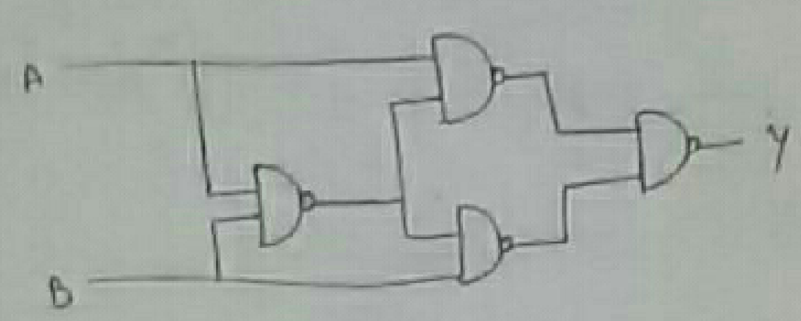
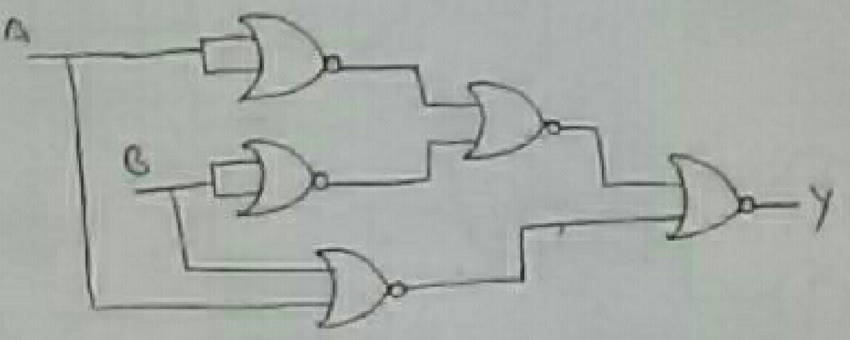
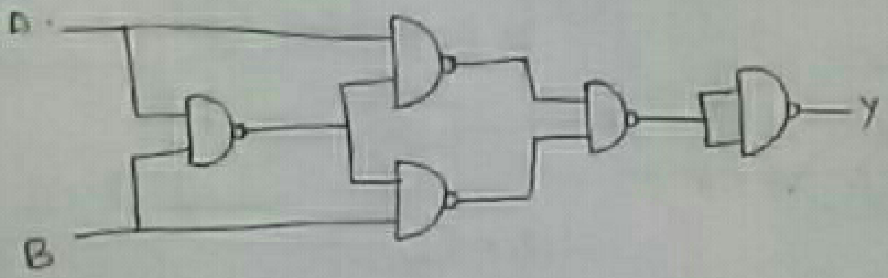
XOR using NAND Gate:-



XOR using NOR Gate:-

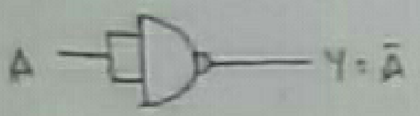


EX-NOR using NAND Gate:-

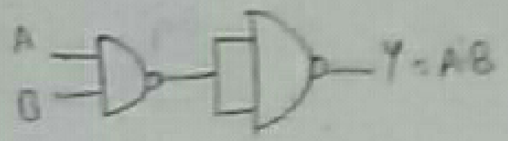


Basic Logic gates using NAND Gate:-

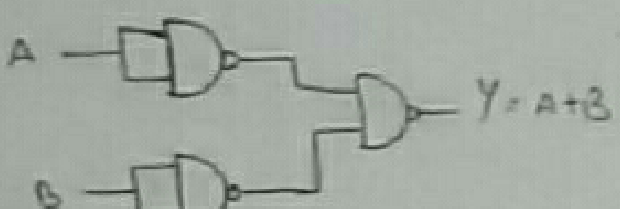
1) NOT Gate:-



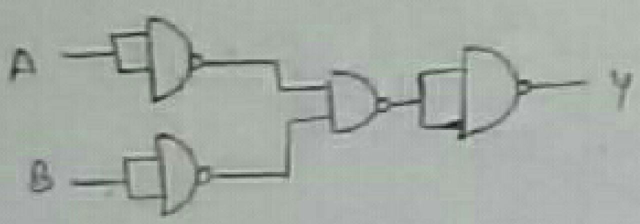
2) AND Gate:-



3) OR Gate:-

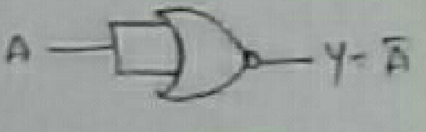


4) NOR Gate:-

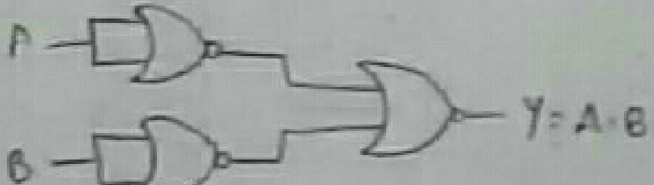


Basic Logic gates using NOR Gates:-

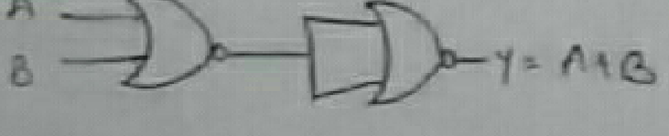
1) NOT Gate:-



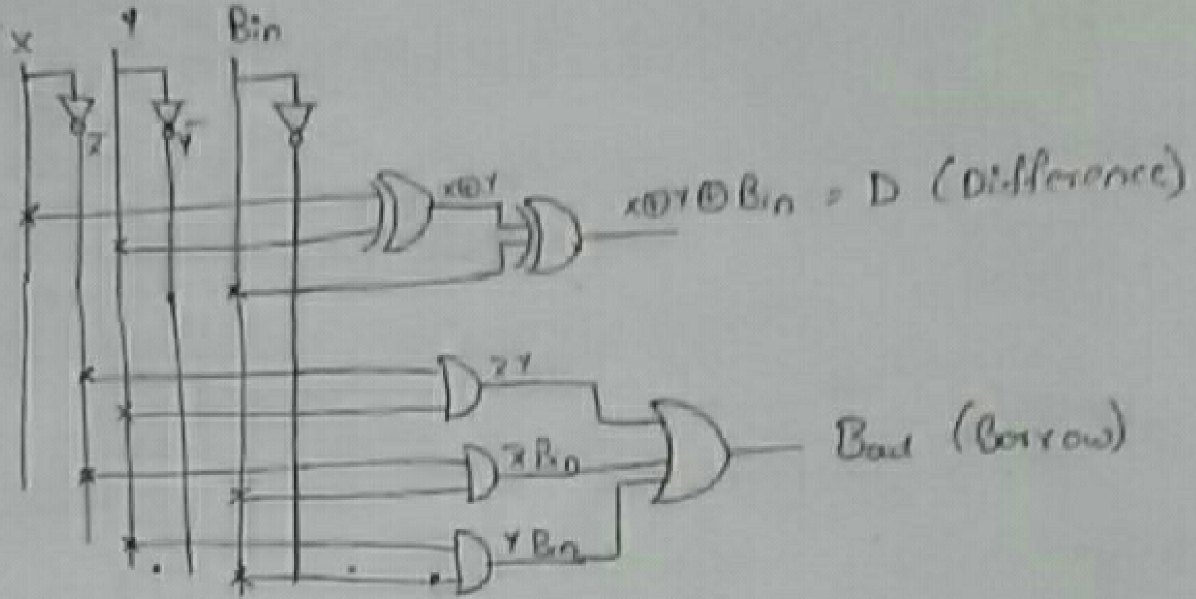
2) AND Gate:-



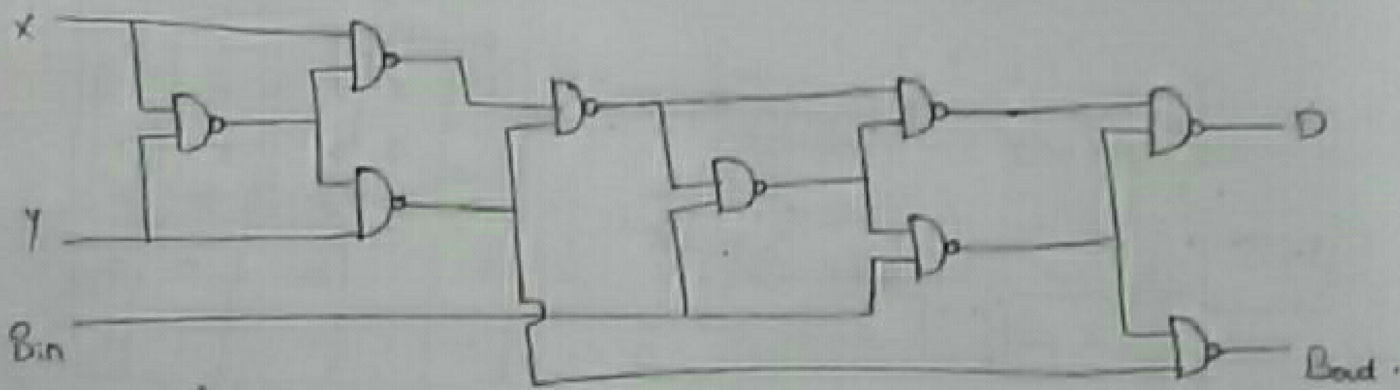
3) OR Gate:-



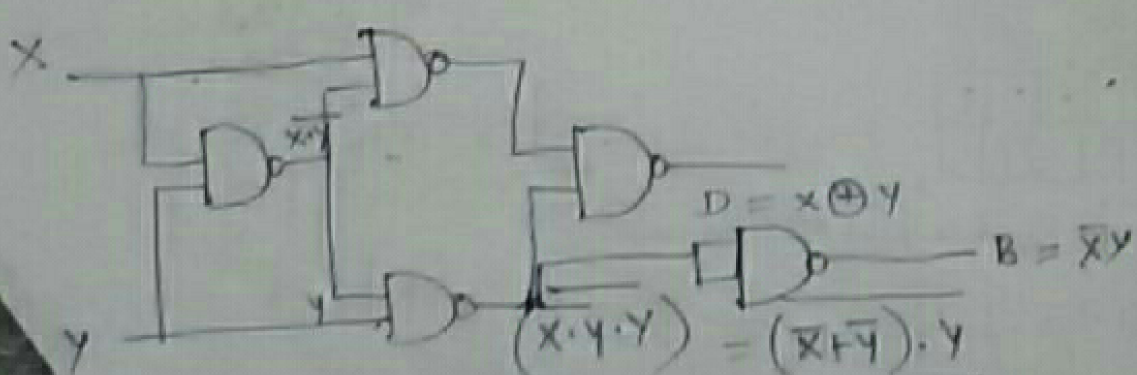
Logic circuit using AOI gates / Basic gates :-



Full subtractor using only NAND gates :-



Half subtraction using NAND gates



$\overline{(\overline{X \cdot Y} \cdot Y)} = \overline{(\overline{X}+\overline{Y}) \cdot Y}$

$= \overline{\overline{X}Y + \overline{Y} \cdot Y}$

$= \overline{\overline{X}Y}$

Full subtractor:

For multibit subtraction we go for full subtractor. There are 3 inputs and 2 outputs.

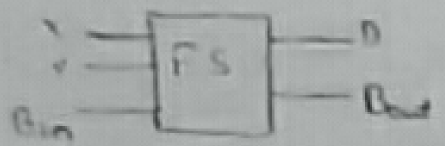
Inputs:-

- x - minuend
- y - subtrahend
- B_{in} - borrow from previous stage

Outputs:-

- D - Difference
- B_{out} - borrow.

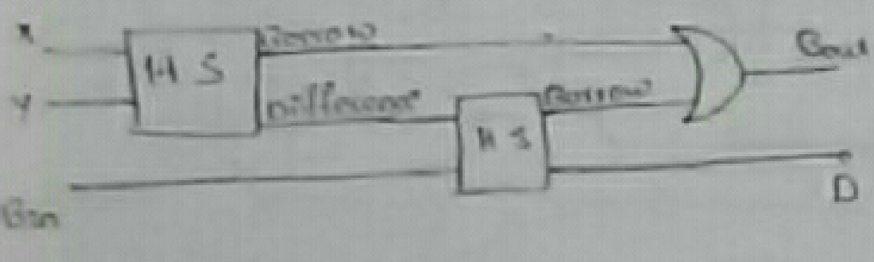
Block diagram:-



Truth table:-

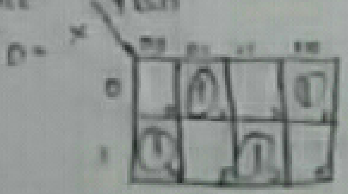
x	y	B_{in}	D	B_{out}
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Full subtractor using 2 half subtractors:-



Output expressions using K-map:-

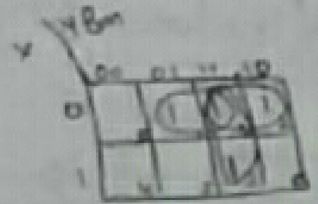
Difference:



$D = \bar{x}\bar{y}B_{in} + \bar{x}y\bar{B}_{in} + x\bar{y}\bar{B}_{in} + xyB_{in}$

$= x \oplus y \oplus B_{in}$

Bout:-



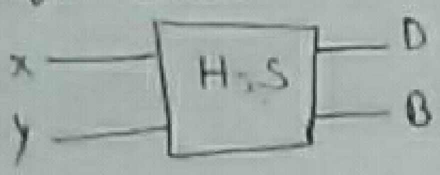
$B_{out} = \bar{x}B_{in} + \bar{x}y + yB_{in}$

Subtractors:-

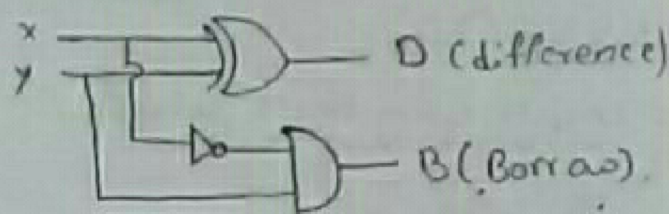
Half subtractors:-

A Logic circuit that subtracts y (subtrahend) from x (minuend) where x & y are 1-bit numbers is known as half-subtractor. Half subtractor has 2 inputs and 2 outputs (difference & Borrow)

Logic symbol:-



Logic circuit:-

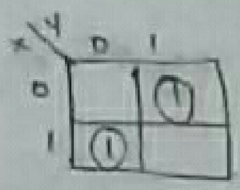


Truth table:-

x	y	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Expression for Difference from K-map:-

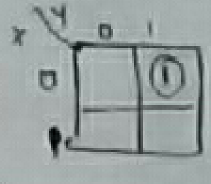
D



$D = \bar{x}y + x\bar{y}$

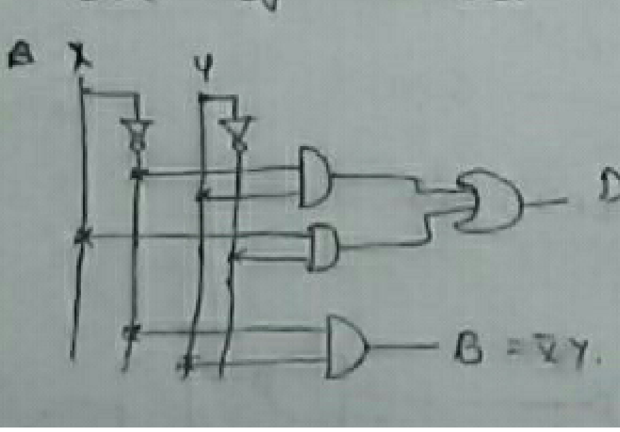
$= x \oplus y$

B



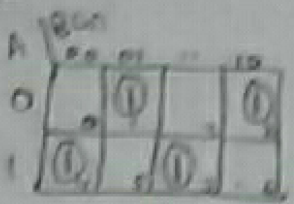
$B = \bar{x}y.$

Logic circuit using basic gates:-

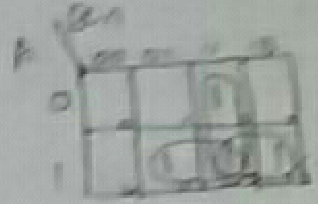


Expressions using K-map:-

Sum:-



Carry:-

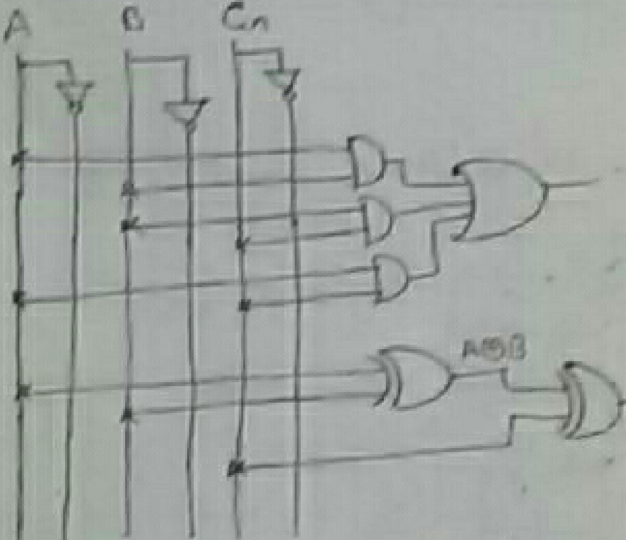


$C = BC_{in} + AC_{in} + AB$

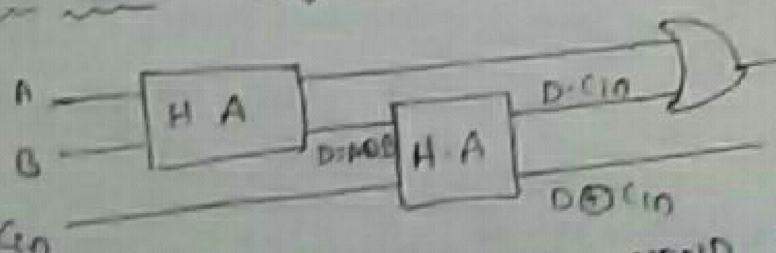
$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$

$= A \oplus B \oplus C_{in}$

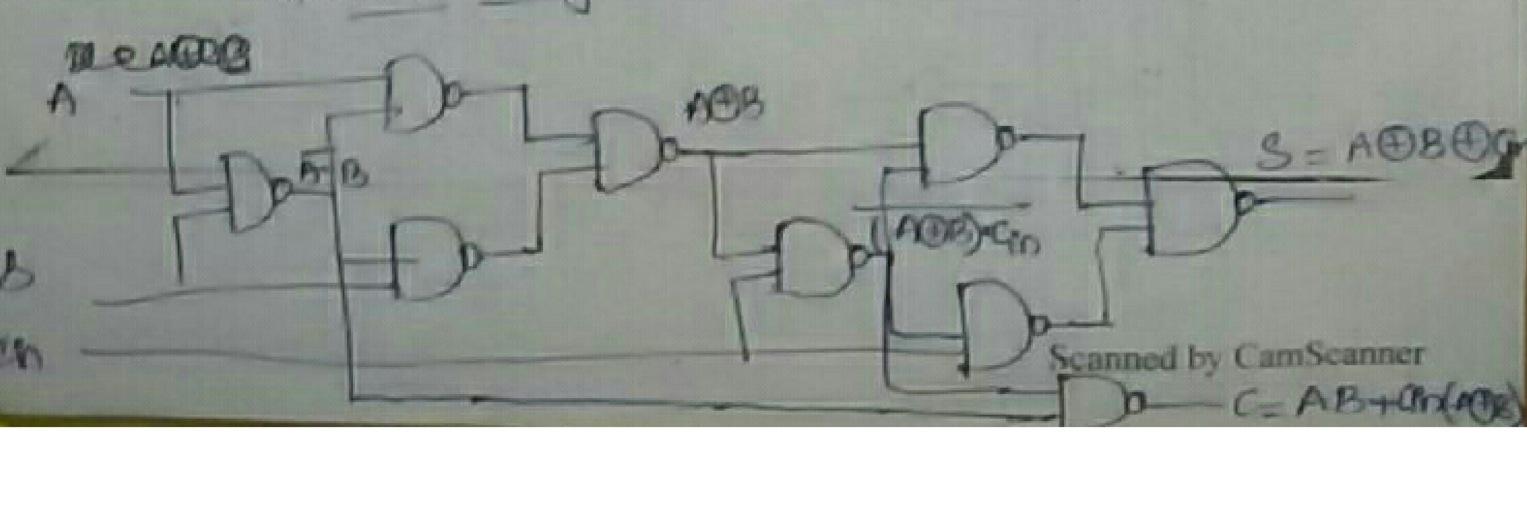
Logic circuit using basic gates:-

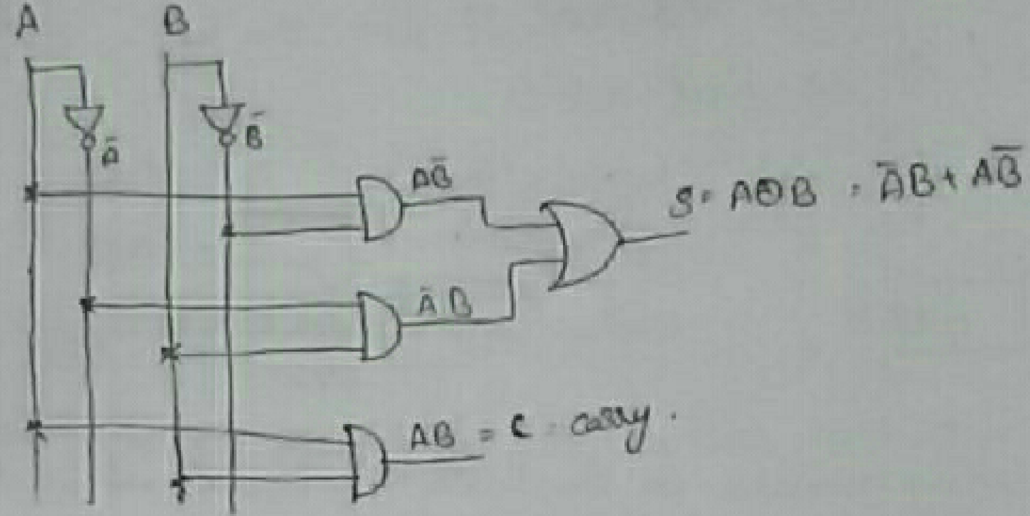


Full adder using 2 half adders:-

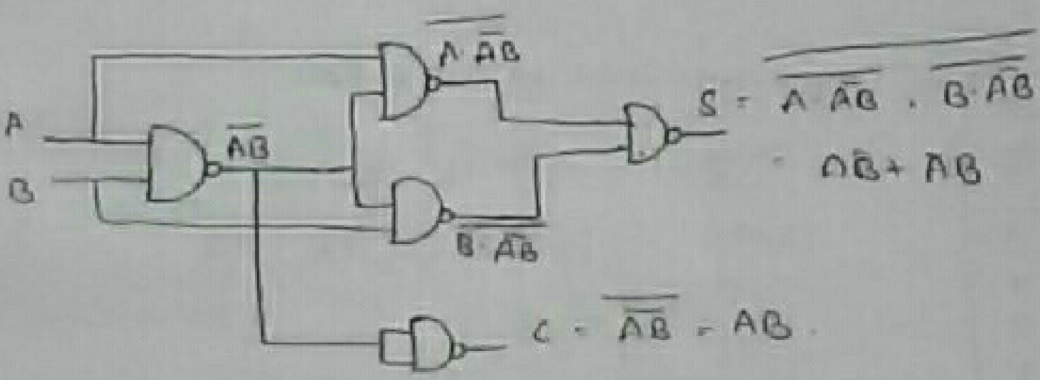


** F.A using NAND Gate



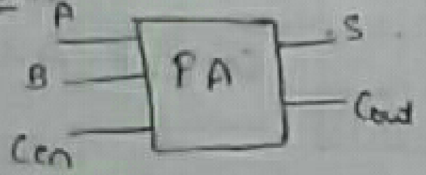


Half adder using NAND gates:-



Full adder:- It has 3 inputs & 2 outputs.

Symbol:-



Truth table:-

A	B	Cin	S	Cout
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

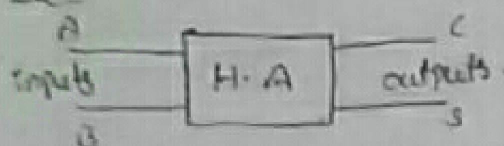
O/P expressions:-

Sum, $S = A \oplus B \oplus C_{in}$

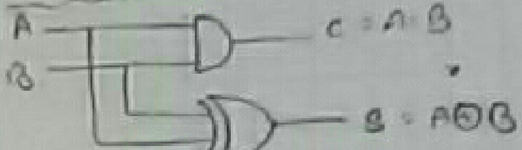
Carry, $C_{out} = AB + BC_{in} + AC_{in}$

A logic circuit used for the addition of two one bit numbers is called as an half-adder.

Logic symbol:-



Logic circuit:-



When we add 2 binary numbers, we start with the Least Significant Bit (LSB). That means we have to add 2 bits with a possibility of a carry.

Truth table:-

Inputs		Outputs	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

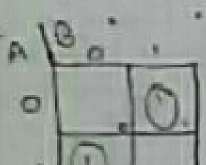
The expressions for output are

Carry, $C = A \cdot B$

Sum, $S = A \oplus B = A\bar{B} + \bar{A}B$

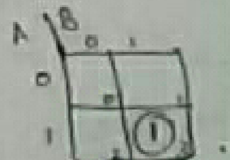
To get the expressions from truth table K-map must be considered.

Sum:-



Sum, $S = \bar{A}B + A\bar{B}$

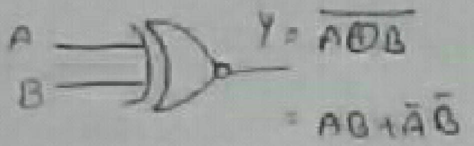
Carry:-



Carry, $C = A \cdot B$.

The logic circuit for half adder using Basic gates is as follows

Symbol :-

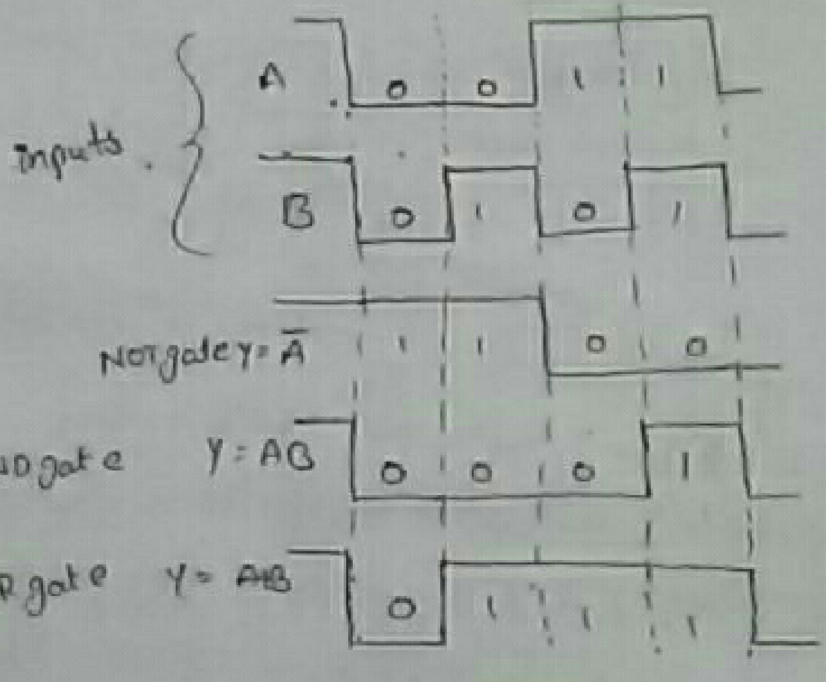


Truth table :-

Inputs		output
A	B	$Y = \overline{A \odot B}$
0	0	1
0	1	0
1	0	0
1	1	1

Timing Diagrams of Basic Logic Gates :-

The timing diagrams of NOT, OR and AND gates with respect to input logic levels is as shown below.



Half Adder :-

Some of the basic Arithmetic circuits are half adder, Full adder, half subtractor, full subtractor.

EX-OR gate:-

2 special logic circuits that occur quite often in digital systems are the Exclusive-OR and exclusive-NOR circuits.

The Ex-OR gate also has 2 inputs and one output. The exclusive-OR operation is denoted by $\oplus$. Hence the output expression is given by

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

The operation of Ex-OR gate is that when the 2 inputs are different the output is high and when the 2 inputs are the same, the output is low.

Truth table:-

Inputs		Output
A	B	$Y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Symbol:-

EX-NOR gate:- (coincidence gate)

This gate is also having 2 inputs and one output. The operation is inverse of Ex-OR gate operation. The output expression is given by

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

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

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

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

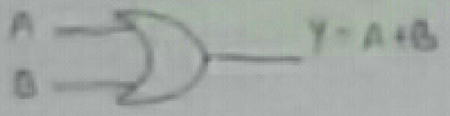
Ex-NOR gate is also called as coincidence gate.

The operation of OR gate is such that the output is logic high when any one of the input is high otherwise the output is low.

Truth table:-

Inputs		output
A	B	Y = A+B
0	0	0
0	1	1
1	0	1
1	1	1

Symbol:-



NAND gate:-

This in inversion of AND gate. It also has 2 & more inputs and one output. NAND gate is called as 'universal gate'.

Truth table:-

inputs		output
A	B	$Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

Symbol:-

NOR Gate:- The operation of NOR gate is inversion of OR gate. It has 2 & more inputs and one output. NOR gate is also a 'universal gate'.

Symbol:-

Truth table:-

inputs		output
A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

fig:- Symbol of NOT gate.

Truth table :-

Input A	Output B
0	1
1	0

AND gate:- The AND gate performs Logical multiplication.

The AND gate has 2 & more inputs and single output. The output expression is as follows $Y = AB$

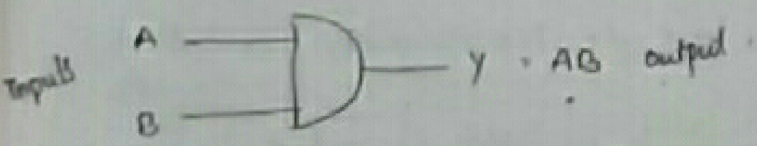


fig: symbol of AND gate.

Truth table :-

Inputs		Output
A	B	Y = AB
0	0	0
0	1	0
1	0	0
1	1	1

The operation of AND gate is such that "The output is Logic high when all inputs are high otherwise output is Logic Low.

OR gate:- OR gate performs Logical addition operation. It is having 2 & more inputs and only one output.

output expression is $Y = A+B$

The inputs and outputs of Logic gates can occur only in 2 l..
namely High & Low (or) True & false (or) ON and OFF (or) Log..
and 0 .

Truth

There are 2 types of Logics. i) positive Logic
2) negative Logic

Positive Logic:- In positive Logic "High level" is Indicated with 1
and "Low Level" is indicated with "0"
Negative Logic:- In negative Logic "High Level" is indicated with 0
and "Low Level" is indicated with "1".

The most common Logic gates are the AND, OR, NOT, NAND, NOR, EX OR and EX-NOR. In these
AND, OR, NOT gates are known as basic gates
NAND, NOR gates are known as "Universal gates", because all the other gates can be realized using either only by NAND gates & only by NOR gates.

1) NOT Gate:-
NOT gate performs the operation of normal inverter. & complementation It is having only one input and one output.

Digital systems are designed to store, process & communicate information in digital form. The digital computer, more commonly called computer, is an example of digital system. A computer manipulates information in digital form or binary form.

Digital systems

Digital systems have a vast application in every area. Digital systems are used in communication, traffic control, entertainment, weather monitoring etc. Most commonly used digital devices such as digital television, digital camera, digital computer etc.

The term digital system refers to the systems which manipulate discrete quantities of information that are represented in binary form.

Some features of digital system are as follows

1. Discrete elements of information are represented by physical quantities called signals that use discrete values ON and OFF hence said to be binary.
2. i.e instructions are represented by a binary digit called a BIT, that has 2 values '0' and '1'.
3. Digital system is an interconnection of digital modules.
4. Digital circuits are also referred to as logic circuits comprising of different logic gates.

Basic Logic Gates:-

Logic Gates are the functional building blocks of digital systems. The circuits that perform the simplest boolean functions are taken as basic elements, called "Logic Gates" and are represented by some special symbols.

(or)

A switch which can be closed or opened is known as gate. The gate has two possible states. Mathematically, two states are expressed by number 1 (one) and 0 (zero). 1 may be used to represent gate as ON and 0 may be used to represent gate as OFF. The circuits which are used to perform switching action are known as logic circuits or logic gates.