Logic gate

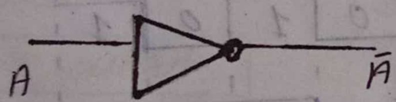
The electronics componend which has ability to make some disk is turn is logic gate.

-> logic gate are 3 types :-

i) Fundamental logic gate -> NOT, OR, AND
ii) Universal logic gate -> NOR, NAND
iii) Exclussive logic gate -> EX-OR, EX-NOR

NOT GATE :- [IC - 7404]

symbol :-



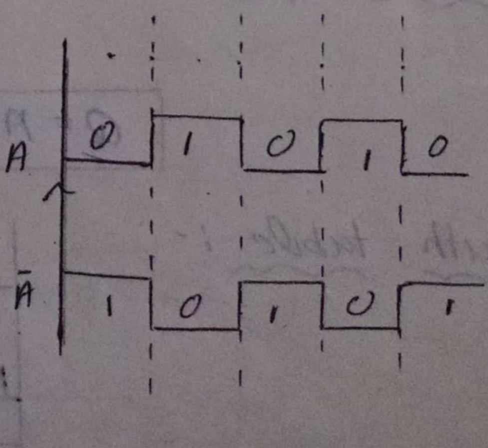
-> NOT gate have only one input $ one output

Boolean Expresion :-

$$\boxed{Q = \overline{A}}$$

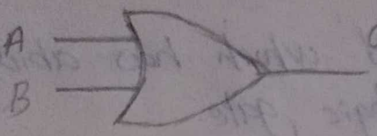
Truth table :-

Input (A)	output ($Q=\overline{A}$)
0	1
1	0



OR GATE :- [IC - 7432]

logic symbol :-



Boolean Expresion :-

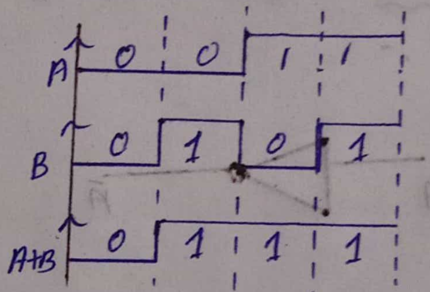
$$\boxed{Q = A + B}$$

It have 2 input and 1 output

Truth table

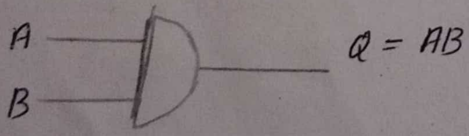
Input		output
A	B	(Q)
0	0	0
0	1	1
1	0	1
1	1	1

Timing diagram :-



AND GATE :- [IC - 7408]

logic symbol :



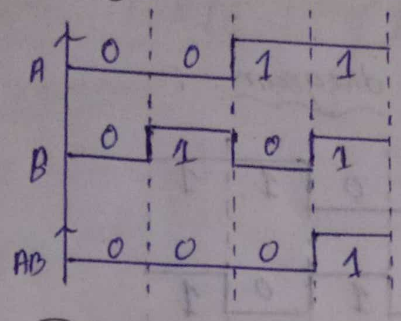
Boolean Expresion :-

$$\boxed{Q = AB}$$

Truth table :-

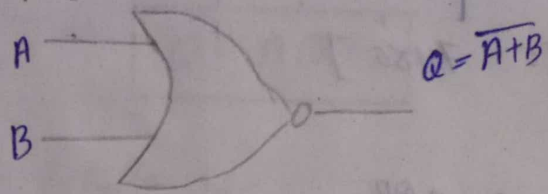
Input		output
A	B	(Q)
0	0	0
0	1	0
1	0	0
1	1	1

Timing diagram :-



NOR GATE :- [IC - 7402]

logic symbol :-



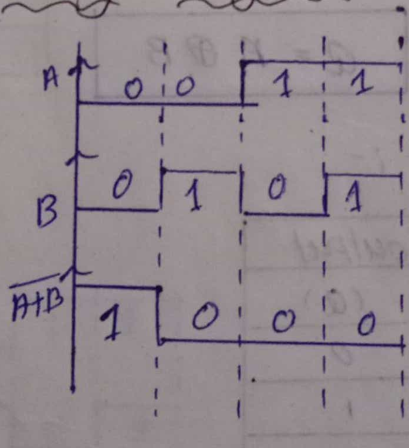
Boolean Expresion :-

$$\boxed{Q = \overline{A+B}}$$

Truth table

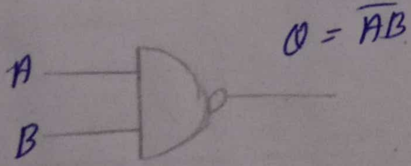
Input		output
A	B	(Q)
0	0	1
0	1	0
1	0	0
1	1	0

Timing diagram :-



NAND GATE :- [IC - 7400]

logic symbol :



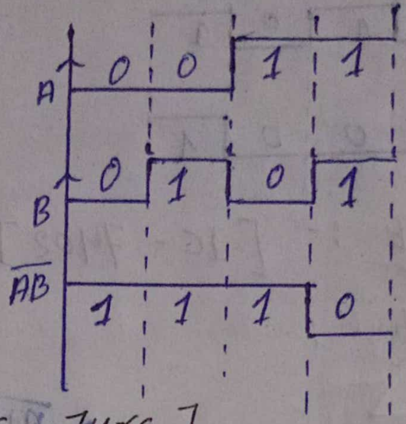
Boolean Expresion :-

$$\boxed{Q = \overline{AB}}$$

Truth table :-

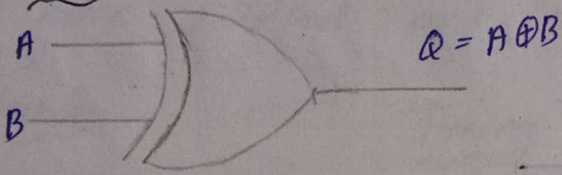
Input		output
A	B	(Q)
0	0	1
0	1	1
1	0	1
1	1	0

Timing diagram :-



EX-OR GATE :- [IC - 7486]

Logic symbol :



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

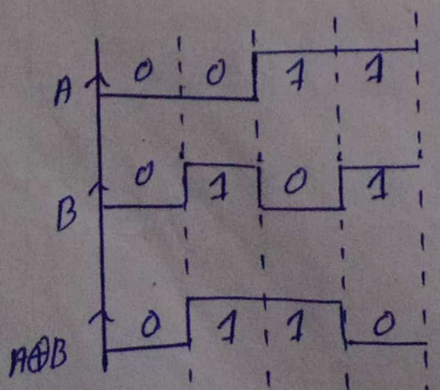
Boolean Expresion :-

$$\boxed{Q = A \oplus B}$$

Truth table :-

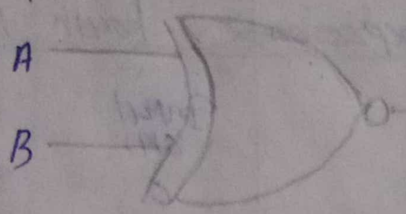
Input		output
A	B	(Q)
0	0	0
0	1	1
1	0	1
1	1	0

Timing diagram :-



EX - NOR GATE :- [IC - 74266]

logic symbol :-



$Q = A \odot B / \overline{A \oplus B}$

$= \overline{A}\overline{B} + AB$

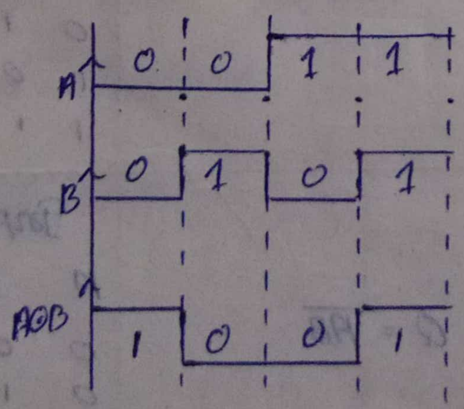
Boolean Expresion :-

$$\boxed{Q = A \odot B}$$

Truth table :-

Input		output
A	B	(Q)
0	0	1
0	1	0
1	0	0
1	1	1

Timing diagram :-



Combinational

- It is only depend upon the present input.
- It does not required feedback
- Ex :- Adder, substractor
  Encoder, decoder
  multiplexer, demultiple

Sequential circuit :

- It is depend upon present input & past output.
- It Required feedback.

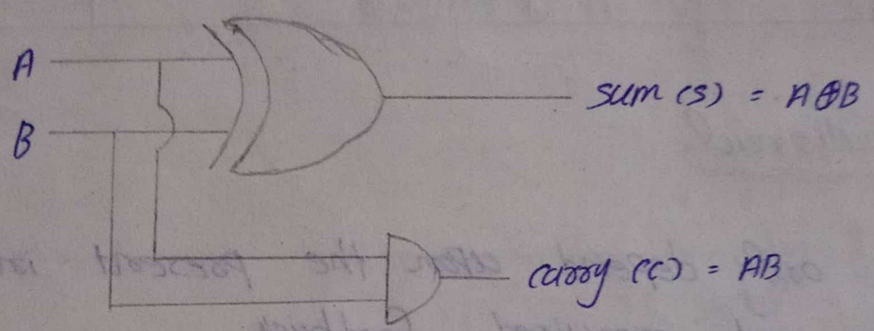
Ex :- i) flipflop ←
- → S-R flipflop
- → JK flipflop
- → T flipflop
- → D flipflop

ii) counter →
- → sequencial →
  - → up counter
  - → down counter
- → Asequencial →
  - → up counter
  - → down counter

Half - Adder :-

Half adder is a circuit in which to binary bit's are added and the resultant will be a two bit binary number. (one bit in term's as some bit and other one is carry bit)

logic symbol :-



No. of Input = 2 (A & B)

No. of output = 2 (sum (S) carry (C))

Truth table :

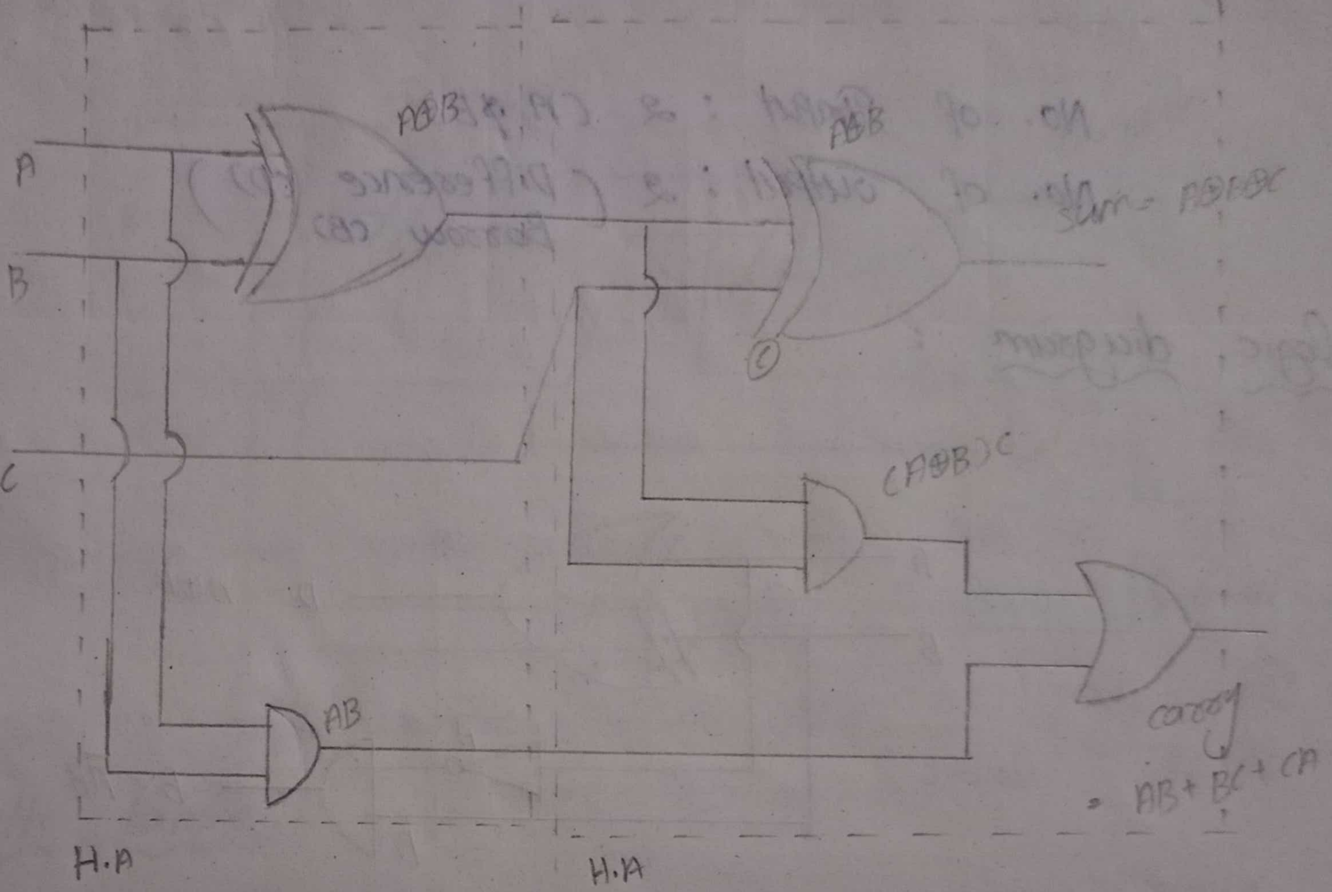
Input		output	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Full adder :

Full adder circuit is a circuit in which three binary bit's are added and resultant will be a two bit binary number.

No. of Input - 3 (A, B, C)
No. of output - 2 (sum(S), carry(C))

Logic diagram :



Truth table :

Input			output	
A	B	C	sum	carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	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

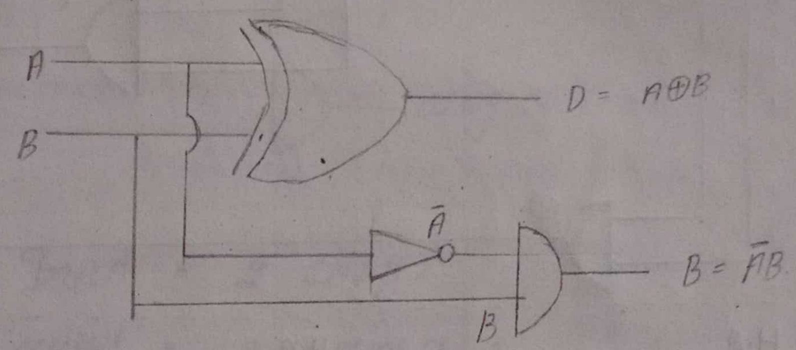
Half - substractor :-

It is the combinational circuit in which we are finding the difference between 2 binary bit's and the resultant will be 2 bit.

No. of Input : 2 (A $ B)

No. of output : 2 (Difference (D) Borrow (B))

logic diagram :



Truth table :-

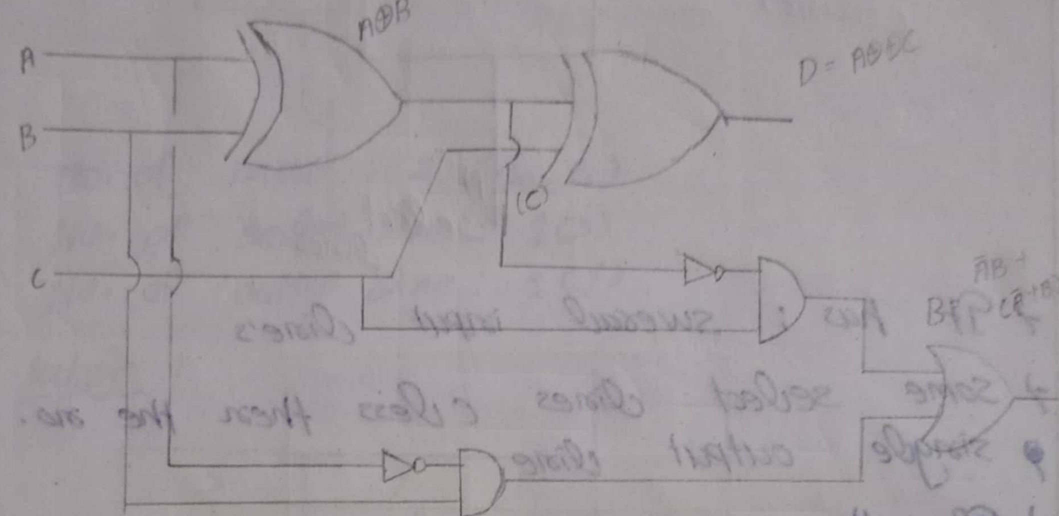
Input		output	
A	B	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Full- substracter :

It is a combinational circuit in which we are going to find the difference between three Binary bit than the resultant will be two bit.

No. of Input : 3 (A, B, C)
No. of output : 2 (Difference (D), Borrow (B))

Logic diagram :-



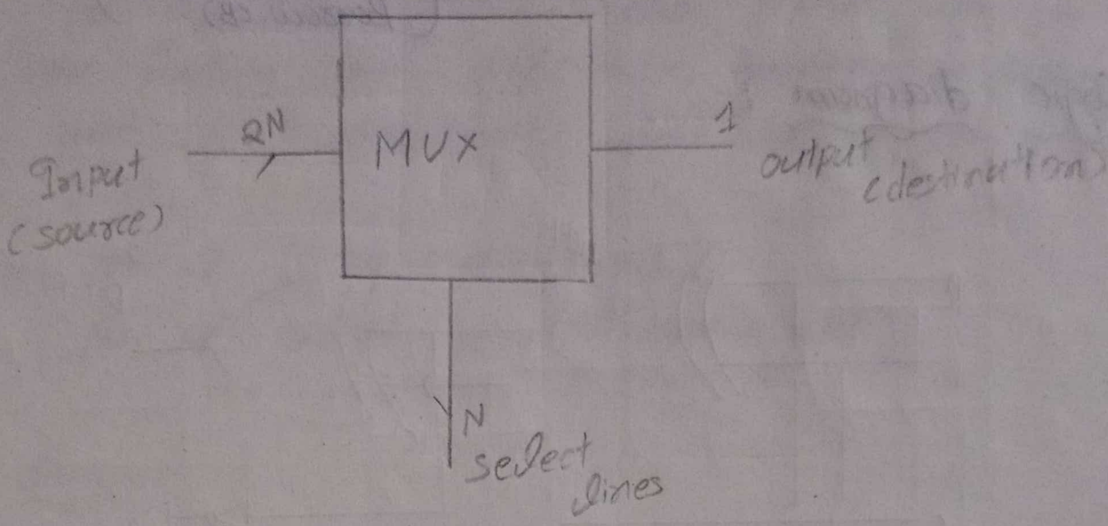
Truth table :

Input			output	
A	B	C	D	B
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Multiplicatiors :- (MUX)

A multiplicatiors is a device that allow's degital information from several sources to mean to be single line output for tounp-meaction.

A mux is a digital switch that has multiple input's (source) and a single output (destination)



→ It has ; several input line's
→ some select lines (less then the no. of input line
• single output line.
→ If there n data input lines and M select lines, then ($2^m = n$)

MUX Types :-

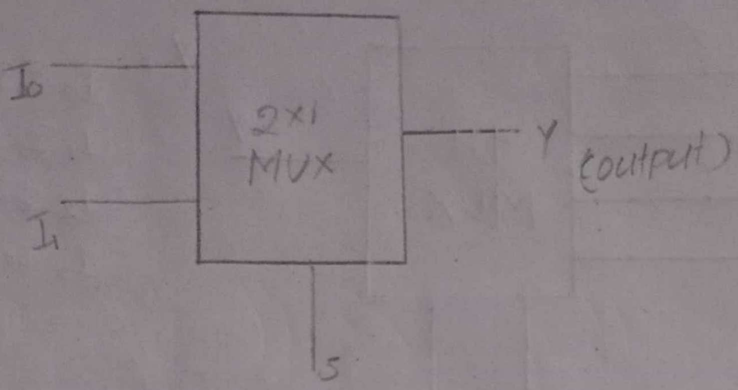
→ 2 to 1 (1 select line)
→ 4 to 1 (2 select line)
→ 8 to 1 (3 select line)
→ 16 to 1 (4 select line)

→ It is also called data selector

2:1 multiplexer :-

→ 2:1 multiplexer is a combinational logic circuit that has only 2 input and one select line and one single output that is Y.

logic symbol:

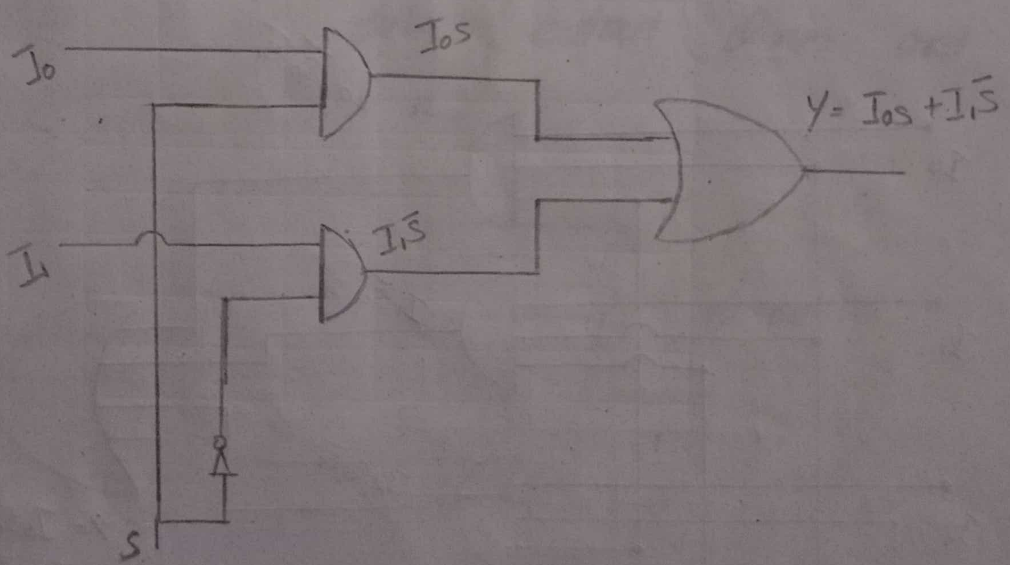


No. of input : 2 (I_0, I_1)
No. of select line : 1 (S)
No. of output line : 1 (Y)

Truth table :

S	Y
0	I_0
1	I_1

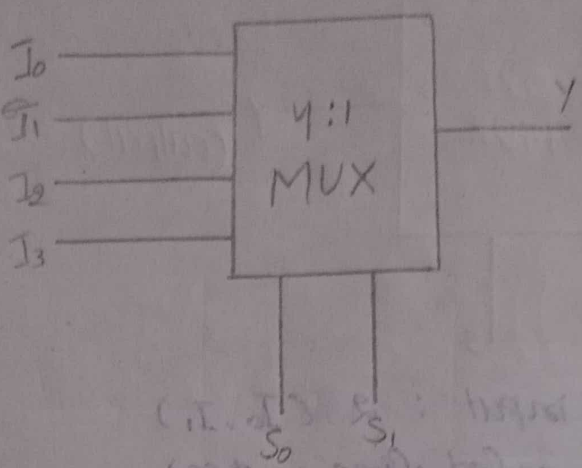
logic diagram :-



4:1 multiplexer :-

No. of Input :- 4 (I_0, I_1, I_2, I_3)
No. of output :- 1 (Y)
No. of select input :- 2 (S_0, S_1)

Logic symbol :-

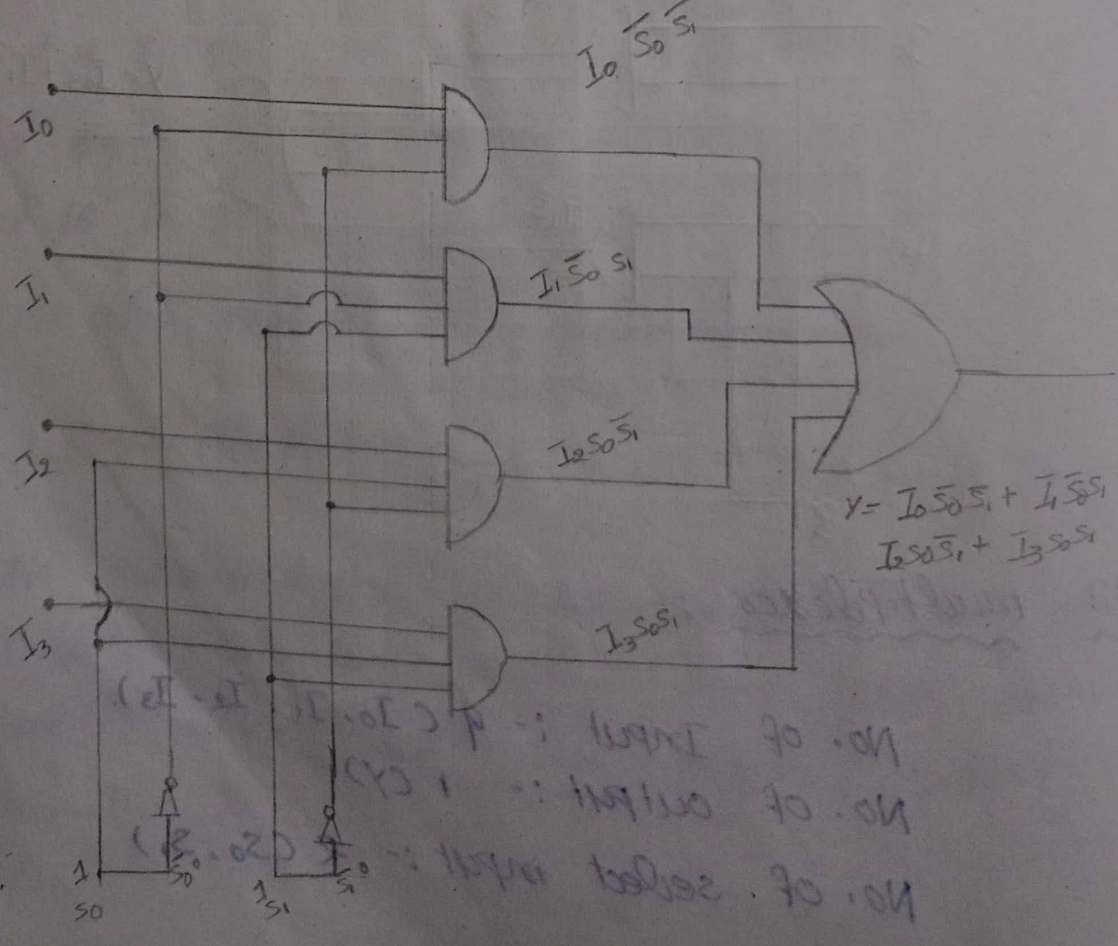


$Y = I_0 \bar{S_0} \bar{S_1} + I_1 \bar{S_0} S_1 + I_2 S_0 \bar{S_1} + I_3 S_0 S_1$

Truth table :-

Input		output
S_0	S_1	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

Logic Diagram :-



$Y = I_0 \bar{S_0} \bar{S_1} + I_1 \bar{S_0} S_1 + I_2 S_0 \bar{S_1} + I_3 S_0 S_1$

De-multiplexer :- (De-MUX)

→ It take's data one line and destribute them when given number in output's line.

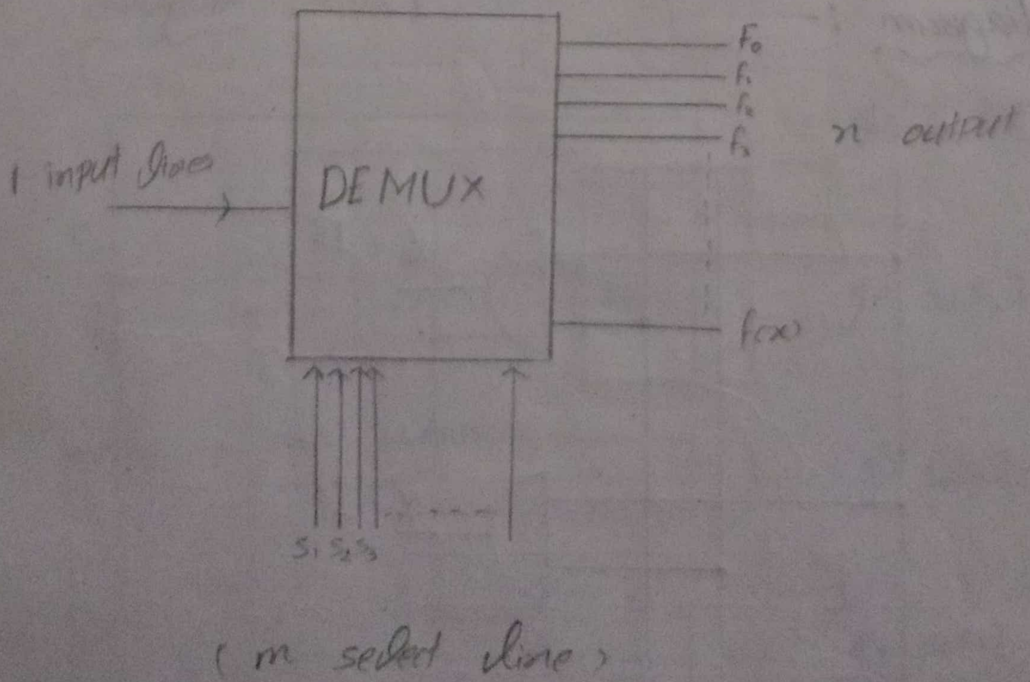
→ From this reason the demultiplexe is also known as a data destribute device.

→ single data input lines

→ Some select line (less than the no. of output lines)

→ several output lines.

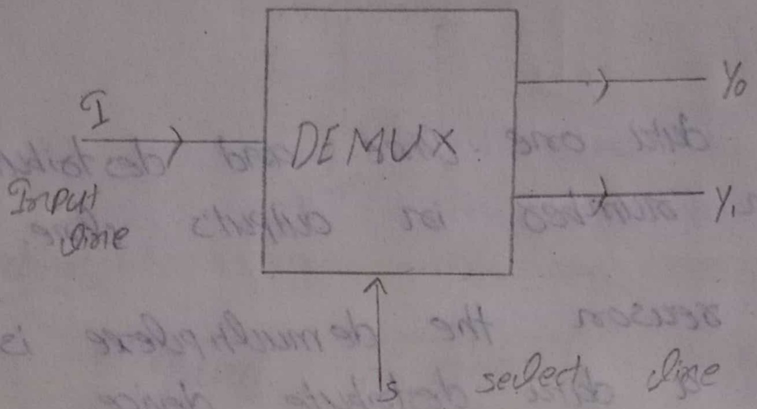
Where are a n' data output lines and m select lines, $(2^m = n)$



1:2 DE-MUX :-

No. of input :- 1 (I)
No. of output :- 2 (Y_0, Y_1)

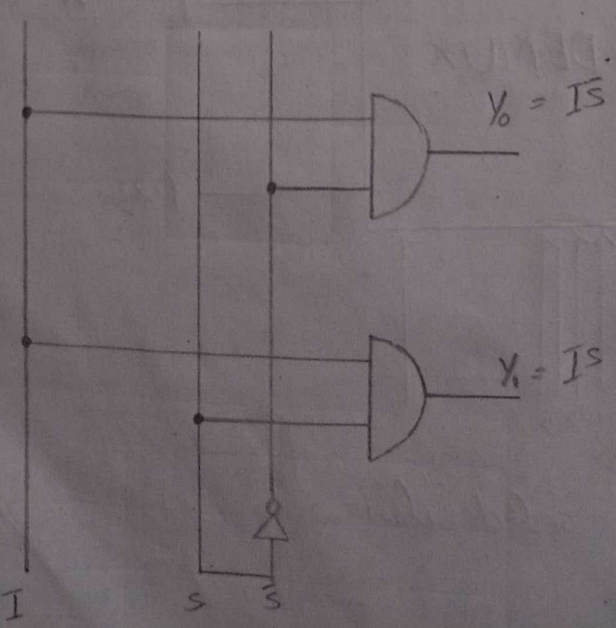
Basic symbol :-



Truth table :-

select line (S)	Input data (I)	Y_0	Y_1
0	I	1	0
1	I	0	1

logic diagram :-



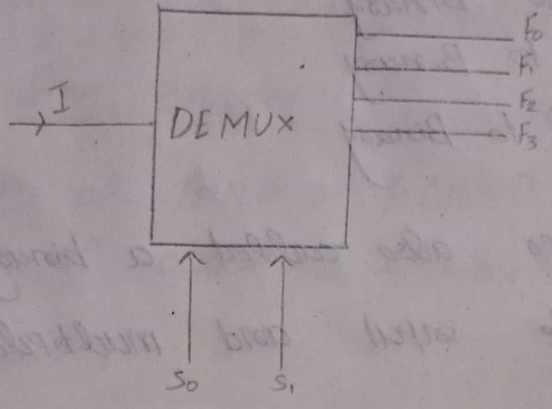
1:4 DE-MUX :-

No. of output : 4 (F_0, F_1, F_2, F_3)

No. of input : 1 (I)

No. of select input : 2 (S_0, S_1)

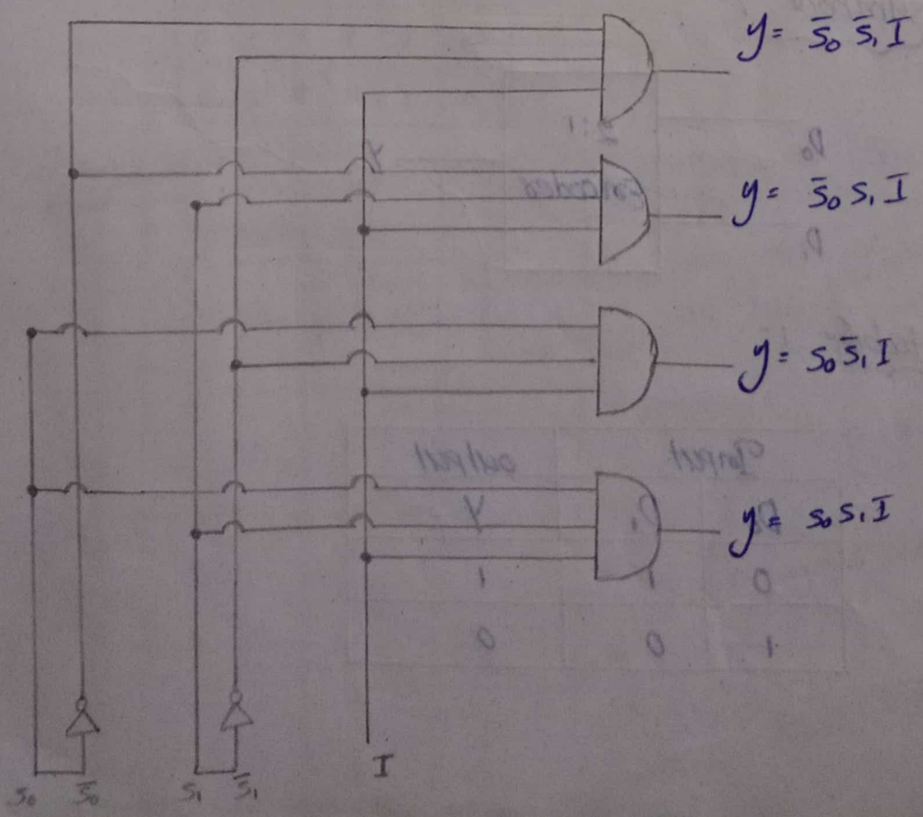
Basic symbol :



Truth table :-

Input			output			
E	S_0	S_1	F_0	F_1	F_2	F_3
0	x	x	0	0	0	0
1	0	0	I	0	0	0
1	0	1	0	I	0	0
1	1	0	0	0	I	0
1	1	1	0	0	0	I

logic diagram :-



Encoder :-

A Encoder is a combinational circuit that convert's information from 1 code to anothe code.

Ex:- Octal to Binary
Decimal to Binary
Hexadeimal to Binary

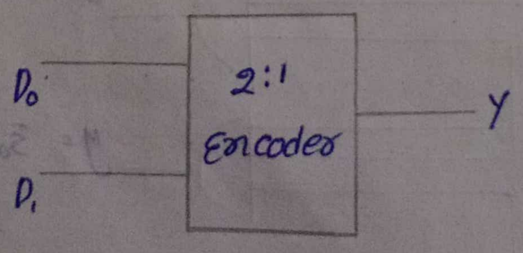
→ A Degital Encoder also called a binary Encoder.
→ It has multiple input and multiple output device.
→ Encoder in convert's 2^n line of input to n lines of output.

Ex:- 2:1 , 4:2 , 8:3 , 16:4

2:1 line Encoder :-

No. of Input : 2 (D_0 , D_1)
No. of output : 1 (Y)

logic symbol :-



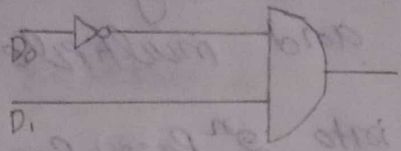
Truth table :-

Input		output
D_0	D_1	Y
0	1	1
1	0	0

Boolean Expresion :-

$$Y = \overline{D_0} D_1$$

Logic diagram :-

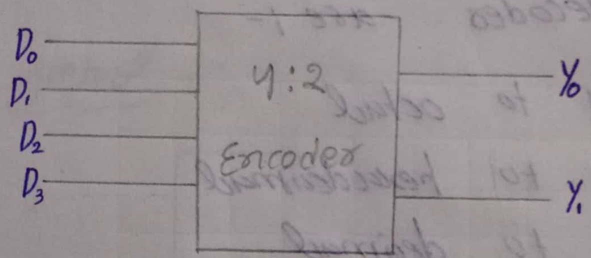


4:2 line Encoder :-

No. of Input :- 4 (D_0, D_1, D_2, D_3)

No. of output :- 2 (Y_0, Y_1)

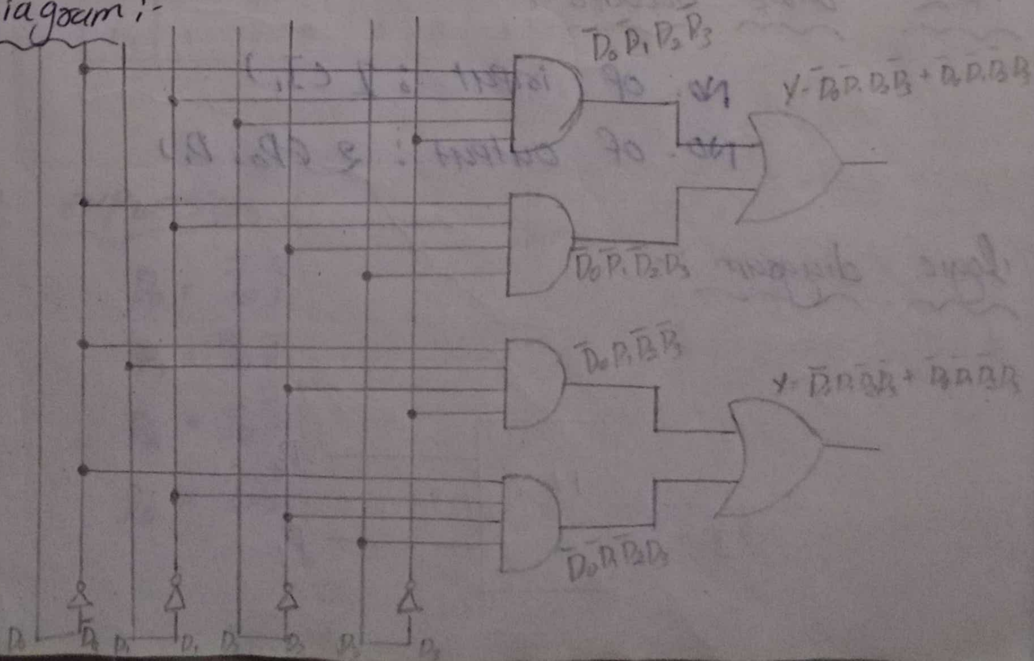
Logic symbol :



Truth table :

Input				output	
D_0	D_1	D_2	D_3	Y_0	Y_1
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

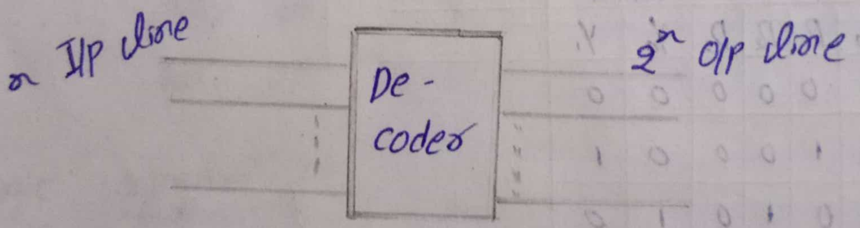
Logic diagram :-



Decoder :-

- Decoder is a combinational logic circuit that have multiple input and multiple output.
- It decoodes n input into 2^n possible output.
- The binary information is past the from of in the from of n input line's. The output line defind the 2^n bit code for the binary information.
- Application of decoder are :-
  - Binary to octal
  - Binary to hexadecimal
  - Binary to decimal

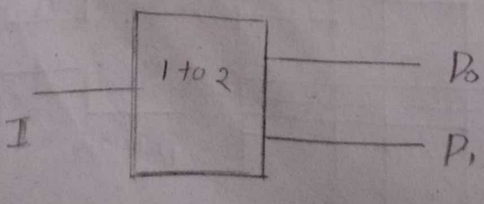
logic symbol :-



1 to 2 line decoder :-

No. of input : 1 (I_1)
No. of output : 2 (D_0, D_1)

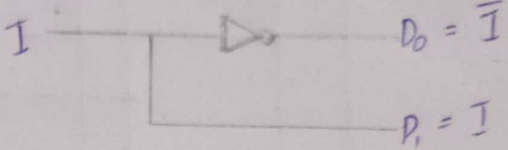
logic diagram :-



Truth table :-

I	D_0	D_1
0	1	0
1	0	1

Boolean Expression :-



$D_0 = \bar{I}$

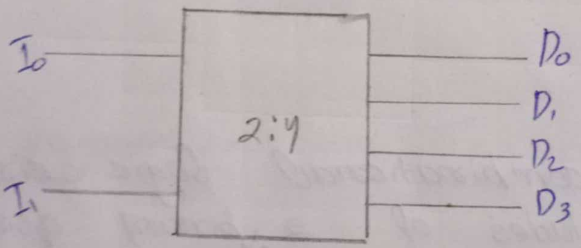
$D_1 = I$

2 to 4 line decoder :-

No. of Input :- 2 (I_0, I_1)

No. of output :- 4 (D_0, D_1, D_2, D_3)

logic symbol :-



Truth table :-

I/p		O/p			
I_0	I_1	D_0	D_1	D_2	D_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Boolean expresion :-

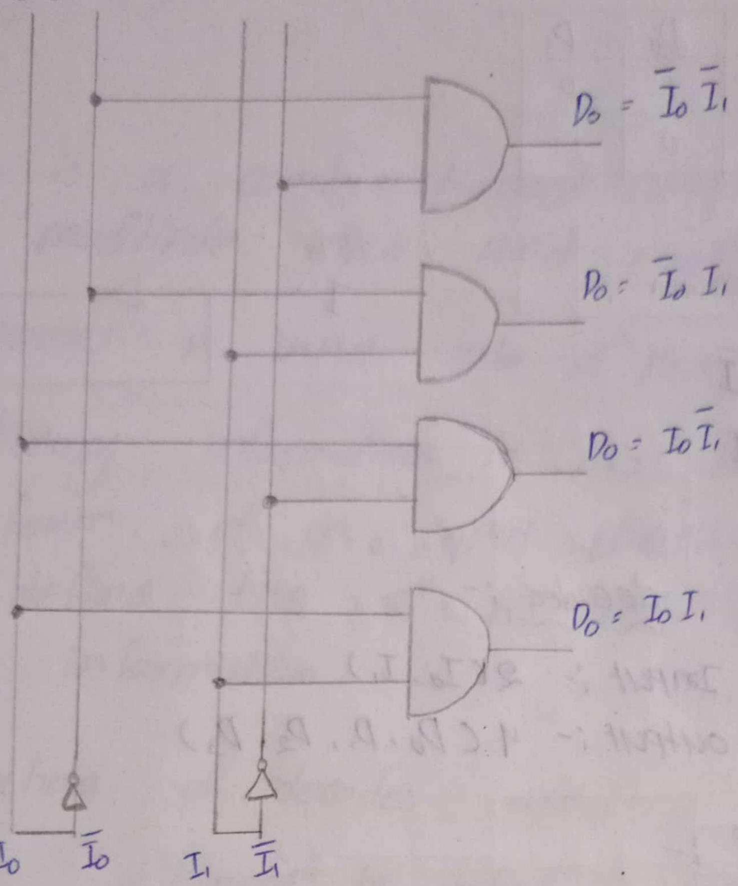
$D_0 = \bar{I_0}\bar{I_1}$

$D_1 = \bar{I_0} I_1$

$D_2 = I_0 \bar{I_1}$

$D_3 = I_0 I_1$

logic diagram :-



comparator :-

→ comparator is a combinational logic circuit that compress the magnitudes of 2 binary quantity's (Numbers). To determind which 1 Number has less, =, greater magnitude.

→ In other word a compared determine the relation on 2 binary (Number)

→ There are many type's of comparator

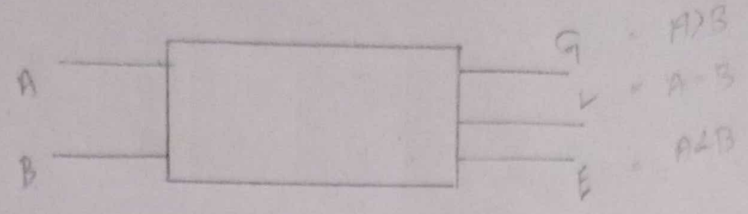
→ 1 - bit magnitude comparator
→ 2 - bit magnitude comparator
→ 3 - bit magnitude comparator

1 bit magnitude comparator :-

No. of Input : 2 (A, B)

No. of output : 3 (G, L, E)

Basic symbol :-



Truth table :-

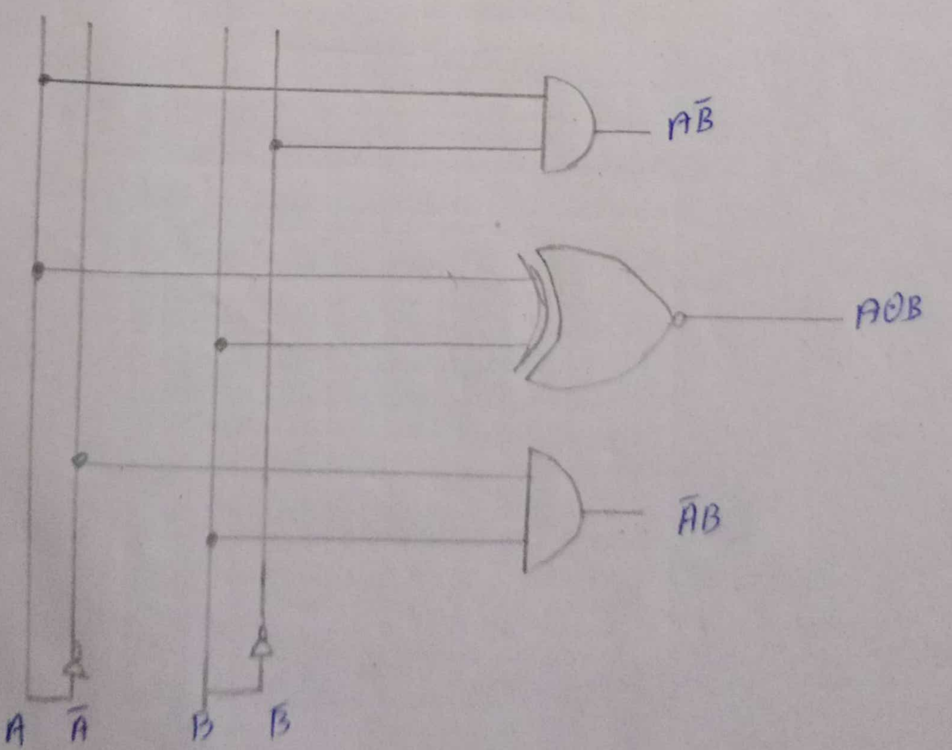
A	B	G A>B	E A=B	L A<B
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

Boolean expression :-

$G = A\bar{B}$, $E = \bar{A}.\bar{B} + A.B$, $L = \bar{A}B$

$A \odot B$

logic diagram :-



Basic of Digital Electronics :-

What is Digital Electronics ?

-> Digital Electronics is the study of electronic circuits that are used to process and control digital signal.

Number system :-

Introduction :-

-> It is a system for representing numeric values are qualifyes using different symbols (digits)

-> A Number system is a code that use symbols to refer to a number of items.

-> The term digital refers to a process that is achieved by using discreate unit.

-> In Number system there are different types of symbol has an absolute value and also has place value.

Radix / Base :-

-> The radix or Base of a Number system is defined as the number of different digits which can occure in each position in the Number system.

Radix point :-

-> The generalized form of a Decimal point is known as radix point. In any positional number system the radix point divides the integer and fractional part.

N_r = [Integer part . Fractional part]

Radix point

Number system :-

→ In general a number in a system having base or radix 'r' can be written as.

$a_n \; a_{n-1} \; a_{n-2} \; ---- \; a_1 \; a_0 \; , \; a_{-1} \; a_{-2} \; ---- \; a_{-m}$

This will be interpreted as ;

$$y = a_n + r^n + a_{n-1} \times r^{n-1} + a_{n-2} \times r^{n-2} + ... + a_0 \times r^0 + a_{-1} \times r^{-1} + a_2 \times r^{-2} + ---- +_{-m} \times r^{-m}$$

where; y = value of the entire Number

a_n = The values of the nth digit

r = radix

Types of Number system :-

There are generally four types of Number systems they are ;

i) Decimal Number system
ii) Binary Number system
iii) octal Number system
iv) Hexadecimal Number system

i) Decimal Number system :-

→ The decimal Number system contain ten unique symbols 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

→ In decimal Number system 10 symbols are involved so the base or radix is 10.

-) The decimal Number system is a radix-10 Number system and therefore has 10 different digits or symbols. It is a Positional weighted Number system.

-) All higher Number ofex (a) are represented in terms of these ten digits only.

Example : $(92.73)_{10}$, $(829.36)_{10}$

ii) Binary Number system :-

-) The binary Number system is a positional weighted system

-) The base or radix of this Number system is 2.

-) It has two idependent symbols that are 0 and 1.

-) A binary digit is called a bit.

Example : $(10101.110)_2$

iii) octal Number system :-

-) It is also a positional weighted system.

-) It's base or radix 8. so it's 8 independent symbols are 0, 1, 2, 3, 4, 5, 6, 7.

-) It's base $8 = 2^3$, every 3-bit group of binary can be reporesented by an octal digit.

Example : $(82.69)_8$, $(72.32)_8$

iv) Hexadecimal Number system :-

-) The Hexadecimal Number system is a positional weighted system.

-) The base or radix of this Number system is 16 such as 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

A = 10, B = 11, C = 12, D = 13, E = 14, F = 15

→ The base $16 = 2^4$, every 4-bit group of binary can be represented by a hexadecimal digit.

Examples :- $(AC \cdot F_3)_{16}$, $(2B \cdot CD)_{16}$

CONVERSION FROM ONE NUMBER SYSTEM TO ANOTHER :-

Decimal → Binary
Decimal → octal
Decimal → Hexadecimal

[Rule : Division & multiplecation]

Convert Decimal to other Number system :-

Decimal to Binary convertion ;-

→ Divide the given Decimal Number, successively by 2 read the integer part remainder upwards to get equivalent binary Number.

→ Multiply the fraction part by 2. keep the integer in the product as it and multiply the new fraction in the Product by 2. The Process is continued and the integers are read in the Products from top to bottom.

Example :-

Q/ convert $(19.35)_{10}$ into binary.

$$\begin{array}{r|l} 2 & 19 \\ \hline 2 & 9 - 1 \\ \hline 2 & 4 - 1 \\ \hline 2 & 2 - 0 \\ \hline & 1 - 0 \end{array}$$

→ LSB

MSB

LSB → (Least significant Bit)
MSB → (Most significant Bit)

$(19.35)_{10} = (1011.0101)_2$

$0.35 \times 2 = 0.70$
$0.70 \times 2 = 1.40$
$0.40 \times 2 = 0.80$
$0.80 \times 2 = 1.60$

Decimal to octal convertion :-

→ To convert the given decimal integer Number to octal, successively divide the number by 8 till the quotient is 0.

→ To convert the given decimal, fractions to octal, successively multiely the decimal fraction and the subsequent decimal fractions by 8 till the product is 0 or till the required accuracy is obtained.

Example :-

Q/ convert $(378.93)_{10}$ into octal.

$$\begin{array}{r|l} 8 & 378 \\ \hline 8 & 47 \to 2 \\ \hline 8 & 5 \to 7 \\ \hline & 0 \to 5 \end{array}$$

$0.93 \times 8 = 7.44$
$0.44 \times 8 = 3.52$
$0.52 \times 8 = 4.16$
$0.16 \times 8 = 1.28$

$(378.93)_{10} = (572.7341)_8$

Decimal to Hexadecimal convertion :-

→ The decimal to hexadecimal convertion is same as octal.

Example :-

Convert $(2598.675)_{10}$ into Hexadecimal.

$$\begin{array}{l|l} 16 & 2598 \\ \hline 16 & 162 - 6 \\ \hline 16 & 10 - 2 \\ \hline & 0 \to 10 \end{array} \uparrow$$

$$\begin{array}{lll} 0.675 \times 16 = 10.8 & A & \downarrow \\ 0.800 \times 16 = 12.8 & C & \\ 0.800 \times 16 = 12.8 & C & \end{array}$$

$(2598.675)_{10} = (A26.ACC)_{16}$

Convert other number system Decimal :-

$$\left.\begin{array}{l} B \\ O \\ H \end{array}\right] \to \text{Decimal}$$

Binary to Decimal Convertion :-

→ In this method, each binary of the number is multiplied by it's positional weight and the Product terms are added to obtain decimal Number.

Example :

i) Convert $(10101)_2$ to Decimal

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

$\Rightarrow 16 + 0 + 4 + 0 + 1$

$\Rightarrow (21)_{10}$

$$\boxed{(10101)_2 = (21)_{10}}$$

ii) convert $(111.101)_2$ to Decimal

$1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 + 2^{-3}$

$\Rightarrow 4 + 2 + 1 + 0.5 + 0 + 0.125$

$\Rightarrow (7.625)_{10}$

$(111.101)_2 = (7.625)_{10}$

Octal to Decimal convertion :-

→ For conversion octal to Decimal Numbers, multiply each digit in the octal Number by the weight of it's Position and add all the Product terms.

Example :

i) convert $(4057.06)_8$ to Decimal

$4 \times 8^3 + 0 \times 8^2 + 5 \times 8^1 + 7 \times 8^0 + 0 \times 8^{-1} + 6 \times 8^{-2}$

$\Rightarrow 2048 + 0 + 40 + 7 + 0 + 0.0937$

$\Rightarrow (2095.0937)_{10}$

Hexadecimal to Decimal convertion :

→ For conversion of Hexadecimal to decimal multiply each digit in the hexadeimal Number by it's Position weight and also those Product terms.

Example :

Convert $(B9F.AE)_{16}$ to Decimal.

$B \times 16^2 + 9 \times 16^1 + F \times 16^0 + A \times 16^{-1} + E \times 16^{-2}$

$\Rightarrow 2816 + 144 + 16 + 0.628 + 0.058$

$\Rightarrow 2976.683$

$(B9F.AE)_{16} = (2976.683)_{10}$

Binary	octal	Hexadecimal	decimal
0000	0	0	0
0001	1	1	1
0010	2	2	2
0011	3	3	3
0100	4	4	4
0101	5	5	5
0110	6	6	6
0111	7	7	7
1000	8	8	8
1001	9	9	9
1010	10	A	10
1011	11	B	11
1100	12	C	12
1101	13	D	13
1110	14	E	14
1111	15	F	15

Binary addition :-

The Binary Addition rules are

0+0 = 1

0+1 = 1

1+0 = 1

1+1 = 10 [ie 0 with a carry 1]

Binary subtraction :-

The Binary subtraction rules are,

0-0 = 0

0-1 = 1 (with a borrow of 1)

1-0 = 1

1-1 = 0

Binary multiplication :-

The Binary multiplication rules are,

0×0 = 0

0×1 = 0

1×0 = 0

1×1 = 1

Q/ multiplication $(1101)_2$ by $(110)_2$

```
    1101
     110
    ----
    0000
   1101
  1101
 -------
 1001110
```

1's complement Representation :-

The 1's compliment of a Binary Number is optain by changing each

0 → 1
1 → 0

Q/ Find $(1100)_2$ 1's complement

1 1 0 0
↓ ↓ ↓ ↓
0 0 1 1 ← 1's complement

Addition by 1's complement method :-

→ Add +4 and +9 by 1s complement method

$$\begin{array}{rcr} 4 & \rightarrow & 0100 \\ + \; 9 & \rightarrow & 1001 \\ \hline 13 & & 1101 \end{array}$$

→ Add +3 and -8 by 1's complement method

$$\begin{array}{rcccr} +3 & \rightarrow & 0011 & \rightarrow & 0011 \\ + \; -8 & \rightarrow & 1000 & \rightarrow & 0111 \\ \hline & & & & 1010 \end{array}$$

[As -ve number, so 1's complement of 8 (1000 = 0111)

1's Complement → 0101

i.e 0101 = (5);

So the sum of +3 and -8 is 1's -5.

→ Add -6 and 2 by using 1's complement

$$\begin{array}{rlll} & -6 \rightarrow 110 & \rightarrow & 001 \\ + & 2 \rightarrow 010 & \rightarrow & 010 \\ \hline & & & 011 \\ & & C & 100 \rightarrow 4 \end{array}$$

substance by using complement method :-

→ substance 7 from 21 by 1's complement

$$\begin{array}{lll} 21 \rightarrow 10101 & \rightarrow & 10101 \\ 7 \rightarrow 00111 & \rightarrow & 11000 \\ \hline & & 101101 \\ & & \quad +1 \\ \hline & & 01110 \rightarrow (14)_2 \end{array}$$

→ substance $(10000)_2$ from (11010) by 1's complement

$$\begin{array}{ll} 11010 \rightarrow & 11010 \\ 10000 \rightarrow & 01111 \\ \hline & 101001 \\ & \quad +1 \\ \hline & 1010 \rightarrow 10 \end{array}$$

2's complement Representation :-

The 2's complet of a binary Number's is a binery Number which is optain by adding boo to the 1's complement of a Number.

2's complement = 1's complement + 1

Example :

Find $(101101)_2$ 2's complement

$$\begin{array}{r} 010010 \\ +\quad 1 \\ \hline \end{array}$$

Result → $(010011)_2$

Law's of Boolean Algebra :-

Complementation	OR Laws	AND Laws
Law-1 : $\bar{0} = 1$	$A+0 = A$ (Null law)	$A.0 = 0$ (Null law)
Law-2 : $\bar{1} = 0$	$A+1 = 1$ (Identify law)	$A.1 = A$ (Identify law)
Law-3 : If $A=0$ then $\bar{A} = 1$	$A+A = A$	$A.A = A$
Law-4 : If $A = 1$ then $\bar{A} = 0$	$A+\bar{A} = 1$	$A.\bar{A} = 0$
Law-5 : $\bar{\bar{A}} = A$		

Demorgan's Theorm :-

1st law state that the complement of a sum of variable is equal to the Product of these individual complement.

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

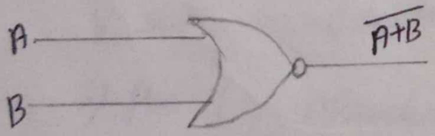
A	B	A+B	$\overline{A+B}$	$\bar{A}$	$\bar{B}$	$\bar{A}\cdot\bar{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

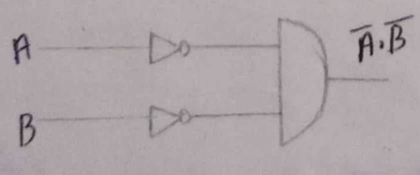
2nd law state that the complement of a product of variable is equal to the sum of their individual compliment.

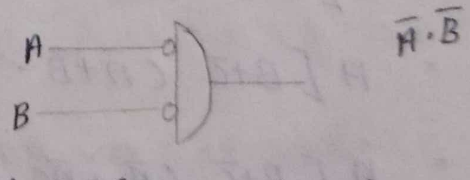
$$\boxed{\overline{AB} = \bar{A} + \bar{B}}$$

A	B	AB	$\overline{AB}$	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

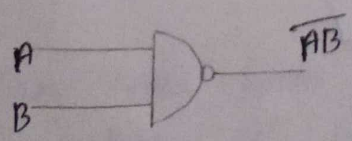
Nor gate is equivalent to bubbled AND Gate:-

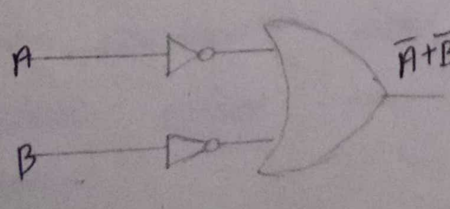


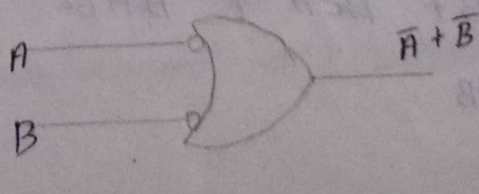




NAND gate is equivalent to bubbled OR gate:-







Reducing Boolean expression :-

1) $\overline{AB + (A+B)}$

$(\overline{AB} + \overline{A+B})$

$(\bar A + \bar B)(\bar A \cdot \bar B)$

2) $Y = \overline{(A+\bar B)(C+\bar D)}$

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

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

$= \bar A B + \bar C \cdot D$

3) $Y = \overline{\overline{AB} + \bar A + AB}$

$= \overline{\overline{AB}} + \bar{\bar A} + AB$

$= AB \cdot A \cdot \overline{A} + \overline{B}$

$= AB \cdot \overline{A} + \overline{B}$

$= \bar A AB \cdot AB\bar B$

$= 0B \cdot A0$

$= 0$

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

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

$= (\bar A \cdot BC)(A + \bar B \cdot ABC)$

$= \bar A BC(A\bar B + ABC)$

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

$= 0$

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

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

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

$= A[B + \bar C\ (\bar A + \bar A C + \bar B \bar A + \bar B C)]$

$= A[B + (\bar C \bar A) + \cancel{\bar A C \bar C}^{\,0} + \bar A \bar B \bar C + \bar B \cancel{C \bar C}^{\,0}]$

$= A[B + (\bar C \bar A + \bar A \bar B C)]$

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

$= AB$

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

$= B(B + \bar{B}C) + B((B + \bar{B}C)]\,(B + D)$

$= [BB + \cancel{B\bar{B}C}^{0} + BCB + \cancel{BC\bar{B}C}^{0}]\,(B + D)$

$= (B + BC)(B + D)$

$= BB + BD + BCB + BCD$

$= B + BD + BCB + BCD$

$= B + BC + BD + BCD$

$= B(\cancel{1 + C})^{1} + BD(\cancel{1 + C})^{1}$

$= B + BD$

$= B(\cancel{1 + D})^{1}$

$= B$

Boolean expression and their Representition :-

There are different base of Representing a given function is 2 way in the following way.

standard from ;

i) sop :- (sum of Product)

ii) Pos :- (Product of sum)

SOP :-

This from is also known as is also called Disjunctive normal from (DNF)

In this from the function is the sum of a number of Product turn where each Product turn contain's all the variable of the function either in complemented or uncomplemented from.

-) A Product turm which contain's alle the variable of the function either in complemented or uncomplemented from is called a MINTERM (Σm)

Ex:- $F(A.B.C) = \bar{A}B + \bar{B}C$

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

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

$= 011, 010, 001, 101$

$3, 2, 1, 5$

$= (1, 2, 3, 5)$

Pos :- (πM)

This from is also called as conjucative conoinical from (ccf)

-) A sum term which contains alle variable's either complemented or uncomplemented from is called a MAXTERM.

Ex:- $F(A.B.C) = (\bar{A}+\bar{B})(B+C)$

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

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

$= 110, 111, 000, 100$

$= 6, 7, 0, 4$

$\pi M = (0, 4, 6, 7)$

If the boolean expresion are representing in term's of MINTERM and MAXTERM then it is from of conical from.

i) MINTERM (Σm)

ii) MAX TERM (πM)

3- variable Expression :-

a	b	c	MINTERM (m)	MAXTERM (M)
0	0	0	m_0 $(\bar{a}\bar{b}\bar{c})$	M_0 $(a+b+c)$
0	0	1	m_1 $(\bar{a}\bar{b}c)$	M_1 $(a+b+\bar{c})$
0	1	0	m_2 $(\bar{a}b\bar{c})$	M_2 $(a+\bar{b}+c)$
0	1	1	m_3 $(\bar{a}bc)$	M_3 $(a+\bar{b}+\bar{c})$
1	0	0	m_4 $(a\bar{b}\bar{c})$	M_4 $(\bar{a}+b+c)$
1	0	1	m_5 $(a\bar{b}c)$	M_5 $(\bar{a}+b+\bar{c})$
1	1	0	m_6 $(ab\bar{c})$	M_6 $(\bar{a}+\bar{b}+c)$
1	1	1	m_7 (abc)	M_7 $(\bar{a}+\bar{b}+\bar{c})$

MINTERMS	MAXTERMS
→ Each individual form is SOP is called as MINTERM	→ Each individual form is POS is called as MAXTERM.
→ In this from '1' is used for representing the MINTERM	→ In this from '0' representing the MAXTERM

Conversion from standard from to conicual form:

$\Rightarrow$ $F(A.B.C) = \bar{a}b + b\bar{c}$

$= \bar{a}b(c+\bar{c}) + (a+\bar{a})b\bar{c}$

$= \bar{a}bc + \bar{a}b\bar{c} + ab\bar{c} + \bar{a}b\bar{c}$

$= 011, 010, 110, 010$

$= 3, 2, 6, 2$

$\Sigma_m = (2, 3, 6)$

$\Rightarrow$ $F(x, y, z) = x + \bar{y}z + xy\bar{z}$

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

$= xyz + xy\bar{z} + x\bar{y}z + x\bar{y}\bar{z} + x\bar{y}z + \bar{x}\bar{y}z + xy\bar{z}$

$= 111, 110, 101, 100, 101, 001, 110$

$= 7, 6, 5, 4, 5, 1, 6$

$\Sigma_m = (1, 4, 5, 6, 7)$

$\Rightarrow$ $F(P.Q.R) = P\bar{R} + QR + P\bar{Q}R$

$= P(Q+\bar{Q})\bar{R} + (P+\bar{P})QR + P\bar{Q}R$

$= PQ\bar{R} + P\bar{Q}\bar{R} + PQR + \bar{P}QR + P\bar{Q}R$

$= 110, 100, 111, 011, 101$

$= 6, 4, 7, 3, 5$

$\Sigma_m = (3, 4, 5, 6, 7)$

$\Rightarrow F(a,b,c) = (\bar{a}+b)(a+\bar{c})$

$= \bar{a}+b\,(c.\bar{c})\quad a\,(b.\bar{b})\,\bar{c}$

$= (\bar{a}+b+c)(\bar{a}+b+\bar{c})(a+b+\bar{c})(a+\bar{b}+\bar{c})$

$= 100,\ 101,\ 001,\ 011$

$= 4,\ 5,\ 1,\ 3$

$\pi_M = (1, 3, 4, 5)$

$\Rightarrow F(x,y,z) = y\,(x+\bar{z})$

$= (x.\bar{x})+y+(z.\bar{z})\quad(x+(y.\bar{y})+\bar{z}$

$= (x+y+z)(x+y+\bar{z})(\bar{x}+y+z)(\bar{x}+y+\bar{z})(x+y+\bar{z})$
$(x+\bar{y}+\bar{z})$

$= 000,\ 001,\ 100,\ 101,\ 001,\ 011$

$= 0,\ 1,\ 4,\ 5,\ 1,\ 3$

$\pi_M = (0, 1, 3, 4, 5)$

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

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

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

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

$= 111,\ 110,\ 101,\ 100,\ 110,\ 010$

$= 7, 6, 5, 4, 6, 2$

$\Sigma m = (2, 4, 5, 6, 7)$

$\Rightarrow F(x,y,z) = xz + \bar{y}z$

$x(y+\bar{y})z + (x+\bar{x})\bar{y}z$

$= xyz + x\bar{y}z + x\bar{y}z + \bar{x}\bar{y}z$

$= 111,\ 101,\ 101,\ 00\phi$

$= 7, 5, 5, 1$

$\Sigma m = (1, 5, 7)$

$\Rightarrow F(P,Q,R,S) = P + \bar{Q}S + \bar{R}S + Q\bar{R}S$

$= P(Q+\bar{Q})(R+\bar{R})(S+\bar{S}) + (P+\bar{P})\bar{Q}(R+\bar{R})S + (P+\bar{P})(Q+\bar{Q})\bar{R}S + (P+\bar{P})Q\bar{R}S$

$= PQRS + PQR\bar{S} + PQ\bar{R}S + PQ\bar{R}\bar{S} + P\bar{Q}RS + P\bar{Q}R\bar{S} + P\bar{Q}\bar{R}S + P\bar{Q}\bar{R}\bar{S} + PQR\bar{S} + PQ\bar{R}\bar{S} + \bar{P}QR\bar{S} + \bar{P}Q\bar{R}\bar{S} + PQRS + P\bar{Q}RS + \bar{P}QRS + \bar{P}\bar{Q}RS + PQ\bar{R}S + \bar{P}Q\bar{R}S$

$= 1111, 1110, 1101, 1100, 1011, 1010, 1001, 1000, 1110, 1100, 0110, 0100, 1111, 1011, 0111, 0011, 1101, 0101$

$= 15, 14, 13, 12, 11, 10, 9, 8, 14, 12, 6, 4, 15, 11, 7, 3, 13, 5$

$\Rightarrow \sum m = (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15)$

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

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

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

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

$= 000, 001, 010, 011, 010, 110$

$= 0, 1, 2, 3, 2, 6$

$\pi_m = (0, 1, 2, 3, 6)$

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

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

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

$= 0000, 0001, 0010, 0011, 1000, 1001, 0010, 0011, 0001, 0011, 1000, 1011, 1000, 1001, 1100, 1101, 0001, 0101$

$\Rightarrow 0, 1, 2, 3, 8, 9, 2, 3, 1, 3, 9, 10, 8, 9, 12, 13, 1, 5$

$\Rightarrow \pi_m = (0, 1, 2, 3, 4, 5, 8, 9, 10, 12, 13)$

$f(x,y,z) = (x+\bar{y})(\bar{y}+z)(\bar{x}+\bar{z})$

$(x+\bar{y}+z.\bar{z})(x.\bar{x}+\bar{y}+z)(\bar{x}+y.\bar{y}+\bar{z})$

$= (x+\bar{y}+z)(x+\bar{y}+\bar{z})(x+\bar{y}+z)(\bar{x}+\bar{y}+z)(\bar{x}+y+\bar{z})(\bar{x}+\bar{y}+\bar{z})$

$= 010, 011, 010, 110, 101, 111$

$= 2, 3, 2, 6, 5, 7$

$\Pi_m = (2, 3, 5, 6, 7)$

$F(P,Q,R,S) = \bar{Q} + PR + \bar{R}S + \bar{P}RS$

$= (P+\bar{P})\bar{Q}(R+\bar{R})(S+\bar{S}) + P(Q+\bar{Q})R(S+\bar{S}) + (P+\bar{P})(Q+\bar{Q})\bar{R}S + \bar{P}(Q+\bar{Q})RS$

$= P\bar{Q}RS + P\bar{Q}R\bar{S} + P\bar{Q}\bar{R}S + P\bar{Q}\bar{R}\bar{S} + \bar{P}\bar{Q}RS + \bar{P}\bar{Q}R\bar{S} + \bar{P}\bar{Q}\bar{R}S + \bar{P}\bar{Q}\bar{R}\bar{S}$
$+ PQRS + PQR\bar{S} + P\bar{Q}RS + P\bar{Q}R\bar{S} + PQ\bar{R}S + P\bar{Q}\bar{R}S + \bar{P}Q\bar{R}S + \bar{P}\bar{Q}\bar{R}S$
$+ \bar{P}QRS + \bar{P}\bar{Q}RS$

$= 1011, 1010, 1001, 1000, 0011, 0010, 0001, 0000, 1111,$
$1110, 1011, 1010, 1101, 1001, 0101, 0001, 0111, 0011$

$= 11, 10, 9, 8, 3, 2, 1, 0, 15, 14, 11, 10, 13, 9, 5, 1, 7, 3$

$\Rightarrow \Sigma_m = (0, 1, 2, 3, 5, 7, 8, 9, 10, 11, 13, 14, 15)$

K- map (karanaugh map) :-

- The k map is a chat or a graph, composed of an arrangement of adiucent cells. representinton perticular combination of varriabal sum of Product form.

- Like a truth table k map show the relation between output's.

- Sence k map is a graphically represent of boolean Expression.

- At to variable k map will have

(2- variable) 2^2 = 4 cells, similarly,

(3- variable) 2^3 = 8 cells,

(4- variable) 2^4 = 16 cells,