar{A}\bar{C}$

Check: $\overline{A+B+C} = \bar{A} \cdot \bar{B} \cdot \bar{C}$

A	B	C	$A+B+C$	$\overline{A+B+C}$	$\bar{A}$	$\bar{B}$	$\bar{C}$	$\bar{A} \cdot \bar{B} \cdot \bar{C}$
0	0	0	0	1	1	1	1	1
0	0	1	1	0	1	1	0	0
0	1	0	1	0	1	0	1	0
0	1	1	1	0	1	0	0	0
1	0	0	1	0	0	1	1	0
1	0	1	1	0	0	1	0	0
1	1	0	1	0	0	0	1	0
1	1	1	1	0	0	0	0	0

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(7) ⇒ $F = \overline{\bar{A}.\bar{B}} + (A+B).\bar{C}$

$F = A + B + A\bar{C} + B\bar{C}$

$F = A(1+\bar{C}) + B(1+\bar{C})$

$F = A + B$

(8) ⇒ $F = \overline{(\bar{A}+B)} + \left(\overline{\bar{A}+\bar{C}}\right)$

$F = A\bar{B} + AC$

$F =$

(9) ⇒ $\overline{(A.\bar{B}+\bar{C})} . (A+C)$ $\qquad C(\bar{A}+\bar{B})$

⇒ $\bar{A}+B.C . (A+C)$

$= (\bar{A}+BC).(A+C)$

⇒ $\bar{A}.A + \bar{A}C + ABC + BC.C$

⇒ $0 + \bar{A} + BC(A+1)$

$= \bar{A} + BC$ (Wrong)

(10) $F = \overline{(A+B+C)} + (AB+\bar{C})$

$= \bar{A}\bar{B}\bar{C} + AB + \bar{C}$

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

$= \bar{C} + AB$

11/8

⇒ Duality → {AND ⟷ OR , '0' ⟷ '1'}

Expression		Dual
$\bar{0} = 1$	-	$\bar{1} = 0$
$0.1 = 0$	-	$1+0 = 1$
$0.0 = 0$	-	$1+1 = 1$
$1.1 = 1$	-	$0+0 = 0$
$A.0 = 0$	-	$A+1 = 1$
$A.1 = A$	-	$A+0 = A$
$A.A = A$	-	$A+A = A$
$A.\bar{A} = 0$	-	$A+\bar{A} = 1$
$A.B = B.A$	-	$A+B = B+A$

→ History of 60 bit ?

→ Pythagoras is applicable for n dimension ?

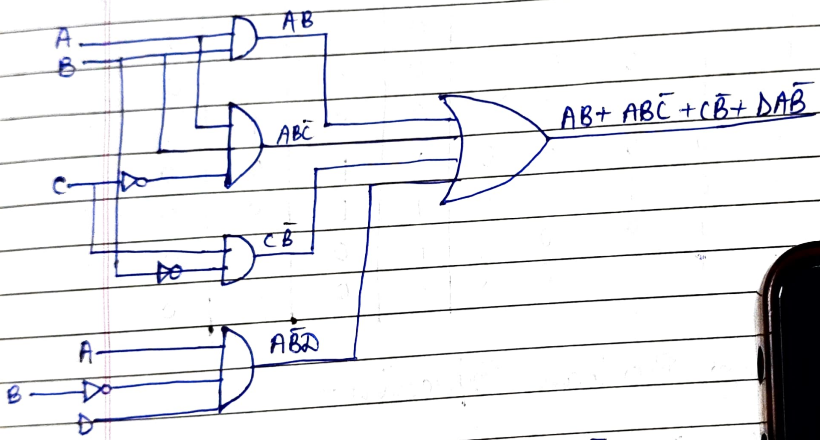
$A.(B+C) = AB + AC$ - $A+(B.C) = (A+B).(A+C)$

$\bar{A}.\bar{B} = \bar{A}+\bar{B}$ - $\bar{A}+\bar{B} = \overline{AB}$

★ Combinational Logic Circuit Design

* Implement the following expression using combinational logic circuits & verify their truth table

① $Y = AB + AB\bar{C} + C\bar{B} + DA\bar{B}$



$\Rightarrow Y = AB + AB\bar{C} + C\bar{B} + DA\bar{B}$

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

$= AB + C\bar{B} + DA\bar{B}$

$=$ n

A	B	C	D	$\bar{C}$	$\bar{B}$	AB	$AB\bar{C}$	$C\bar{B}$	$DA\bar{B}$	Y
0	0	0	0	1	1	0	0	0	0	0
0	0	0	1	1	1	0	0	0	0	0
0	0	1	0	0	1	0	0	1	0	1
0	0	1	1	0	1	0	0	1	0	1
0	1	0	0	1	0	0	0	0	0	0
0	1	0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0
1	0	0	0	1	1	0	0	0	0	0
1	0	0	1	1	1	0	0	0	1	1
1	0	1	0	0	1	0	0	1	0	1
1	0	1	1	0	1	0	0	1	1	1
1	1	0	0	1	0	1	1	0	0	1
1	1	0	1	1	0	1	1	0	0	1
1	1	1	0	0	0	1	0	0	0	1
1	1	1	1	0	0	1	0	0	0	1

☆ Reducing Boolean Expression -

- Look for identical terms, relation one such term only & remove redundancy.
  Eg: $AB + AB + AB = AB$

- Multiply all variables necessary to remove all parenthesis.
- Look for variable and its negation in the same term. It can then be dropped.
  Eg. $A.B.\bar{B} = 0$

- Look for pair of term that are identical except for 1 variable which may be missing in one of the terms.

Eg→ $AB\bar{C}D + AB\bar{C} = AB\bar{C}$

- Look for pair of term which are complement

Eg→ $AB\bar{C}\bar{D} + AB\bar{C}D = AB\bar{C}$

$\overline{AB} \cdot \overline{A\bar{C}}$

Ques- $Y = A[B+\bar{C}(\overline{AB+A\bar{C}})]$

$\cancel{Y = A[B+\bar{C}((\bar{A}+\bar{B})\cdot(\bar{A}+C))]}$

$\cancel{Y = A[B+\bar{C}[\bar{A}+\bar{A}C+\bar{A}B+\bar{B}C]]}$

$\cancel{Y = A[B+\bar{A}\bar{C}}$

Solution $Y = A[B+\bar{C}(\overline{A}B + \overline{A}\bar{C})]$

$Y = A[B + \overline{A}BC + \cancel{A\bar{C}C}]$

$Y = AB + \cancel{A\cdot\bar{A}B\bar{C}}$

$Y = AB$

☆ Boolean Function Representation

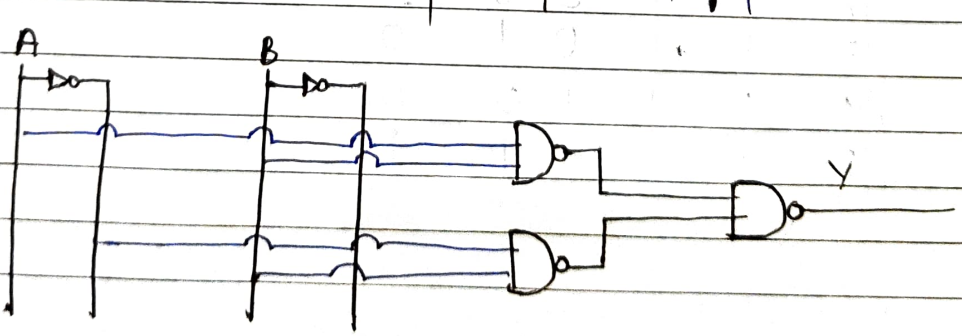
* Sum of Products (SOP) (NAND)

It is also called 'Disjunctive Normal Form'

Eg→ $Y = AB + \bar{A}B = \Sigma_M(1,3)$

$\bar{A}$	A	B	AB	$\bar{A}B$	Y
1	0	0	0	0	0
1	0	1	0	1	1
0	1	0	0	0	0
0	1	1	1	0	1

	A	B	Y
0	0	0	0
1	0	1	1
2	1	0	0
3	1	1	1



Ques → $Y = \underset{011}{\bar{A}BC} + \underset{101}{A\bar{B}C} + \underset{111}{ABC} + \underset{100}{A\bar{B}\bar{C}} = \sum_M (3,4,5,7)$

	A	B	C	Y
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1

Ques $\underset{1011}{A\bar{B}CD} + \underset{1111}{ABCD} + \underset{1100}{AB\bar{C}\bar{D}} + \underset{0101}{\bar{A}B\bar{C}D} + \underset{0000}{\bar{A}\bar{B}\bar{C}\bar{D}} = \sum_M (0,5,11,12,15)$

	A	B	C	D	Y
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	1
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	0
15	1	1	1	1	1

★ MIN TERM : A product term which contains all the variables of the function either in complemented or uncomplemented form.

★ PRODUCT OF SUM - (NOR)

- It is also called Conjective Normal form

★ MAX TERM : A "sum" term which contains "all" the variables in either complemented or uncomplemented form.

Eg → $Y = (\overset{1}{A} + \overset{1}{B})(\overset{0}{\bar{A}} + \overset{1}{B}) = \cancel{\Pi_M (1, 3)}$

$\Pi M(1, 3)$

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

Eg ⇒ $Y = (\overset{0}{\bar{A}} + \overset{1}{B} + \overset{1}{C})(\overset{1}{A} + \overset{0}{\bar{B}} + \overset{1}{C}) \cdot (\overset{1}{A} + \overset{1}{B} + \overset{1}{C})(\overset{1}{A} + \overset{0}{\bar{B}} + \overset{1}{C})$

$\Pi M(3, 5, 7)$

	A	B	C	Y
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1

★ KARNAUGH MAP (K Map)

- It is a systematic method of simplifying the boolean expressions. The K-Map is a chart or graph compost of arrangements of adjacent cells, each representing a particular combination of variables in sum or product form.

Eg ⇒ $Y = \bar{A}B + A\bar{B} = \sum m(1,2)$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

B \ A	$\bar{A}$ 0	A 1
$\bar{B}$ 0	0	1
B 1	1	0

Eg ⇒ $Y = A\bar{B} + \bar{A}\bar{B}$

B \ A	0	1
0	1	1
1	0	1

H.W → $Y = \bar{A}B + \bar{A}B$

B \ A	0	1
0	0	0
1	1	0

$Y = AB + \bar{A}B$

B \ A	0	1
0	0	0
1	1	1

★★ ★★★ Important

★ POS CORRECTION

A	B	Min Terms		Max Terms	
0	0	m_0	$\bar{A}.\bar{B}$	M_1	$A+B$
0	1	m_1	$\bar{A}.B$	M_2	$A+\bar{B}$
1	0	m_2	$A.\bar{B}$	M_3	$\bar{A}+B$
1	1	m_3	$A.B$	M_4	$\bar{A}+\bar{B}$

$Y = \sum m(0,1) = \sum M(2,5)$

$Y = \sum m(0,1)$

	A	B	Y	Min Terms		Max Terms
0	0	0	1	m_0	$\bar{A}.\bar{B}$	
1	0	1	1	m_1	$\bar{A}.B$	
2	1	0	0		0	$(\bar{A}+B)$
3	1	1	0		0	$(\bar{A}+B)$

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

$Y = \bar{A}(\bar{B}+B)$

$Y = \bar{A}$

$Y = (\bar{A}+B)(\bar{A}+\bar{B})$

$Y = \bar{A} + \bar{A}\bar{B} + \bar{A}B + \cancel{B\bar{B}}^{\,0}$

$Y = \bar{A}(1+\bar{B}+B)$

$Y = \bar{A}$

$\bar{A}+\bar{B}$ (✓)

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

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

$(1+\bar{B})\bar{A} + A\bar{B}$

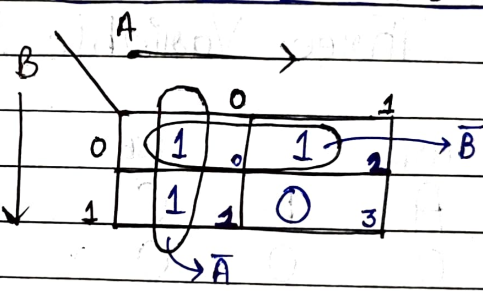
$\bar{A}(\bar{B}+B) + A\bar{B}$

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

✯ KARNAUGH MAP

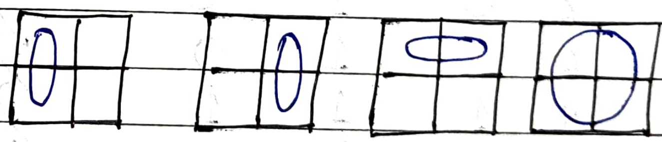
$Y = \sum m(0,1,2)$

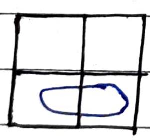
	A	B	Y	Min terms
0	0	0	1	$\bar{A}\bar{B}$
1	0	1	1	$\bar{A}B$
2	1	0	1	$A\bar{B}$
3	1	1	0	-



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

* Possible groups →





Note :- No diagonal groupings in K-map

$Y = \Sigma m(0,3)$

B \ A	0	1
0	1 (0)	0 (2)
1	0 (1)	1 (3)

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

$Y = \Sigma m(0,1,2,3)$

B \ A	0	1
0	1 (0)	1 (2)
1	1 (1)	1 (3)

$Y = 1$

$Y = \Sigma m(0,1,2)$

B \ A	0	1
0	1 (0)	1 (2)
1	1 (1)	0 (3)

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

$Y = \Sigma m(0,2,3)$

	0	1
0	1 (0)	1 (2)
1	(1)	1 (3)

$\rightarrow \bar{B} + A = Y$

22/08/25

★ Three Variable K-Map

	A (MSB)	B	C (LSB)
0	0	0	0
1	0	0	1
3	0	1	1
2	0	1	0
6	1	1	0
7	1	1	1
5	1	0	1
4	1	0	0

1 bit change

A \ BC	00	01	11	10
0	0	1	3	2
1	4	5	7	6

Ques→ $F(A,B,C) = \sum m(0,1,3,4)$

A \ BC	00	01	11	10
0	1 ₀	1 ₁	1 ₃	₂
1	1 ₄	₅	₇	₆

Remove the bit which is changing

$Y = \bar{A}C + \bar{B}\bar{C}$ ← Same

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

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

$\bar{A}\bar{B} + \cancel{\bar{A}BC} + A\bar{B}\bar{C}$

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

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

Ques→ $f(ABC) = \sum m(0,4,6,2)$

A \ BC	00	01	11	10
0	1 ₀	₁	₃	1 ₂
1	1 ₄	₅	₇	1 ₆

$\bar{B}\bar{C} + B\bar{C} \rightarrow \bar{C}(\bar{B}+B) = \bar{C}$

or

A \ BC	00	01	11	10
0	1 ₀	₁	₃	1 ₂
1	1 ₄	₅	₇	1 ₆

$f(A,BC) = \bar{C}$

(only $\bar{C}$ is same)

Ques⇒ $Y = \sum m(1,4,5,7)$

A \ BC	00	01	11	10
0	₀	1 ₁	₃	₂
1	1 ₄	1 ₅	1 ₇	₆

$Y = \bar{B}C + A\bar{B} + AC$

Ques→ $F(A,B,C) = \sum m(0,3,5,6)$

A \ BC	00	01	11	10
0	1 ₀	0 ₁	1 ₃	0 ₂
1	0 ₄	1 ₅	0 ₇	1 ₆

$Y = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}C + AB\bar{C}$

① $Y = \sum m(1,3,5,7,0)$

	00	01	11	10
0	1_0	1_1	1_3	$_2$
1	$_4$	1_5	1_7	$_6$

$\cancel{Y = \bar{A}B + BC + \bar{A}C}$ $\quad \bar{Y} = C + \bar{A}\bar{B}$

③ $Y = \sum m(0,2,3,5)$

	00	01	11	10
0	1_0	$_1$	1_3	1_2
1	$_4$	1_5	$_7$	$_6$

$Y = \bar{A}B + \bar{A}\bar{B}\bar{C} + A\bar{B}C$

② $Y = \sum m(1,3,5,6,7)$

	00	01	11	10
0	$_0$	1_1	1_3	$_2$
1	$_4$	1_5	1_7	1_6

$\cancel{Y = \bar{A}C + AC + AB}$ $\quad Y = C + AB$

④ $Y = \sum m(0,1,2,3,4,5,6)$

	00	01	11	10
0	1_0	1_1	1_3	1_2
1	1_4	1_5	$_7$	1_6

$Y = \bar{C} + \quad + \bar{A}C + \bar{B}$

⑤ $Y = \sum m(0,3,5,7)$

	00	01	11	10
0	1_0	$_1$	1_3	$_2$
1	$_4$	1_5	1_7	$_6$

$\bar{Y} = \bar{A}\bar{B}\bar{C} + \quad + AC + BC$

⑥ $Y = \sum m(0,1,3,4,6)$

	00	01	11	10
0	1_0	1_1	1_3	$_2$
1	1_4	$_5$	$_7$	1_6

$Y = A\bar{C} + \bar{A}\bar{B} + \bar{A}C$