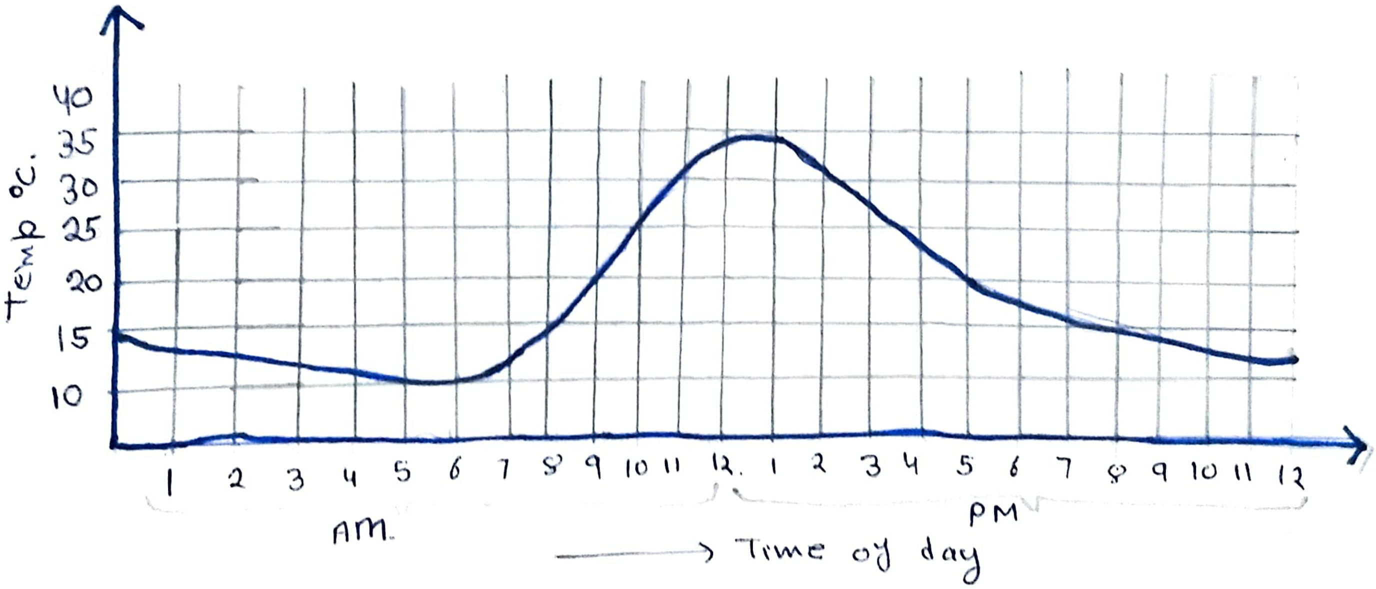
Analog and Digital Signals.

~~Ans~~ Electronic circuits can be divided into two broad categories, digital and analog. Digital electronics involves quantities with discrete values, and analog quantities involves quantities with continous values.

An anlog quantity is one which has continous values. A digital quantity is one having a discrete set of values. Example of analog quantities are temperature, ~~time~~. voltage. pressure, velocity, distance, sound, speed and ~~time~~. Switch is an example of digital quantity.

Graph of analog quantity (temperature) with time during day and night time. is shown below in figure 1



It is a smooth curve. Air temperature changes over a continous range of values. During ~~d~~ day, the temperature does not go from 15° to 20°C instantaneously, it takes on all the infinite values in between.

Rather than graphing the temperature on a continous basis, suppose you take temperature reading every hour. The variation of temperature so obtained is shown in figure 2.

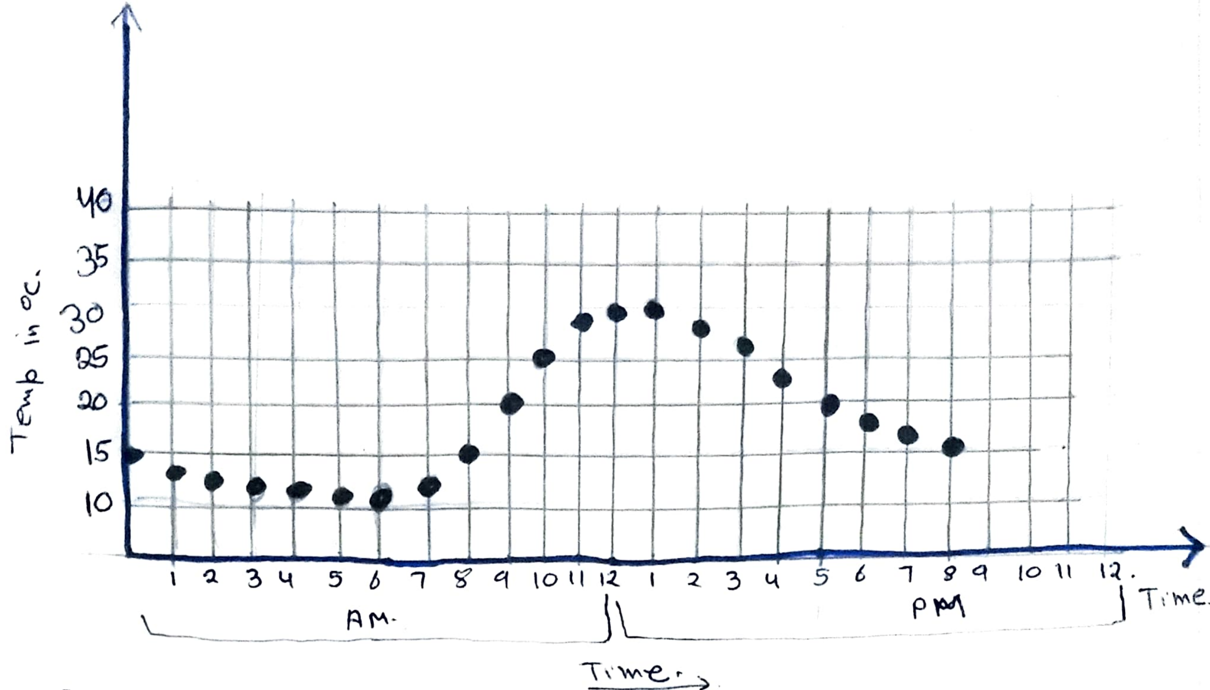


Fig 2. quantization of analog quantity.

we can now say that an analog quantity is converted to a form that can now be digitized by representing each value by a digital code (consists of a series of 0's and 1's). So we can that figure 2 itself is not the digital representation of analog quantity.

~~Ad...~~ Digital electronics involves circuits in which there are only two possible states. These states are represented by two different voltage levels. A High and a low. These states can ~~be~~ also be reprented by voltage level, bits and bumps on a DVD or CD etc. In digital system such as computers combination of those two states are called codes, and codes are used to represents numbers symbols, alphabetic characters and other types of information. The two state number is called binary and its two digits are 0 and 1.

Advatages of Digital system: over Analog ~~sign~~ system.

1. Digital systems are easier to design, because circuits used in digital systems are switching circuits, where exact values of voltage or current are not imporatand, only the range (High or low) in which they fall

2. Information storage is easy.
3. Digital data can be processed and transmitted more efficiently and reliably than analog data.
4. Digital circuits are less affected by noise.

Mechatronics: Both digital and analog electronics are used in the control of various mechanical system. The interdisciplinary field that comprises both mechanical and electronic components are called mechatronics. These systems are ~~found~~ in used in homes, industry and transportation.

Example- washing machine.
Electronics controls the operation of washing machine in terms of water flow, temperature and time of operation.

Analog	Digital.
1. Values of quantities are in continous form.	Numerical values are in steps (discrete).
2. can have any of the infinite theoretically possible values between two extremes. example: In between 2.2 & 2.3 we can have an infinite values 2.22, 2.221, 2.2231, ------	Digital representation produce a discrete output. 0 and 1. Low and High. True and false.
3. To anlyse, we have to use KVL/KCL, node method superposition, Thevenin, Norton's theorem.	Value discretization, High 5V 1, Low. 0V. 0. Boolean Laws.

Why discretization is important?

Consider an example of value discretization shown in Fig 3, where a voltage signal is discretized into two levels.

In this example, an observed voltage value between 0 Volt and 2.5 Volt is treated as a "0" and a value between 2.5 Volts and 5 volts as a "1".

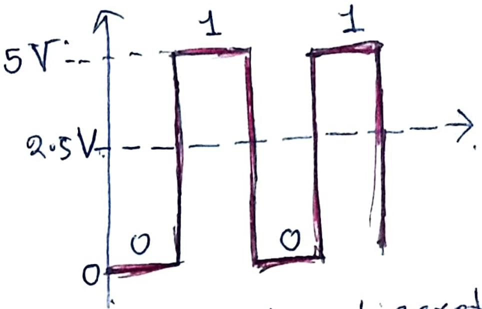


Fig (3). Value discretization into two levels.

Correspondingly, to transmit the logical value "0" over a wire, we place the nominal ~~value~~ voltage of 2.0V on the wire. Similarly to transmit the logical level "1" we place the nominal voltage level of 3.75 volts on the wire. The digital discrete signal shown in Fig. 3 comprises the sequence of values "0", "1", '0', '1'

Although the digital approach seems wasteful of signal dynamic range, it has a significant advantage over analog transmission in the presence of noise. This representation is immune to symmetric noise with a peak to peak value less than 2.5 V.

To illustrate, consider the situation depicted in figure 4, in which a ~~son~~ you want to transmit a value 'A' to a receiver. This figure illustrates both an analog case and a digital case.

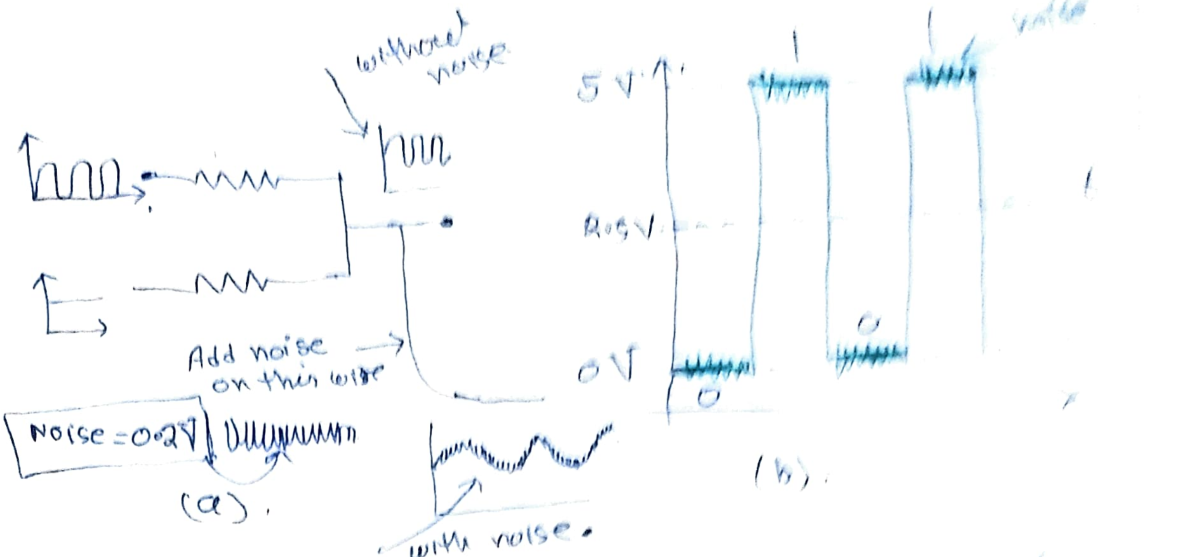


Fig (4) Effect of noise in (a) analog signal and (b) digital signal.

In the analog case, let us suppose that the value A is 2.0 V. The sender transmits A by representing it as a voltage level of 2.0 V on a wire. Noise during the ~~transmitt~~ transmission (represented as 0.2 V noise voltage source in the figure) changes this voltage to ~~2.0 ± 0.2~~ 2.0 ± 0.2 V at the receiver, resulting in hampering our ability to distinguish between small differences in the value eg between 2.2 V and 1.8 V. (Fig 4(a))

In digital case, suppose that the value A is a logical 0. The sender transmits this value of A by representing it as a voltage level of 1.25 V on the wire, which is received as a voltage level of 1.45 by the receiver because of noise source. This value 0 falls below the 2.5 V threshold, the receiver interprets it correctly as a logical level 0. Thus the sender and receiver were able to communicate without errors in digital case.

To illustrate further, consider the wave forms in fig 4(b). This shows the same signal with the superposition of some amount of noise possibly during transmission through a noisy environment. The receiver will be able to receive the sequence correctly provided noise in the signal are small enough that the voltage ~~for~~ for a logical '0' signal do not exceed 2.5 V and the voltage for a logical 1 signal do not fall below 2.5 V.