



[Document subtitle]

ANALOG COMMUNICATION

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About the Tutorial

The communication based on analog signals and analog values is known as Analog Communication.

This tutorial provides knowledge on the various modulation techniques that are useful in Analog Communication systems. By the completion of this tutorial, the reader will be able to understand the conceptual details involved in analog communication.

Audience

This tutorial is prepared for beginners who are interested in the basics of analog communication and who aspire to acquire knowledge regarding analog communication systems.

Prerequisites

A basic idea regarding the initial concepts of communication is enough to go through this tutorial. It will definitely help if you use our tutorial Signals and Systems as a reference. A basic knowledge of the terms involved in Electronics and Communications would be an added advantage.

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1. Analog Communication – Introduction

The word communication arises from the Latin word *commūnicāre*, which means “to share”. Communication is the basic step for exchange of information.

For example, a baby in a cradle, communicates with a cry when she needs her mother. A cow moos loudly when it is in danger. A person communicates with the help of a language. Communication is the bridge to share.

Communication can be defined as the process of exchange of information through means such as words, actions, signs, etc., between two or more individuals.

Parts of a Communication System

Any system, which provides communication consists of the three important and basic parts as shown in the following figure.



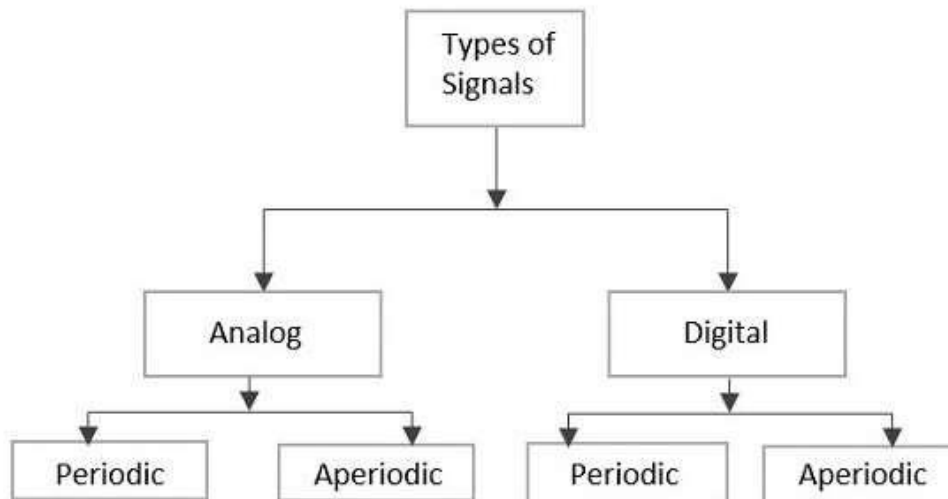
- **Sender** is the person who sends a message. It could be a transmitting station from where the signal is transmitted.
- **Channel** is the medium through which the message signals travel to reach the destination.
- **Receiver** is the person who receives the message. It could be a receiving station where the transmitted signal is being received.

Types of Signals

Conveying an information by some means such as gestures, sounds, actions, etc., can be termed as **signaling**. Hence, a signal can be a source of energy which transmits some information. This signal helps to establish a communication between the sender and the receiver.

An electrical impulse or an electromagnetic wave which travels a distance to convey a message, can be termed as a **signal** in communication systems.

Depending on their characteristics, signals are mainly classified into two types: Analog and Digital. Analog and Digital signals are further classified, as shown in the following figure.



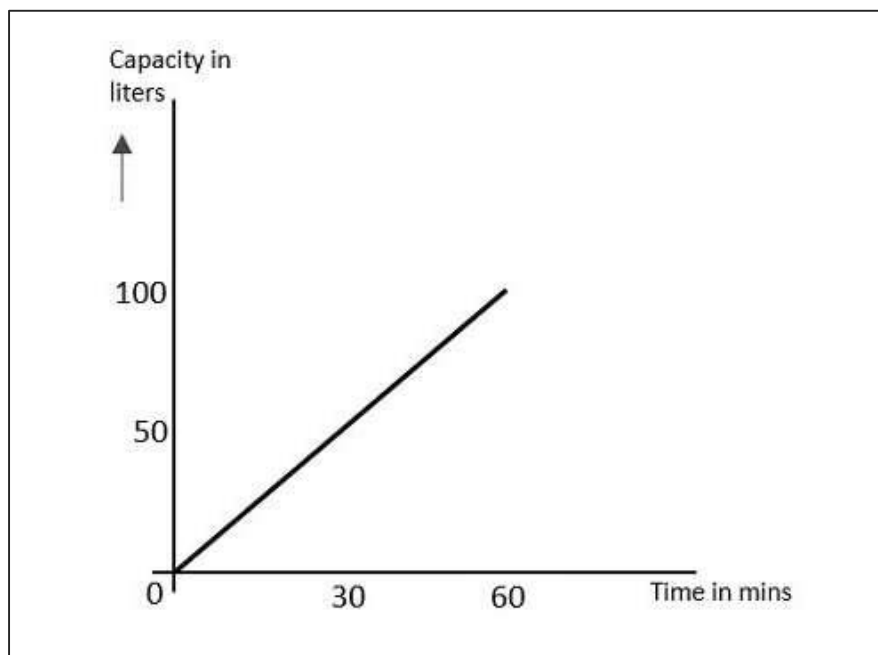
Analog Signal

A continuous time varying signal, which represents a time varying quantity can be termed as an **Analog Signal**. This signal keeps on varying with respect to time, according to the instantaneous values of the quantity, which represents it.

Example

Let us consider a tap that fills a tank of 100 liters capacity in an hour (6 AM to 7 AM). The portion of filling the tank is varied by the varying time. Which means, after 15 minutes (6:15 AM) the quarter portion of the tank gets filled, whereas at 6:45 AM, $\frac{3}{4}$ th of the tank is filled.

If we try to plot the varying portions of water in the tank according to the varying time, it would look like the following figure.



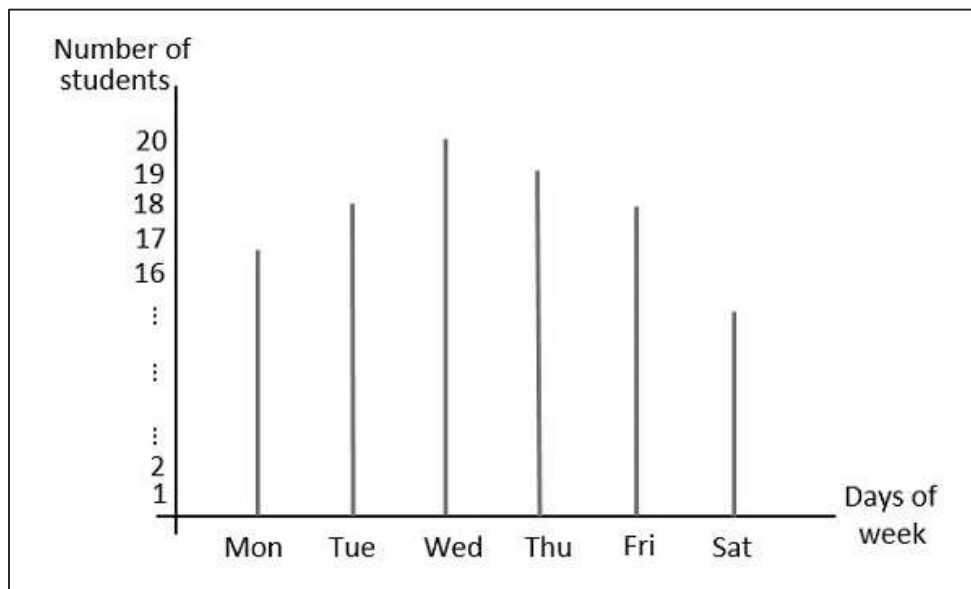
As the result shown in this image varies (increases) according to time, this **time varying quantity** can be understood as Analog quantity. The signal which represents this condition with an inclined line in the figure, is an **Analog Signal**. The communication based on analog signals and analog values is called as **Analog Communication**.

Digital Signal

A signal which is discrete in nature or which is non-continuous in form can be termed as a **Digital signal**. This signal has individual values, denoted separately, which are not based on the previous values, as if they are derived at that particular instant of time.

Example

Let us consider a classroom having 20 students. If their attendance in a week is plotted, it would look like the following figure.



In this figure, the values are stated separately. For instance, the attendance of the class on Wednesday is 20 whereas on Saturday is 15. These values can be considered individually and separately or discretely, hence they are called as **discrete values**.

The binary digits which has only 1s and 0s are mostly termed as **digital values**. Hence, the signals which represent 1s and 0s are also called as **digital signals**. The communication based on digital signals and digital values is called as **Digital Communication**.

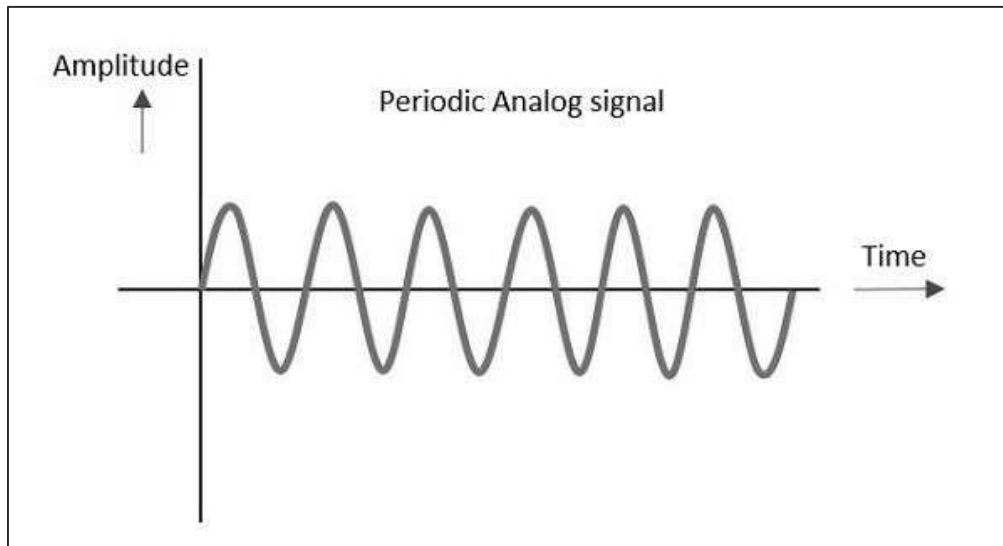
Periodic Signal

Any analog or digital signal, that repeats its pattern over a period of time, is called as a **Periodic Signal**. This signal has its pattern continued repeatedly and is easy to be assumed or to be calculated.

Example

If we consider a machinery in an industry, the process that takes place one after the other is a continuous procedure. For example, procuring and grading the raw material, processing the material in batches, packing a load of products one after the other, etc., follows a certain procedure repeatedly.

Such a process whether considered analog or digital, can be graphically represented as follows.



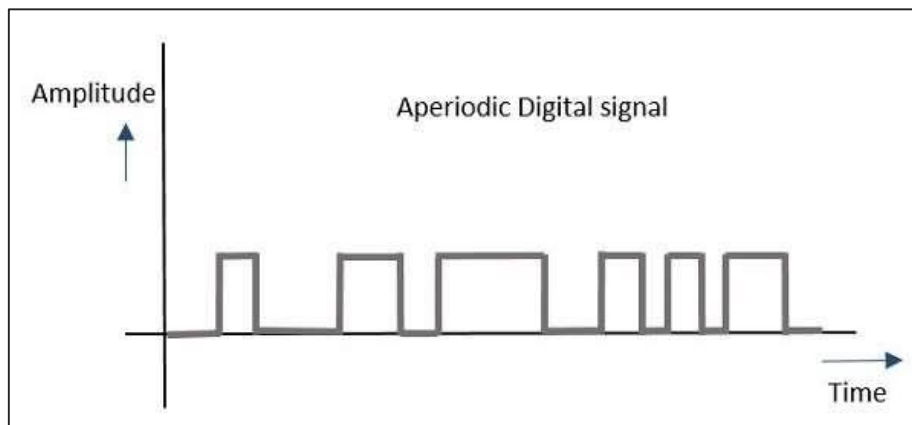
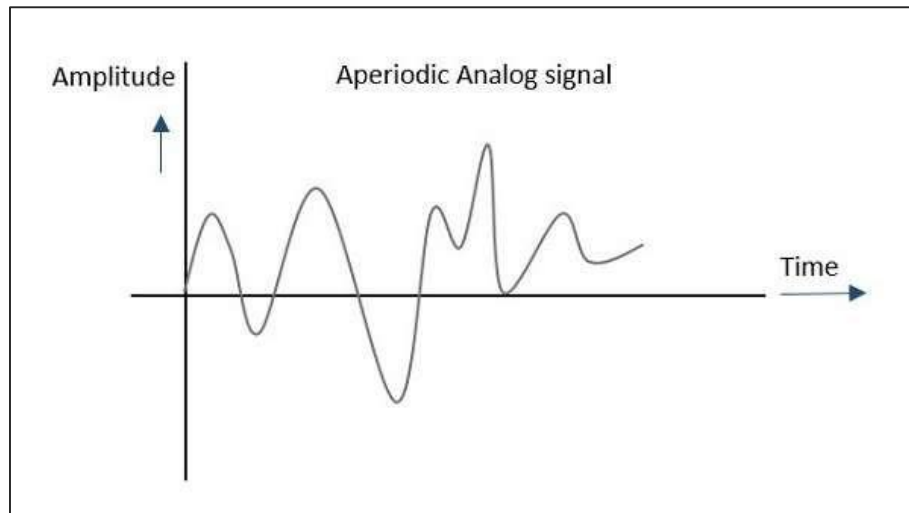
Aperiodic Signal

Any analog or digital signal, that doesn't repeat its pattern over a period of time is called as **Aperiodic Signal**. This signal has its pattern continued but the pattern is not repeated. It is also not so easy to be assumed or to be calculated.

Example

The daily routine of a person, if considered, consists of various types of work which take different time intervals for different tasks. The time interval or the work doesn't continuously repeat. For example, a person will not continuously brush his teeth from morning to night, that too with the same time period.

Such a process whether considered analog or digital, can be graphically represented as follows.



In general, the signals which are used in communication systems are analog in nature, which are transmitted in analog or converted to digital and then transmitted, depending upon the requirement.

2. Analog Communication–Modulation

For a signal to be transmitted to a distance, without the effect of any external interferences or noise addition and without getting faded away, it has to undergo a process called as **Modulation**. It improves the strength of the signal without disturbing the parameters of the original signal.

What is Modulation?

A message carrying a signal has to get transmitted over a distance and for it to establish a reliable communication, it needs to take the help of a high frequency signal which should not affect the original characteristics of the message signal.

The characteristics of the message signal, if changed, the message contained in it also alters. Hence, it is a must to take care of the message signal. A high frequency signal can travel up to a longer distance, without getting affected by external disturbances. We take the help of such high frequency signal which is called as a **carrier signal** to transmit our message signal. Such a process is simply called as Modulation.

Modulation is the process of changing the parameters of the carrier signal, in accordance with the instantaneous values of the modulating signal.

Need for Modulation

Baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn't affect the parameters of the modulating signal.

Advantages of Modulation

The antenna used for transmission, had to be very large, if modulation was not introduced. The range of communication gets limited as the wave cannot travel a distance without getting distorted.

Following are some of the advantages for implementing modulation in the communication systems.

- Reduction of antenna size
- No signal mixing
- Increased communication range
- Multiplexing of signals
- Possibility of bandwidth adjustments
- Improved reception quality

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