Unit 1 – Introduction

Digital electronics is a branch of electronics that deals with signals or data in the form of digits usually 0's and 1's

It is foundation of modern electronics system which are fast, reliable and efficient.

Examples - computer, calculators, smartphones, digital watches, TV's etc.

Advantages -
- More accurate and noise resistant
- Easy to design and replicate
- Allow data storage, processing, communication efficiently

Digital Circuits

Basic Building block of digital circuits are logic gates.

There are two types of digital circuits
Combinational circuits —
output depends only on current inputs
(eg. Adder, multiplexers)

Sequential circuits -
output depends on current input and past inputs (eg. flip-flop, counters).

Digital circuits are electronic circuit that operate using digital signals which are in discrete form.

Digital Signals

Digital signals are signals that represent data as a sequence of discrete values.

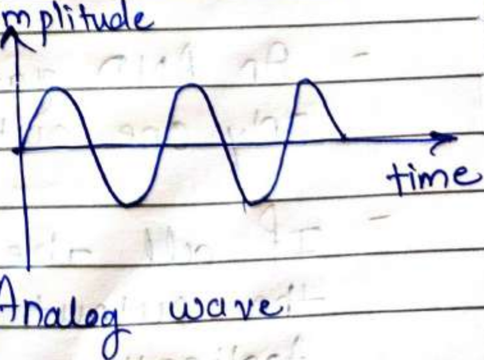
Unlike analog signals which vary continuously over time, while digital signal switch beetween a finite number of states, most commonly (0 and 1) binary.

Digital signal Vs Analog signals

	Digital	Analog
1) Nature	Discrete (0 and 1)	continuous
2) Noise immunity	High	low
3) Transmission	Easier over long distances	susceptible to degradation
4) Equipment	Requires digital circuitry	Requires Analog circuitry
5) eg.	Computer, CD's USB, Wi-Fi	Microphones, FM Radio, tape etc.

6) waveform

square wave



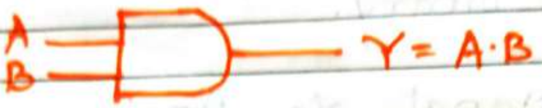
Analog wave

Logic gates

AND gate (IC 7408 – 2 input AND gate)

An AND gate is basic digital logic gate that outputs High (1) only when all its inputs are high (1)

Symbol →



A, B → are inputs to AND gate
Y → output of AND gate

Boolean expression

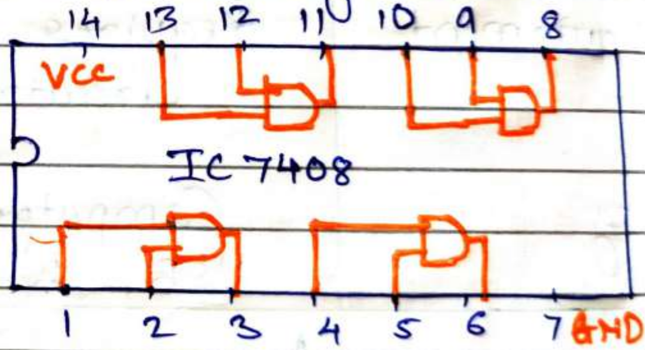
$$Y = A \cdot B$$

(Y equals A and B)

Truth table

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

Pin diagram



- An AND gate has two or more inputs and only one output which is product of all inputs.
- If all the inputs of AND gate are '1' then the output (Y) is logic '1', otherwise o/p is '0'.

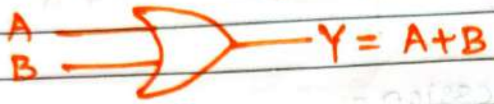
Applications

- Decision making circuit
- digital locks
- Control System.

OR gate (IC 7432 - 2 input OR gate)

An OR gate is a basic digital logic gate that outputs High (1) if any one or more inputs are High (1)

Symbol →



A, B → input to OR gate
Y → output of OR gate.

Boolean expression

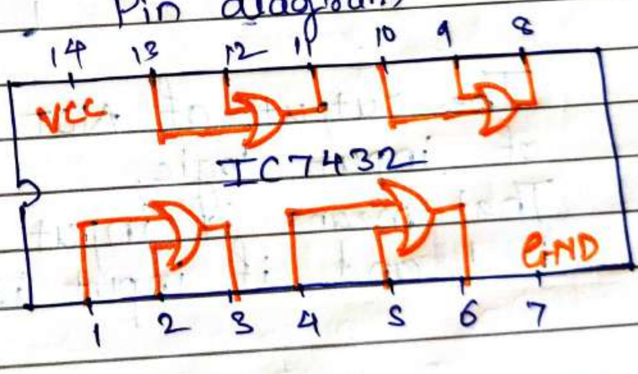
$$Y = A+B$$

(Y equals A OR B)

Truth table

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

Pin diagram

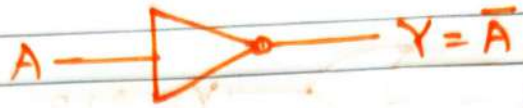


- OR gate has two or more input and only one output, which is equal to the sum of all inputs.
- It performs addition operation.
- Output of OR gate is '1' if at least one input is '1'. The output is '0' only when all i/ps are '0'.
- Application ⟶ Alarm system, control circuit.

NOT gate (IC 7404 – 1 input NOT gate)

- A NOT gate is a basic digital logic circuit that reverses the input signal.
- It is known as an 'Inverter'.

Symbol →



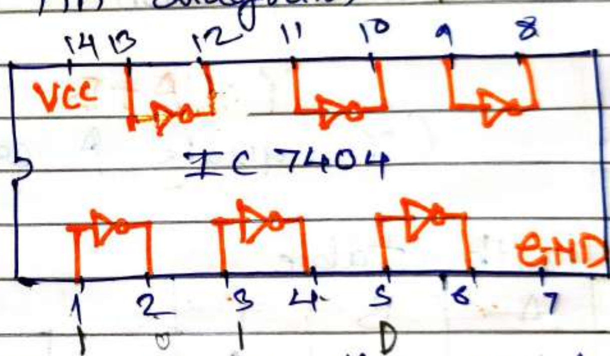
Boolean expression -

$$Y = \overline{A}$$

Truth table

A	$Y = \overline{A}$
0	1
1	0

Pin diagram

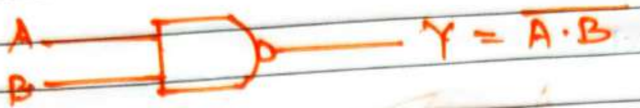


The output of NOT gate is the complement of input logic.
That means if input to NOT gate is 0 then output is 1 and if input is 1 then output is 0.

NAND gate (IC 7400 - 2 input NAND gate)

A NAND gate is a digital logic gate that outputs low (0) only when all it's inputs are high (1)

Symbol →



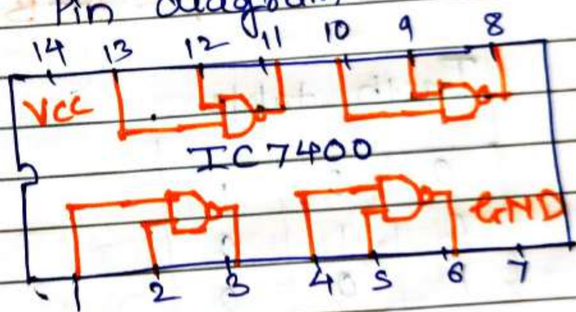
Boolean expression →

$$Y = \overline{A \cdot B}$$

Truth table

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

Pin diagram



- It is also called Universal gate because one can build any other logic gate (AND, OR, NOT ... etc) using this gate.

It is used to perform complement operation of AND gate

Application
- Memory element
- Processor design
- digital circuits

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Ex-NOR (IC 74266 - 2 input Ex-NOR gate)

- Exclusive NOR gate

The output of Ex-NOR gate is '1' only when the inputs are equal.

Symbol

$Y = A \odot B$
$= \overline{A \oplus B}$
$= AB + \bar{A}\bar{B}$

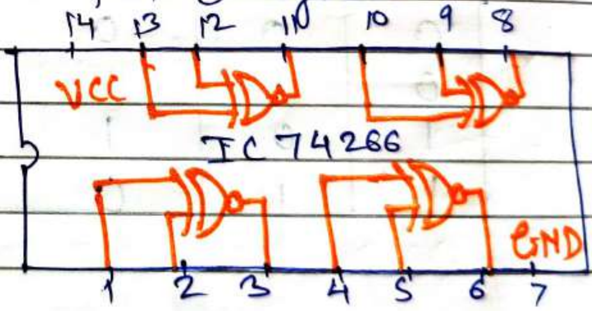
Boolean expression

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

Truth table

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

Pin diagram



- It is complement of Ex-OR gate
- It is used to obtain inverse exclusive-OR operations of input variable.

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Boolean Algebra

It is also called as B nary or logical Algebra.

It is invented by George Boole in 1854

It is mathematical system for analyzing and simplifying digital circuits.

Laws of Boolean Algebra.

1) Identity law
Boolean variable combined with neutral element (0 or 1) using OR or AND operation will not change the original value of variable

a) $A + 0 = A$
b) $A \cdot 1 = A$

2) Null (Dominance) law)

Boolean variable combined with a dominating value (0 or 1) using OR or AND operations. the result is always dominated by that value.

a) $A + 1 = 1$
b) $A \cdot 0 = 0$

3) Idempotent law
It states that the same operation to the same variable more than once doesn't change the result.

a) $A + A = A$

4) Complement law

If you OR a variable with its complement the result is always 1 . and if you AND a variable with its complement the result is always 0.

a) $A + A' = 1$

b) $A \cdot A' = 0$

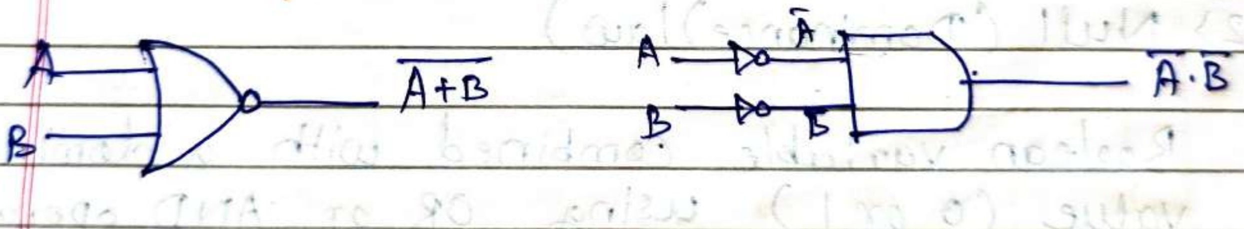
5) De-Morgan's Theorems

A famous mathematician De-Morgan derived two most important theorems of Boolean Algebra.

a) DeMorgans First Theorem

Statement — The complement of the sum of all the terms is equal to the product of the complement of each term.

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



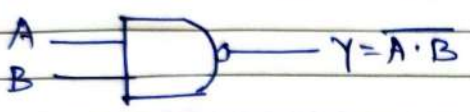
Truth table

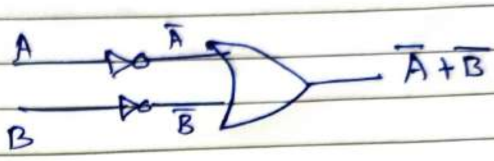
Input		Output				
A	B	A+B	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

b) DeMorgans Second Theorem

Statement – The complement of the product of all terms is equal to complement of sum of each term.

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





Truth table

input		output				
A	B	$A \cdot B$	$\overline{A \cdot B}$	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
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