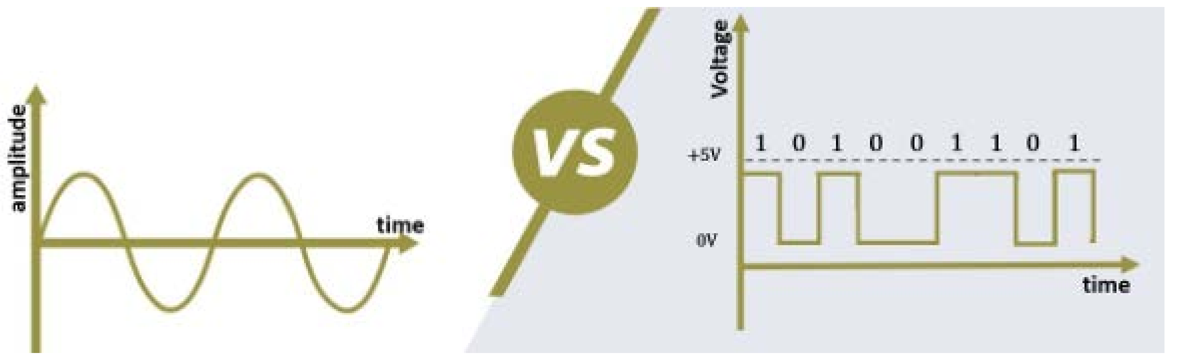
Analog and Digital signals

Analog and digital signals are the types of signals carrying information. The major difference between both signals is that the analog signals have continuous electrical signals, while digital signals have non-continuous electrical signals.

Analog signals were used in many systems to produce signals to carry information. These signals are continuous in both values and time. A human voice, analog phones, and thermometer are some of the examples of analog signals.



Unlike analog signals, digital signals are not continuous, but signals are discrete in value and time. These signals are represented by binary numbers and consist of different voltage values. Digital signals do not produce noise. Digital computers and digital phones are some of the examples of digital signals. **Long-distance transmission:** Because digital signals can be sent over greater distances without considerable signal deterioration, they are ideal for long-distance communication.

Difference between Analog and Digital Signals	
Analog Signals	**Digital Signals**
Continuous signals	Discrete signals
Represented by sine waves	Represented by square waves
Human voice, natural sound, analog electronic devices are a few examples	Computers, optical drives, and other electronic devices
Continuous range of values	Discontinuous values
Records sound waves as they are	Converts into a binary waveform
Only used in analog devices	Suited for digital electronics like computers, mobiles and more

Digital Circuits

Digital Signals

A Digital Signal is a type of Signal that has two discrete levels, either HIGH (1) or LOW (0). These two levels are usually represented by-

LOGIC 1 = HIGH = TRUE = ON = YES

LOGIC 0 = LOW = FALSE = OFF = NO

The concept of the Binary number system is the accurate representation of Digital Signals. Digital Signals work on the principles of Boolean Algebra, binary mathematics developed by George Boolean.

Digital Circuits

Digital Signals operate at high speeds and drive Digital Circuits that contain some basic components such as Diodes, Inductors, Capacitors, Resistors, Batteries, and Logic Gates.

There are many Logic families that follow the principle of Digital Signals. Examples of such Logic families consider 3.5V to 5V voltage as high logic and 0V to 1V as low logic. This means voltage lying anywhere between 3.5V to 5V would be represented by 1 and voltage lying anywhere between 0V to 1V would be represented by 0. The actual value of voltage is not important in digital signals.

Digital Circuits

Representation for a range of voltages as 1 or 0, makes digital circuit operation simpler than analog circuits. Operating only in two states, either high or low, makes these signals fast, and less susceptible to noise, temperature, and irrespective of the aging components.

As compared to analog systems, Digital circuits follow the concepts of electrical network analysis and have a “memory”.

There are **two types of Digital Circuits**: Combinational Digital circuits and Sequential Digital Circuits.

Combinational Digital Circuits are the type of digital circuits in which output depends upon inputs at that present time.

Sequential Digital Circuits are time-dependent digital circuits in which the outputs depend upon past states as they have memory units.

Binary Number System

In the Binary Number System, we have two states “0” and “1” and these two states are represented by two states of a transistor. If the current passes through the transistor then the computer reads “1” and if the current is absent from the transistor then it read “0”. Thus, alternating the current the computer reads the binary number system. Each digit in the binary number system is called a “bit”.

Binary Number System

Binary Number System is the number system in which we use two digits “0” and “1” to perform all the necessary operations. In the Binary Number System, we have a base of 2. The base of the Binary Number System is also called the radix of the number system.

In a binary number system, we represent the number as,

- $(11001)_2$

In the above example, a binary number is given in which the base is 2. In a binary number system, each digit is called the “bit”. In the above example, there are 5 digits.

Decimal Number	Binary Number	Decimal Number	Binary Number
1	001	11	1011
2	010	12	1100
3	011	13	1101
4	100	14	1110
5	101	15	1111
6	110	16	10000
7	111	17	10001
8	1000	18	10010
9	1001	19	10011
10	1010	20	10100

Binary to Decimal Conversion

A binary number is converted into a decimal number by multiplying each digit of the binary number by the power of either 1 or 0 to the corresponding power of 2. Let us consider that a binary number has n digits, B = $a_{n-1}...a_3a_2a_1a_0$. Now, the corresponding decimal number is given as

$$D = (a_{n-1} \times 2^{n-1}) + \ldots + (a_3 \times 2^3) + (a_2 \times 2^2) + (a_1 \times 2^1) + (a_0 \times 2^0)$$

Example: Convert $(10011)_2$ to a decimal number.

Solution:

The given binary number is $(10011)_2$.

$$\mathbf{(10011)_2 = (1 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 16 + 0 + 0 + 2 + 1 = (19)_{10}}$$

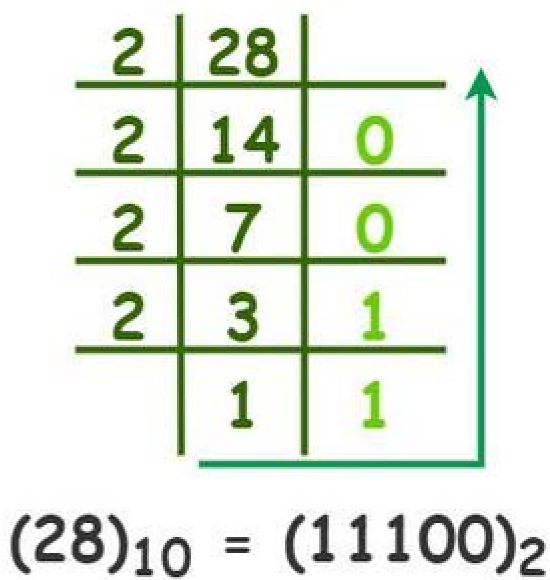
Hence, the binary number $(10011)_2$ is expressed as $(19)_{10}$.

Decimal to Binary Conversion

A decimal number is converted into a binary number by dividing the given decimal number by 2 continuously until we get the quotient as 1, and we write the numbers from downwards to upwards.

Example: Convert $(28)_{10}$ into a binary number.

Solution:



Hence, $(28)_{10}$ is expressed as $(11100)_2$.