Subject : 3IT3-04 : Digital Electronics

UNIT - 1

Fundamental Concepts

NUMBER SYSTEMS and codes :-

INTRODUCTION -

The electronic circuits have wide application in our daily life. The electronic circuits can be divided into two parts Digital and Analog. The digital word refers to the term digit (0,1). The term digital is mostly associated with a computer

Applications of digital circuit -

Computers
Calculators
Video games
television etc
Wide applications in Communication systems -

Radar,
Navigation system
Military system
Control system
In consumer Electronics -
Compact discs,
VCRs
Television
Medical science.

Analog and Digital systems –

There are two types of Electronic Circuits and system; Analog and digital. Analog system are those in which physical quantities are represented over a continuous range of values. They can take infinite values within the specified range
Ex.:→ The amplitude of the output signal to the speaker in a radio receiver can have any value between zero and its maximum limit.

Digital system are those in which physical quantities are represented in digital form; that is, the quantities can take on only discrete values. Any quantity in the physical world, such as temperature, pressure, or voltage, can be symbolized in a digital circuit by a group of logic levels that, taken together, represent a binary number. Logic levels that, taken together, represent a binary number. Logic levels are usually as 0 or 1; at times, it may be more convenient to use low/High, false/true, or OFF/ON.

Advantages of Digital systems—

Following advantages of digital systems over Analog systems:-

1.) Easy to design :- Since all the modern digital circuits use only two voltage levels, High and LOW, hence they are easier to design. the exact numerical values of voltages are not important because they have only logical significance; only the range in which they fall is important. In Analog systems, signals have numerical significance; so their design is more complex.

2.) Storage Capacity and low Cost :-> The storage of digital information is easy because there are many types of Semiconductor and magnetic memories of large capacity which can store digital data for periods as long a necessary. The digital device has low cost because of the advances of digital integrated circuit technology. The number of components can be fabricated on a single chip which reduces the cost of the digital system.

3.) Less affected by noise — Unwanted Electrical signals are called noise. since in Analog systems the exact values of voltages are important and in digital systems only the range of values is important, the effect of noise is more critical in analog systems. In digital systems as long as their values are lying in the range of High or LOW

4) **Accuracy and precision:-**
Digital systems are much more accurate and precise than analog systems, because digital systems can be expanded to handle more digits simply by adding more switching circuits. Analog systems are quite complex and costly for the same accuracy and precision.

5) **Programmable:-** The controlling operations of the digital circuit can be programmed so we can change them as and when required. The analog systems can also be programmed but they have some limitations and complexity.

6) **Efficient:-** Digital data can be processed, manipulated and transmitted more efficiently as compared to analog data. Digital systems are more reliable than Analog systems.

7) Fabrication on IC devices - The fabrication of digital ICs is simpler and economical compared to the analog ICs.

Limitations of Digital Systems - In digital system these analog quantities are used through following steps-

1) Convert the analog inputs to digital form by a using analog to digital converted, ADC.
2) Process the digital information
3) Convert the digital outputs back to analog form by digital to analog converter, DAC

NUMBER SYSTEMS —

Numer system is one of the most basic topics in digital Electronics. A number system is nothing more than a code that uses symbols to represent a number. In general in any number system, there is an ordered set of symbols known as digits.

The most widely used number system is Positional number system. In positional number system, a number is represented by a string of digits and each digit position has an associated weight.
A number is made up of a collection of digits and it has two parts; i) Integer ii) Fraction, both are separated by a radix point (.).
The number is represented as —

$$(\underbrace{d_{n-1}\, d_{n-2}\, d_{n-3} \cdots d_1\, d_0}_{\text{Integer part}} \underset{\substack{\uparrow \\ \text{Radix Point}}}{\cdot} \underbrace{d_{-1}\, d_{-2}\, d_{-3} \cdots d_{-m}}_{\text{Fractional part}})_r$$

Where,
r = radix or base of the number system
n = number of digits in the integer part
m = number of digits in Fractional part
d_{n-1} = Most significant digit (MSD)
d_{-m} = Least significant digit (LSD)

Radix OR Base (r) –

The number of independent digits or systems used in a number system, is known as radix or base of the number system.

All Positional number systems must have a radix or Base denoted as r. It is defined as the weight of a digit which depends on its relative position within the number. The weights of different digits in the integer part of the number are given by $r^0, r^1, r^2, r^3, \ldots$ and so on, starting with the digit adjacent to radix point. For the fractional part, these are $r^{-1}, r^{-2}, r^{-3} \ldots$ and so on, again starting with the digit next to the radix point.

Classification of number System :–

These are many types of number systems as – i) Binary number (2) ← radix ii) Decimal number system (10) iii) Octal number system (8) iv) Hexadecimal number system (16)

i) **Binary Number system** :→ Binary number system is a radix-2 number system with '0' and '1' as the two independent digits. All larger binary numbers are represented in terms of '0' and '1'. The radix point is known as the binary point (.). These symbols are known as bits (binary digits). It is a positional number system; the weight of a bit is defined by its position with base 2.

Starting from the binary point, the weights of different digits in a mixed binary number are $2^0, 2^1, 2^2, 2^3$ and so on for the integer part and $2^{-1}, 2^{-2}, 2^{-3}$, and so on for the fractional part.

For example –

$$(1011.101)_2 = 1\times2^3+0\times2^2+1\times2^1+1\times2^0+1\times2^{-1}+0\times2^{-2}+1\times2^{-3}$$

Decimal No.	Binary No.
0	00
1	01
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

ii) **Octal Number System (Radix-8) :–**

The octal number system has a radix of 8 and therefore has 8 digits to represent a number. The independent digits are 0, 1, 2, 3, 4, 5, 6, and 7. In the octal number system, the radix point is known as the octal point. The weights for different digits in the octal number system are $8^0, 8^1, 8^2$ and so on for the integer part and $8^{-1}, 8^{-2}, 8^{-3}$, and so on for the fractional part.

For example – $(367.721)_8 = 3\times8^2+6\times8^1+7\times8^0+7\times8^{-1}+2\times8^{-2}+1\times8^{-3}$

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iii) Decimal Number System :- (Radix-10) -

The decimal number system is a radix 10 number system and therefore has 10 different digits or ~~system~~ symbols to represent a number. These are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

The weights of different digits in a mixed decimal number, starting from the decimal point, are 10^0, 10^1, 10^2, and so on for the Integer part and 10^{-1}, 10^{-2}, 10^{-3}, and so on for the fractional part.

For Example -

$$(145.86)_{10} = 1 \times 10^2 + 4 \times 10^1 + 5 \times 10^0 + 8 \times 10^{-1} + 6 \times 10^{-2} \quad (\because 10^0 = 1)$$

$$= 100 + 40 + 5 + 0.8 + 0.06$$

$$= 145.86$$

iv) Hexadecimal Number System :- (radix-16)

The hexadecimal number system is a radix-16 number system and its 16 basic digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, $\underbrace{A}_{10}$, $\underbrace{B}_{11}$, $\underbrace{C}_{12}$, $\underbrace{D}_{13}$, $\underbrace{E}_{14}$ and $\underbrace{F}_{15}$.

In the hexadecimal number system, the radix point is known as the hexadecimal point. The decimal equivalent of A, B, C, D, E and F are 10, 11, 12, 13, 14, and 15, respectively, for obvious reasons.

The weights of different digits in a mixed hexadecimal number are 16^0, 16^1, 16^2, 16^3, and so on for the Integer part and 16^{-1}, 16^{-2}, 16^{-3} and so on for the fractional part.

For Example - $(621A.825)_{16} = 6 \times 16^3 + 2 \times 16^2 + 1 \times 16^1 + 10 \times 16^0 + 8 \times 16^{-1} + 2 \times 16^{-2} + 5 \times 16^{-3}$

NUMBER System

- Binary — Represent → $( )_2$
- Octal — $( )_8$
- Decimal — $( )_{10}$
- Hexadecimal — $( )_{16}$

Conversion :→ Some Number —

Binary $( )_2$	Octal $( )_8$	Decimal $( )_{10}$	Hexadecimal $( )_{16}$	
0	0	0	0	10 → A
1	1	1	1	11 → B
	2	2	2	12 → C
	3	3	3	13 → D
	4	4	4	14 → E
	5	5	5	15 → F
	6	6	6	
	7	7	7	
		8	8	
		9	9	

Conversion →

$( )_2 \rightarrow ( )_8$ Binary into octal

$( )_2 \rightarrow ( )_{10}$ Binary into Decimal

$( )_2$ — $( )_{16}$ Binary into Hexadecimal

$( )_8 \rightarrow ( )_2$ ~~Binary~~ octal into Binary

$( )_8 \rightarrow ( )_{10}$ octal into Decimal

$( )_8 \rightarrow ( )_{16}$ octal into Hexadecimal

$( )_{10} \to ( )_2$ Decimal into Binary

$( )_{10} \to ( )_8$ Decimal into octal

$( )_{10} \to ( )_{16}$ Decimal into Hexadecimal

$( )_{16} \to ( )_2$ Hexadecimal into Binary

$( )_{16} \to ( )_8$ Hexadecimal into octal

$( )_{16} \to ( )_{10}$ Hexadecimal into Decimal

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1) Conversion Binary into octal
2) " octal into Binary

Binary :	2
Octal :	8

Q. What should be the power of 2 to get 8 ?

Ans. $2^3 = 8$ ∵ Bin.

Let's make the table that contains 3 columns & 8 rows
We'll use the table

0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

i) $8/2 = 4$
write 4 times 0
write 4 times 1

ii) $4/2 = 2$, write 2 times 0
write 2 times 1

iii) $2/2 = 1$, write 1 times 0
write 1 times 1

3) Conversion Binary into Hexadecimal

4) Conversion Hexadecimal into Binary

Binary is :	2
Hexadecimal is :	16

Q.) What should be the power of 2 to get 16 ?

Ans. $2^4 = 16$ ∵ It means 4 columns or digits

Make the table that contains 4 columns 16 Rows

$16/2 = 8$ → Write 8 times 0
Write 8 times 1

$8/2 = 4$ → Write 4 times 0
Write 4 times 1

$4/2 = 2$ → Write 2 times 0
Write 2 times 1

Again →
$2/2 = 1$ → Write 1 times 0
Write 1 times 1

This is for Hexadecimal $()_{16}$

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

Table will be used for — 1 Conversion Binary into octal
2 " " octal into Binary

Table

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

1> octal into Binary Conversion :— For Integer part

Q. 1> Convert $(761)_8 = (\ )_2$?

Ans 1.> $(111110001)_2$

Q.2> Convert $(71.3)_8 = (\ )_2$? For Fraction part

← octal Number

Ans.> $(111001.011)_2$ ← Binary Number

2> Binary into octal Conversion :—

Q.3> Convert $(10011)_2 = (\ )_8$?

∵ Right to Left move ←

Ans.> $(\overset{Add}{0}10\,011)_2 = (\ )_8$

2 3

$(10011)_2 = (23)_8$ Ans.

Q.4> Convert $(10.11)_2 = (\ )_8$?

Ans. 10.11 ⇒ Adding $\overset{Add}{0}10.11\overset{Add}{0}$ ⇒ $(2.6)_8$

2 . 6

Hexa-decimal into Binary Conversion —

Q.5) Convert $(61)_{16} = (\ )_2$?

Ans) $(0110\ 0001)_2$ OR $(61)_{16} = (01100001)_2$ Ans.

Q.6) Convert $(8A.D)_{16} = (\ )_2$?

Ans) $(10001010.1101)_2$ OR $(8A.D)_{16} = (10001010.1101)_2$ Ans.

4) Binary into Hexadecimal Conversion —

Q.7) Convert $(101101)_2 = (\ )_{16}$?

Ans)

$$\underbrace{0010}_{2}\ \underbrace{1101}_{D}$$

OR $(101101)_2 = (2D)_{16}$ Ans

Q.8) Convert into $(11.110)_2 = (\ )_{16}$?

Ans)

Add   Add

$$\underbrace{0011}_{3}\ .\ \underbrace{1100}_{C}$$

OR $(11.110)_2 = (3.C)_{16}$ Ans

5) Conversion octal into Hexa-decimal

6) Conversion Hexadecimal into octal

Imp 5) Conversion octal into Hexa decimal :-

$$\text{octal} \xrightarrow[\text{into}]{\text{Convert}} \text{Binary} \xrightarrow[\text{into}]{\text{Convert}} \text{Hexa-decimal}$$

Imp 6) Conversion Hexa-decimal into octal :-

$$\text{Hexadecimal} \xrightarrow[\text{into}]{\text{Convert}} \text{Binary} \xrightarrow[\text{into}]{\text{Convert}} \text{octal}$$

Q.9) Convert $(76.1)_8 = (\quad)_{16}$?

Ans. Firstly we'll convert octal into Binary

$(76.1)_8 \longrightarrow (\quad)_2$

$(111110.001)_2$

Binary into Hexadecimal

$\underbrace{0011}\ \underbrace{1110}\ .\ \underbrace{0010}$

$(3 \quad E \quad . \quad 2)_{16}$

OR $(76.1)_8 = (3E.2)_{16}$ Ans.

Table

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

Conversion Hexadecimal into octal –

Q.10) Convert $(7A.C)_{16} = (\quad)_8$?

Ans. Firstly, convert Hexadecimal into Binary

$(7A.C)_{16} = (\quad)_2$?

Hexadecimal in to Binary conversion

$(01111010.1100)_2$

Binary into octal conversion.

Add ↓ Add.

$\underline{001}\,\underline{111}\,\underline{010}\,.\,\underline{110}\,\underline{000}$

$(7A.C)_{16} = (1\ 7\ 2\ .\ 6\ 0)_8$

- OR $(7A.C)_{16} = (172.60)_8$ Ans.

Table $(\ )_{16}$

Hexadecimal Table

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

octal table

octal Table use ↓

For Integer part conversion

⇒ Decimal into Binary conversion → $(\ )_{10} = (\ )_2$?

Divide the given number by 2

Q.11) Convert $(198)_{10} = (\quad)_2$?

Ans)

2	198	
2	99	0 ←
2	49	1 ←
2	24	1 ←
2	12	0 ←
2	6	0 ←
2	3	0 ←
2	1	1 ←

Remainder

up to down

$\Rightarrow (11000110)_2$ Ans

$2)\cancel{198}(\cancel{99}$

∴ Quotient 99

Remainder 0

Quotient

$2)198(99$
18
18
18
0

Remainder

⇒ Decimal into octal conversion — $(\ )_{10} = (\ )_8$

Divide the given number by 8

⇒ Decimal into Hexa-decimal conversion — $(\ )_{10} = (\ )_{16}$

Divide the given number by 16

Decimal into octal conversion: → $( )_{10}$ $( )_8$?

Q.12) Convert $(798)_{10} = ( )_8$?

8	798		quotient 99
8	99	6	Remainder 6
8	12	3	
8	1	4	

$(798)_{10} = (1436)_8$ **Ans**

quotient

$$8\overline{)798}(99$$
72
78
72
Remainder 6

$$8\overline{)99}(12$$
8
19
16
3

$$8\overline{)12}(1$$
8
4

Decimal into Hexadecimal Conversion:

$( )_{10} = ( )_{16}$?

Q.13) Convert $(798)_{10} = ( )_{16}$?

16	798		
16	49	E	↑ up
16	3	1	to
		3	down

$(798)_{10} = (31E)_{16}$ **Ans**

$$16\overline{)798}(49$$
64
158
144
14 OR E

$$16\overline{)49}(3$$
48
1

For fractional part conversion
→ system adopt by multiplication

Decimal into Binary Conversion:

Q.14) Convert $(.625)_{10} = ( )_2$?

Ans →

		Integer part	fractional part
$.625 \times 2 =$	1.25	1 ↓ up to down	.25
$.25 \times 2 =$	.5	0	.5
$.5 \times 2 =$	1.0	1	.0

Now fraction part is 0, then STOP

So $(.625)_{10} = (.101)_2$ **Ans**

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For fraction part —

Decimal into octal conversion :→

Q.15) Convert $(\cdot 015625)_{10} = (\ \ )_8$?

Ans →

$\cdot 015625 \times 8 = 0.125$

$\cdot 125 \times 8 = 1.000$

Integer part	Fractional part
0	·125
1	·0

So $(\cdot 015625)_{10} = (\cdot 01)_8$ Ans

For Fractional part —

Decimal into Hexa-decimal conversion :→ only integer part is considered

Q.16) Convert $(\cdot 93)_{10} = (\ \ )_{16}$?

Ans. →

$\cdot 93 \times 16 = 14.88$

$\cdot 88 \times 16 = 14.08$

$\cdot 08 \times 16 = 1.28$

$\cdot 28 \times 16 = 4.48$

$\cdot 48 \times 16 = 7.68$

Integer part	Fraction part
14 or E	·88
14 or E	·08
1	·28
4	·48
7	·68

only five times is calculate

So $(\cdot 93)_{10} = (\cdot EE147)_{16}$ Ans

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* Binary into Decimal conversion — $(\ \ )_2 = (\ \ )_{10}$? only Integer part

Q.17) Convert $(1011)_2 = (\ \ )_{10}$?

Ans.)

1 0 1 1

$1 \times 2^0 = 1$

$1 \times 2^1 = 2$

$0 \times 2^2 = 0$

$1 \times 2^3 = 8$ adding

$(11)_{10}$ Ans

$(1011)_2 =$

Binary into Decimal conversion $(\ )_2 = (\ )_{10}$

Octal into Decimal conversion $(\ )_8 = (\ )_{10}$

Hexa-decimal into Decimal conversion $(\ )_{16} = (\ )_{10}$

* Octal into Decimal conversion :→ $(\ )_8 = (\ )_{10}$?

Q.18) Convert $(106)_8 = (\ )_{10}$?

Ans) 1 0 6 $\because 8^0 = 1$

$6 \times 8^0 = 6$

$0 \times 8^1 = 0$

$1 \times 8^2 = 64$

70

$(106)_8 = (70)_{10}$ Ans.

* Hexa-decimal into Decimal conversion :→ $(\ )_{16} = (\ )_{10}$?

Q.19) Convert $(13A)_{16} = (\ )_{10}$?

Ans) 1 3 A $\because 16^0 = 1$

$A = 10 \times 16^0 = 10$

$3 \times 16^1 = 48$

$1 \times 16^2 = 256$

314

$(13A)_{16} = (314)_{10}$ Ans.

only for Fractional part

* Binary into Decimal :-

Q.20) Convert $(.101)_2 = (\ )_{10}$?

Ans) . 1 0 1

$1 \times 2^{-3} = 1/8$ +

$0 \times 2^{-2} = 0$ + Adding.

$1 \times 2^{-1} = 1/2$ = $.625$

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$(\cdot 101)_2 = (\cdot 625)_{10}$ Ans.

* octal into Decimal (for fractional part) —

Q.21) Convert $(\cdot 32)_8 = (\quad)_{10}$?

Ans) $\cdot 3\ 2$

$\to 2 \times 8^{-2} = 2/64$

$\to 3 \times 8^{-1} = 3/8$

$= (\cdot 40625)_{10}$

$(\cdot 32)_8 = (\cdot 40625)_{10}$

* Hexa-decimal into Decimal (for fractional part) —

Q.22) Convert $(\cdot B8)_{16} = (\quad)_{10}$?

Ans.) $\cdot\ B\ 8$

$\to 8 \times 16 = 8/256$

$\to B \times 16 = 11/16$

or 11

Adding

$\cdot 71875$

$(\cdot B8)_{16} = (\cdot 71875)_{10}$ Ans.

Binary into Decimal (Both (Integer+fraction) part) —

Q.23) Convert $(1011 \cdot 101)_2 = (\quad)_{10}$?

Ans. $(\underbrace{1011}_{\text{Refer Q.17}} \cdot \underbrace{101}_{\text{Refer. 20}})_2 = (11.625)_{10}$ Ans.

octal into Decimal —

Q.24) convert $(106 \cdot 32)_8 = (\quad)_{10}$?

Ans.) $(\underbrace{106}_{\text{Refer Q.18}} \cdot \underbrace{32}_{\text{Refer Q.21}}) = (70 \cdot 40625)_{10}$ Ans.

Basic Logic Gates :→

Logic Gates are the fundamental building blocks of digital systems. Logic Gates are electronic circuits that perform the most elementary Boolean operations.

There are three basic logic Gates, namely the OR Gate, the AND Gate and the NOT Gate. Other logic gates that are derived from these basic gates are the NAND Gate, the NOR gate, the EXCLUSIVE-OR gate and the EXCLUSIVE-NOR gate.

Logic gates are electronic circuits with a number of inputs and one O/P. I/Ps and O/Ps of logic gates can occur only in two levels. These Two levels are termed HIGH and LOW, or TRUE & FALSE, or ON and OFF, or simply 1 & 0.

Logic gate circuits are most commonly represented by symbols & each gate has its truth Table.

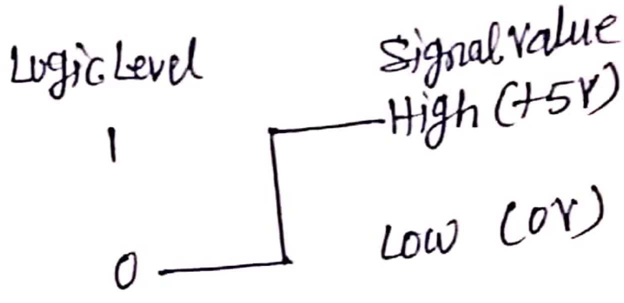
POSITIVE AND NEGATIVE LOGIC :-

The Binary I/P-O/P signals have always one of two values; logic '0' & logic '1'. These logic states in digital systems are represented by two different Voltage levels or two different current levels.

These are two different ways to assign a signal value to logic level such as Positive logic & Negative logic.

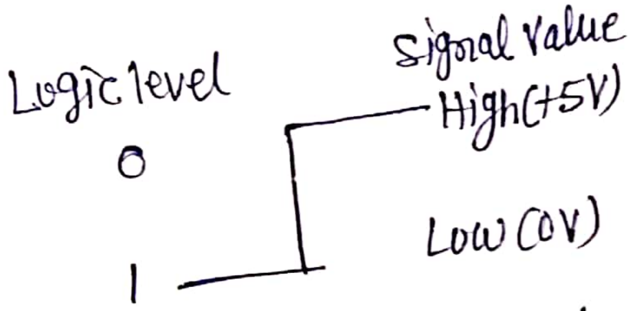
Positive logic system –

Signal value	Logic Level
High	1
Low	0



Negative logic system –

Signal value	Logic Level
High	0
Low	1



For Example –i) If the two Voltage levels are 0V & 5V, then in the positive logic system the 0V represents a logic '0' & the +5V represents a logic '1'.
In –ive logic system, 0V represents a logic 1 & +5V represents a logic '0'.

Example(2) – If the two voltage levels are 0V & –5V, then in the +ive logic system the 0V represents a logic '1' and the –5V represents a logic '0'.
In the –ive logic system, 0V represents a logic '0' and –5V represents a logic '1'.

Logic Gates

* Logic gates are digital circuits
* The building blocks of any digital system
* It is an electronic circuit having one or more I/Ps & only one O/P

Types of Logic Gates

i) Basic Gate	ii) Universal Gates	iii) Special Gates
a) AND Gate	d) NAND Gate	f) EX-OR Gate
b) OR Gate	e) NOR Gate	g) EX-NOR Gate
c) NOT Gate		

i) Basic Gate :-

AND Gate
OR Gate
NOT Gate

ii) Universal Gates :-

NAND Gate
NOR Gate

iii) Special Gates :-

EX-OR Gate
EX-NOR Gate.

The AND GATE :-

Symbol –

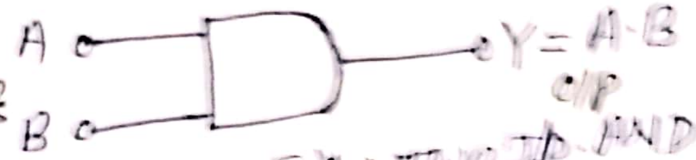


Fig.: Two I/P AND gate

Where, A & B = Inputs

Y = O/P

Fig.:- Symbol for 3 I/P AND gate

An AND gate has two or more I/Ps & only one O/P which is equal to the product of all I/Ps

Truth Table :-

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

An AND Gate is a logic circuit with two or more I/Ps and one O/P that performs ANDing operation. the O/P of an AND gate is HIGH only when all of its I/Ps are in the HIGH state. In all other cases, the O/P is low. AND gate IC 7408, having 4 AND Gates are available

The OR GATE – IC 7432

Symbol –

Figure :- Two Input OR gate

Truth Table –

I/P		O/P
A	B	Y = A+B
0	0	0
0	1	1
1	0	1
1	1	1

Where, A & B = Input

Y = O/P

The O/P of an OR gate is LOW only when all of its I/Ps are LOW. For all other possible I/P combinations, the O/P is HIGH

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The NOT GATE :- Not gate IC 7404, having 6 Not gate

Inverter or Symbol -
Gate

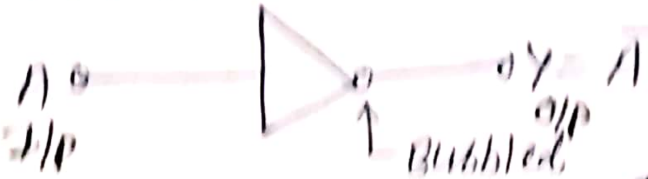


Fig.: Symbol for a NOT gate

Truth table -

Complement of the I/P

Input A	O/P $Y = \bar{A}$
0	1
1	0

* Universal gates :- (NAND & NOR Gates) :-

The NAND Gate :-

Symbol —

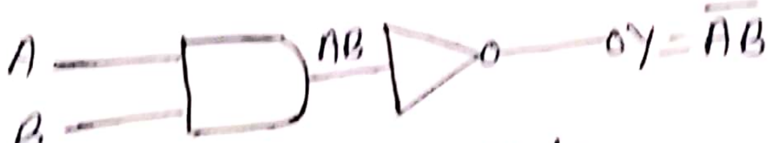
* The O/P is the Complement of the Product of I/Ps

Symbol of NAND Gate

Truth Table

I/Ps A	B	O/P $Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

OR



AND Gate + Not Gate

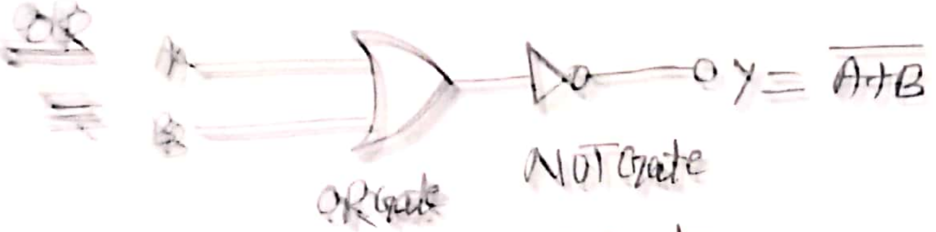
Contraction of ~~AND +~~ AND + NOT gate, Mini 2 I/P and one O/P. The logic is that O/P is high, when any I/P is low and O/P is low when all I/P's are High

The NOR GATE :- [NOT + OR Gate]

* It has two or more I/Ps but only one O/P (Combination)

* The O/P is the Complement of the sum of the I/Ps.

Symbol —



Truth Table :- of NOR Gate

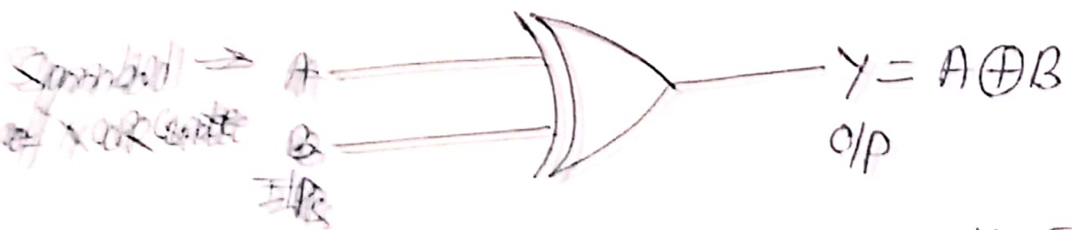
Inputs		$A+B$	$Y = \overline{A+B}$
A	B		
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

iii> Special Gates :- Example i> EX-OR Gate ii> EX-NOR Gate

i> EX-OR Gate OR Exclusive-OR Gate OR X-OR Gate :->

* It has two or more Inputs and only one O/P

$$\boxed{Y = A \oplus B = A\overline{B} + \overline{A}B}$$



Truth Table :-

Inputs		O/P $Y = A \oplus B$
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

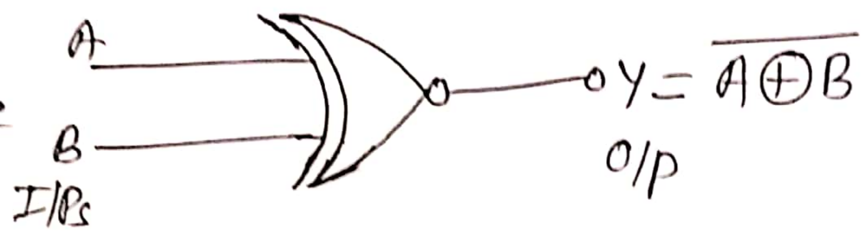
* If any one of the I/Ps is low, then the O/P is High

* It can be used in Half adder. Full adder & Subtractor circuits

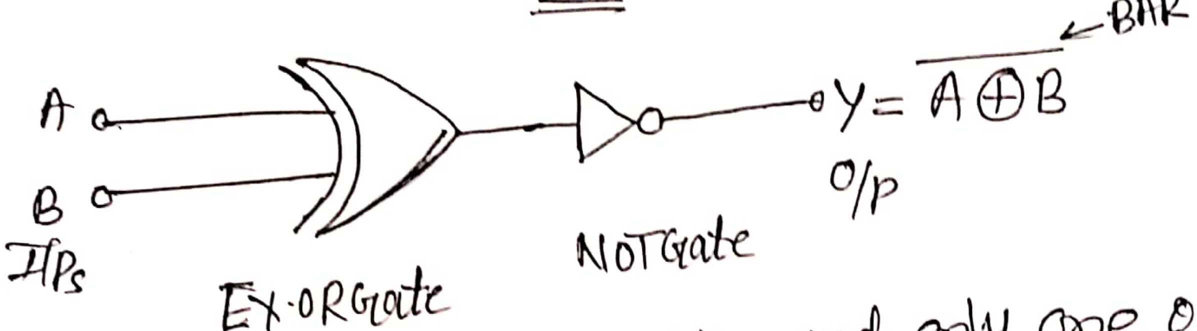
ii> **Exclusive NOR Gate OR EX-NOR OR XNOR Gate :-**

→ Combination of EX-OR Gate + NOT Gate

Symbol :- of X NOR Gate



OR



* It has two or more I/Ps and only one O/P

* The O/P is the complement of the XOR Gate

$$\boxed{Y = \overline{A \oplus B} = AB + \bar{A}\bar{B}} \quad \text{OR} \quad \boxed{Y = \cancel{A \oplus B}\, A \odot B}$$

Truth Table :-

Inputs		XOR	X NOR
A	B	$A \oplus B$	$Y = \overline{A \oplus B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Binary Arithmetic :→ There are many types as

i) Binary Addition
ii) Binary Subtraction
iii) Binary multiplication
iv) Binary Division

i) Binary Addition :-

Rules:-

$0+0=0$
$0+1=1$
$1+0=1$
$1+1=10$ [carry=1]

carry ↑ ↑ sum

Problem(1):- 100101 + 100101,

Ans.

$$
\begin{array}{r}
1\ \ 1 \\
100101 \\
+\ 100101 \\
\hline
1001010
\end{array}
$$

Ans.

Decimal

$$
\begin{array}{r}
1111 \\
1010 \\
\hline
11001
\end{array}
\qquad
\begin{array}{r}
15 \\
10 \\
\hline
25
\end{array}
$$

Problem(2):- 1011.01 + 1001.11

Ans.

$$
\begin{array}{r}
1\ 11\ \ 1 \leftarrow \text{carry} \\
1011.01 \\
1001.11\ (+) \\
\hline
10101.00
\end{array}
$$

Ans.

$(\because 1+1=10)$

$1+1=10$ $(\because 1+1+1=11)$

$$
\begin{array}{r}
10 \\
1+ \\
\hline
11
\end{array}
$$

ii) Binary subtraction :- Binary subtraction can be perform using the following Rules-
Rules :-

0 - 0 = 0

1 - 0 = 1

0 - 1 = 10-1 = 1, Borrow = 1 (Imp)

Difference = 1

1 - 1 = 0

Problem 1 :-

```
  1001
- 0100
------
```

Problem 2 :-

```
  110.01
  100.10
--------
  001.11
```

Problem 3 :- 11.01111

iii) Binary multiplication :-

Rules :-

0 X 0 = 0

0 X 1 = 0

1 X 0 = 0

1 X 1 = 1 (Imp)

100101 X 1001

100101

Problem 4) 10X11

```
  10X11
 ------
    10
   10
 ------
   110
```

1.01 X 10.1

```
    101
    101 X
  -------
    101
   000
  101
```

⇒ 11.001 Ans

iv) Binary Division ÷—

Rules :—

$0 \div 0 =$ No meaning

$0 \div 1 = 0$ ✓

$1 \div 0 = \infty$ [No meaning]

$1 \div 1 = 1$ ✓

Problem 1) $11001 \div 101$

```
        101
101 ) 11001
     -101
     -----
      00101
     -  101
     ------
          0
```

$\Rightarrow$ 101 Ans.

Binary Codes :— It is a way of representing letters, characters, and numbers using group of '1' and '0'. The Binary system of representation is the most extensively used one in digital systems i.e, digital data is represented, stored and processed as group of binary digits (bits). Hence the numerals, alphabets, special characters and control functions are to be converted into binary format. The process of conversion into binary format is known as binary coding.