

1. Details of Module and its structure

Module Detail	
Subject Name	Physics
Course Name	Physics 04 (Physics Part-2, Class XII)
Module Name/Title	Unit-10, Module-01:Introduction to electronic communication Chapter-15: Communication System
Module Id	leph_201501_eContent
Pre-requisites	Basic knowledge of electronic communication
Objectives	<p>After going through this module the learner will be able to</p> <ul style="list-style-type: none"> • Become aware of history of communication systems • Understand special vocabulary used for modern communication system • Know the three essential elements of communication are transmitter, channel and receiver
Keywords	History of communication, signals, bandwidth of signal, bandwidth of transmission medium, transducer, transmitter, receiver, noise, modulation, Repeater Antenna

2. Development Team

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1. UNIT SYLLABUS

Unit 10: Communication Systems

Chapter 15: Communication System

Elements of a communication system (block diagram) bandwidth of signals speech, TV and digital data) bandwidth of transmission medium, propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, satellite communication, need for modulation, types of modulation, amplitude modulation, production of amplitude modulated wave, detection of amplitude modulated wave, Internet and mobile phones

2. MODULE WISE DISTRIBUTION OF UNIT SYLLABUS 6 MODULES

Module 1	<ul style="list-style-type: none"> • History of communication • Special vocabulary • Signals and bandwidth
Module 2	<ul style="list-style-type: none"> • Propagation of electromagnetic wave • Ground wave • Sky wave

	<ul style="list-style-type: none"> • Space wave • Satellite communication
Module 3	<ul style="list-style-type: none"> • Modulation • Need for modulation • Types of modulation • Amplitude modulation AM • Frequency modulation FM • Meaning of tuner frequencies 98.3FM
Module 4	<ul style="list-style-type: none"> • Amplitude modulation • Modulation index • Production of amplitude modulated wave • Detection of amplitude modulated wave • Applications of amplitude modulation
Module 5	<ul style="list-style-type: none"> • Short range communications • Increasing the area of influence using antenna • Use in factories, villages, towns for police work • Internet • Internet servers
Module 6	<ul style="list-style-type: none"> • Mobile phones • Mobile towers • 3G, 4G, 5G • Mobile companies, what do they do?

MODULE 1

3. WORDS YOU SHOULD KNOW

Communication- the process of putting across ideas through words and pictures

Audio communication- communication by means of speech/sound or messages that can be received by our ears

Video communication - communication by means of pictures, still or moving or messages that can be received by our eyes

Audio video communication - communication by means of speech/sound or messages that can be received by our ears

Device- an apparatus designed for special functions

Mode of transfer of information- method of transfer of information

Antenna- a metal device designed to send out and receive electromagnetic waves.

Electromagnetic waves- The range of electromagnetic signals encompassing all frequencies is referred to as the electromagnetic spectrum

4. Introduction

Every living creature in the world experiences the need to impart or receive information almost continuously with others in the surrounding world. The practice of sending and receiving information influences our lives daily in multiple ways. Man has made constant efforts to improve the quality of communication with other human beings. Languages and methods used in communication have kept evolving from pigeon in prehistoric time to internet and mobile phones in modern times to meet the growing demand in terms of speed and complexity of information



Communication as we understand is the process of exchanging information. The main barriers are language and distance. Contemporary society's emphasis is now the accumulation, packaging, and exchange of information



<https://www.maxpixel.net/Mobile-Phone-Tower-Antenna-Send-Telecommunications-775945>

There are many ways in which we reach out to one another, Mobile phones, internet; social media via wireless etc. are some of the newest ways in which we interact with one another these days. Human effort is to make the communication faster more accurate and less expensive.

What we will study is a simple picture of communication system, without going into details of how exactly it is achieved.

The aim of this unit is to introduce the concepts of communication, namely

- **The mode of communication,**
- **The need for modulation,**
- **Methods of production of amplitude modulation**
- **Methods of detection of amplitude modulation.**

5. HISTORY OF COMMUNICATION

From the beginning of life there is evidence to believe that communication between members of a species developed. Humans, animals, birds and insects every living creature communicates with those around its existence. There have been different methods of communication direct face to face, or indirect by messengers.

Communication is the act of transmission of information.

Every living creature in the world experiences the need to impart or receive information almost continuously with others in the surrounding world.

For communication to be successful, it is essential that the sender and the receiver understand a common language.

Think about a person with different abilities not able to see, not able to hear or speak the method of communication would be very different

Man has constantly made endeavours to improve the quality of communication with other human beings. Languages and methods used in communication have kept evolving from prehistoric to modern times, to meet the growing demands in terms of speed and complexity of information.

It would be worthwhile to look at the major milestones in events that promoted developments in communications

Modern communication has its roots in 19th and 20th century in the work of scientists like J.C Bose, F.B Morse, G. Marconi and Alexander Graham Bell.

The pace of development seems to have increased dramatically after the first half of the 20th century.

We can hope to see many more accomplishments in the coming decades.

Some major milestones in events that promoted developments in communications are listed in the following table:



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<https://www.infotechnology.com/gadgets/Cuantas-horas-hay-que-trabajar-en-la-Macri-Economia-para-tener-un-iPhone-20180726-0001.html>



<https://pixabay.com/en/social-media-world-communication-1405601/>

SOME MAJOR MILESTONES IN THE HISTORY OF COMMUNICATION

Time	Event	Remarks
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Around 1565 A.D.	The reporting of the delivery of a child by queen using drum beats from a distant place to King Akbar.	It is believed that minister Birbal experimented with the arrangement to decide the number of drummers posted between the place where the queen stayed and the place where the king stayed.
1835	Invention of telegraph by Samuel F.B. Morse and Sir Charles Wheatstone	It resulted in tremendous growth of messages through post offices and reduced physical travel of messengers considerably.
1876	Telephone invented by Alexander Graham Bell and Antonio Meucci	Perhaps the most widely used means of communication in the history of mankind.
1895	Jagadis Chandra Bose and Guglielmo Marconi demonstrated wireless telegraphy.	It meant a giant leap - from an era of communication using wires to communicating without using wires. (wireless)
1936	Television broadcast(John Logi Baird)	First television broadcast by BBC
1955	First radio FAX transmitted across continent.(Alexander Bain)	The idea of FAX transmission was patented by Alexander Bain in 1843.
1968	ARPANET- the first internet came into existence(J.C.R. Licklider)	ARPANET was a project undertaken by the U.S. defence department. It allowed file transfer from one computer to another connected to the network.
1975	Fiber optics developed at Bell Laboratories	Fiber optical systems are superior and more economical compared to traditional communication systems.
1989-91	Tim Berners-Lee invented the World Wide Web.	WWW may be regarded as the mammoth encyclopedia of knowledge accessible to everyone round the clock throughout the year.

6. TERMS USED IN COMMUNICATION (COMMUNICATION VOCABULARY)

Communication means transfer of information from one place to another place.

We all are quite used to communication devices like TV, radio or cell phones. How do these devices work? How do we watch a live football, cricket match on our TV set, which is being played thousands of kilometers away?

How can you talk to your friend on your cell phone, which has gone on vacations abroad?

How do you communicate to people on Facebook or WhatsApp through internet?

You will get an idea of how they work, without knowing the exact mechanics of the operating devices. Today, with the advancement of technology, video phones, voice mail and satellite communication we are used to live streaming and we are able to communicate directly with people located at far off places. Digital data transmission and retrieval has made it possible to realize email internet.

Present day communication systems are electrical, electronic or optical in nature.

First of all, we understand the terms used in communication:

COMMUNICATION the transmission and retrieval of information from one point to any distant location-

COMMUNICATION SYSTEM the setup used to achieve the goal of communication

TRANSDUCER: These are the devices which converts one form of energy into another form of energy. Any device that converts one form of energy into another can be termed as a transducer. In electronic communication systems, we usually come across devices that have either their inputs or outputs in the electrical form. An electrical transducer may be defined as a device that converts some physical variable (pressure, displacement, force, temperature, etc.) into corresponding variations in the electrical signal at its output.

For example, a microphone converts sound energy into electrical energy. On the other hand a loudspeaker converts electrical energy into sound energy. This is how you enjoy a live concert in a hall.

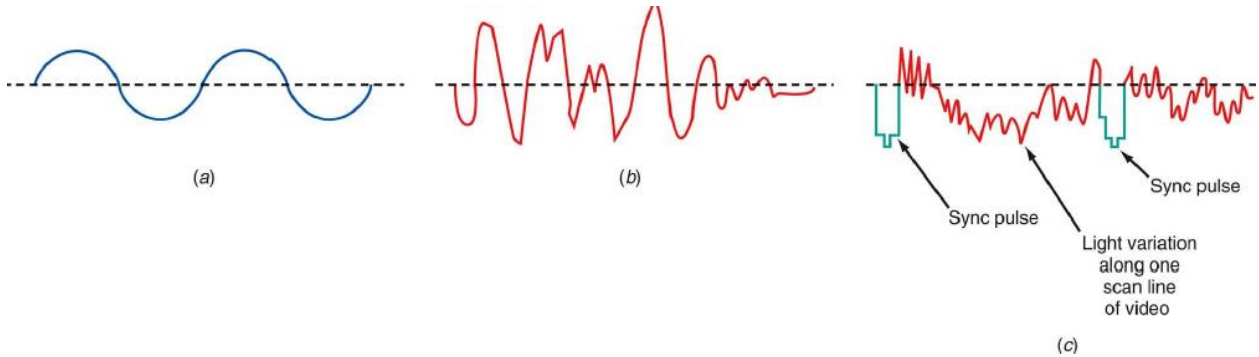
SIGNAL: It is the information, modified into a form suitable for transmission. Consider an example of on line shopping, suppose you placed an order of a shirt to an online shopping company. Can the company send the shirt as it is, as was shown in their advertisement? No, the shirt will undergo few processes like ironing, folding, packaging and putting address on the packet. This packet bearing your address is the required signal which is sent (transmitted) to you through the courier boy. **Information converted in electrical form and suitable for transmission is called a signal.**

Signals can be either **analog or digital**.

Analog signals are continuous variations of voltage or current. They are essentially single-valued functions of time. Sine wave is a fundamental analog signal.

All other analog signals can be fully understood in terms of their sine wave components.

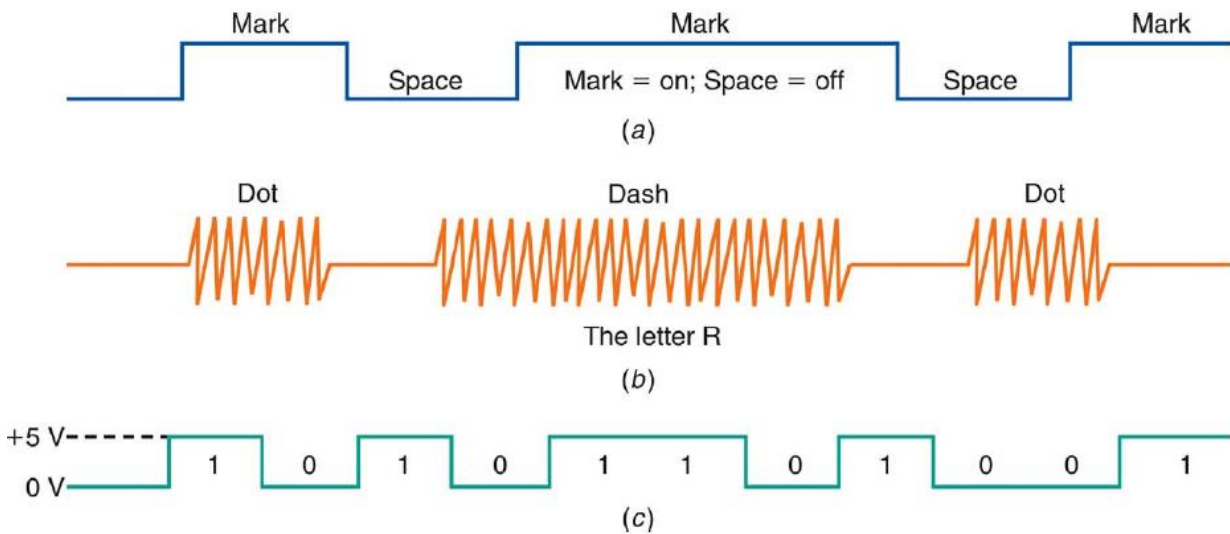
Sound and picture signals in TV are analog in nature.



Analog signals (a) Sine wave “tone.” (b) Voice. (c) Video (TV) signal.

Digital signals are those which can take only discrete stepwise values.

Binary system that is extensively used in digital electronics employs just two levels of a signal. ‘0’ corresponds to a low level and ‘1’ corresponds to a high level of voltage/current.



Digital signals (a) Telegraph (Morse code). (b) Continuous-wave (CW) code. (c) Serial binary code

There are several coding schemes useful for digital communication. They employ suitable combinations of number systems such as the binary coded decimal (BCD)*. American Standard Code for Information Interchange (ASCII) is a universally popular digital code to represent numbers, letters and certain characters

Technically speaking, a signal is a wave, amplitude or frequency of which varies with time and the signal can be analog or digital.

NOISE: These are unwanted signals having same or similar frequency as that of required signal. They distort the transmission and receiving process. A virus in a computer is example of noise. A virus is an unwanted programme in the same language in which your required programme is, it disrupts your programme.

COMMUNICATION CHANNEL: The **communication channel** is the medium by which the electronic signal is sent from one place to another. Types of media include electrical conductors, Optical media, Free space, and System-specific media (e.g., water is the medium for sonar).

TRANSMITTER: It is the device that converts the information (message) into a form suitable for transmission. In above example the online shopping company is the transmitter.

RECEVIER: It is the device that retrieves the information from received signal. In shopping example, you are the receiver. A **receiver** is a collection of electronic components and circuits that accepts the transmitted message from the channel and converts it back into a form understandable by humans. Receivers contain **amplifiers, oscillators, mixers, tuned circuits** and **filters**, and a detector that recovers the original intelligence signal from the modulated carrier

TRANSCIEVERS

A **transceiver** is an electronic unit that incorporates circuits that both send and receive signals. Examples are: Telephones, Fax machines, Hand held, radios, Cell, mobile phones and computers.

AMPLIFICATION: It is the process of increasing the strength of signal. Amplification compensates for attenuation. Amplification is done by electronic circuit.

CARRIER WAVE the signal cannot be transmitted and carried over large distances. Electromagnetic waves (radio waves) of suitable frequency are used for the purpose. A **carrier** is a high frequency signal that is modulated by audio, video, or data. The combined radio-frequency (**RF**) **wave** is an electromagnetic signal that is able to travel long distances through space

The signal is made to ride over the carrier wave in suitable ways and transmitted from antenna in multiple directions.

FREQUENCY: It is defined as number of cycles per second or number of waves per second.

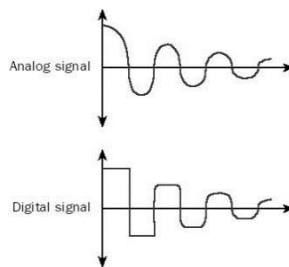
WAVELENGTH is the distance occupied by one cycle of a wave and is usually expressed in meters. Wavelength is also the distance traveled by an electromagnetic wave during the time of one cycle. The wavelength of a signal is represented by the Greek letter lambda (λ).

MODULATION: It is the process of superimposing a low frequency signal over a high frequency wave called carrier wave.

To understand it simply, consider a courier, who has to deliver your desired package? If he walks on his foot, then delivery might takes days or months, depending upon the distance. But if we board him (low freq.) on a train or bus (high freq.), then this boarding process is called modulation. And the train or bus is called carrier wave. You can guess well that modulation is done at transmitting end.

DEMODULATION: It is the process of extracting the information from received signal. It is the reverse process of modulation. Obviously demodulation is done at receiver end.

ATTENUATION: It refers to loss in strength of signal while propagating from transmitter to receiver. Signal **attenuation**, or degradation, exists in all media of wireless transmission. It is usually proportional to the square of the distance between the transmitter and receiver



RANGE: It is the maximum distance that a signal can travel with sufficient strength.

BAND WIDTH: It is the frequency range over which a system works. It is calculated as highest frequency – lowest frequency. For example, the human audio frequency range is 20 Hz to 20,000 Hz, so audio bandwidth = 20,000 - 20 = 19,980 Hz. **Bandwidth** is that portion of the electromagnetic spectrum occupied by a signal. **Channel bandwidth** refers to the range of frequencies required to transmit the desired information.

REPEATER: These are used to increase the range of communication system.

Suppose you are Suresh standing 500m away from your friend who wish to say Suresh come here. Obviously his voice can't reach such a far distance. But if we put 8 boys, each at a distance of 50m and each repeating Suresh come here, Suresh come here..... then you can receive the message. The boys in between you and your friend are called repeaters. Now observe carefully what processes each repeater is doing. First he is receiving the message,

then resending it to next (transmitting) with fresh voice (amplifying). So each repeater station is equipped with Receiver, Amplifier and Transmitter.

The mobile phone towers in your area are repeater stations.

COMMUNICATION SATELLITES are repeater stations in space. They receive signal from one ground station amplify it and transmit it to another ground station.

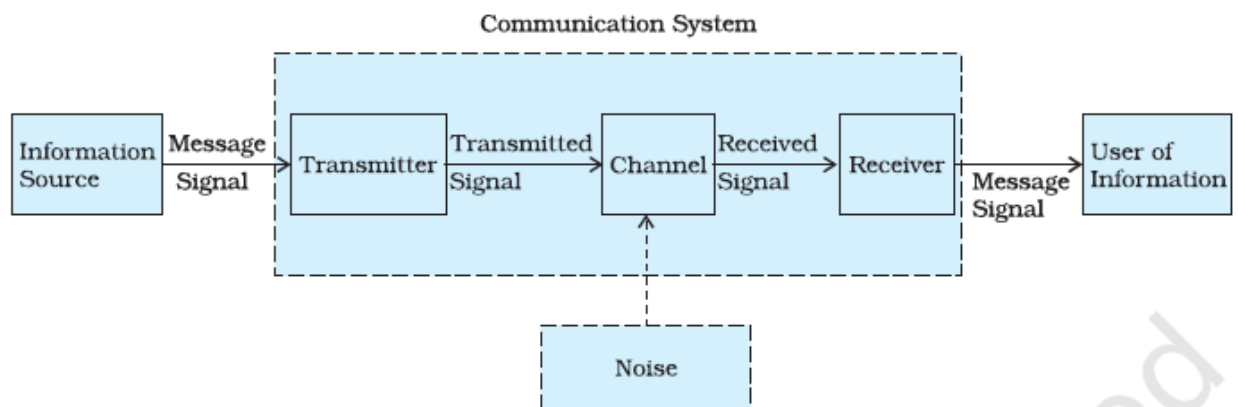
ANTENNA: It is the device through which transmission and receiving process are done. The dish connected to your TV set is an antenna in itself.

7. BASIC ELEMENTS OF A COMMUNICATION SYSTEM

Every communication system irrespective of its nature has **three basic elements**;

- **Transmitter,**
- **Channel or medium and**
- **Receiver**

BLOCK DIAGRAM OF COMMUNICATION SYSTEM



- i) **TRANSMITTER:** It is the device that makes information into a form suitable for transmission by modulation. In modulation the low frequency message signal (modulating signal) is superimposed over a high frequency wave (carrier wave). By superposition or modulation, a new wave is formed called modulated wave. This modulated wave is then transmitted through transmitting antenna. If information is of non-electrical nature, then we use transducer to convert it into electrical form.

- ii) **CHANNEL/ MEDIUM:** This is the path through which the transmitted signal (modulated wave) travels. Commonly used mediums are coaxial cables, free space and optical fiber.
- iii) **RECEIVER:** It is the device extracts information from received signal by demodulation process.

8. MODES OF COMMUNICATION: There are basically two modes of communication; *point to point* and *broadcast*.

- I. **POINT TO POINT COMMUNICATION:** This mode of communication has one transmitter and one receiver. Telephony is an example of this mode of communication.
- II. **BROADCAST:** In this mode of communication there is one transmitter and multiple receivers. TV radio is examples of this mode of communication. The public addressing system (PA system) used in your schools by the principal or the loud speaker system used during your assembly are also broadcast mode of communications.

9. BANDWIDTH OF SIGNALS

You all are mobile phone users, have you ever noticed that a small text message occupies smaller storage space while even a small picture occupies larger space? And if the contains some audio then it requires much larger storage space. We can consider storage space similar to bandwidth. Similar, not same. Recall that shirt packet, larger the size of packet, larger is the storage space (bandwidth).

In communication system also, we have different types of message signals like voice,, music, picture or computer data. Each of these signals has different range of frequencies. The type of communication system needed for a given signal depends on the band of frequencies which are essential for the communication process.

For example, the **human audio frequency range is 20Hz to 20,000Hz**. Means human ear can't hear below 20Hz and above 20,000Hz, so bandwidth = $20000 - 20 = 19,980\text{Hz}$.

For **speech signals**, frequency range 300Hz to 3100Hz is sufficient. Therefore speech signal requires a bandwidth of 2800Hz ($3100\text{Hz} - 300\text{Hz}$). This we use in commercial telephonic communication. This falls well under our audio range.

To **transmit music** a bandwidth of 20,000Hz is required because musical instruments can produce variable frequencies. You must have heard the very thin shrieking sound of guitar

string; it's a very high note (frequency). The irritating sound produced by mosquito also belongs to very high frequencies while roar of lion belongs to low frequencies.

To **transmit pictures**, we require a bandwidth of 4.2 MHz. you may wonder why picture require such a large bandwidth? It is because it has large frequencies otherwise picture will be formed slowly in pieces and you won't enjoy your favorite movie.

Video signals have both picture and sound, so they require a bandwidth of 6 MHz. This is the bandwidth you require for your TV set.

10. BAND WIDTHS OF TRANSMISSION MEDIUM

In above topic we discussed the bandwidths required by the various message signals. Now we will discuss the bandwidths offered by different transmission media. The commonly used **transmission media are coaxial cable, free space and optical fiber.**

Coaxial cable is most widely used in **wired system; like in offices** it offers a bandwidth of 750MHz. Have you seen a coaxial cable?

The wire connecting your dish to set top box is the coaxial cable.

The wires connecting set top box to TV are also coaxial cables.

The connecting wires of your desktop are also coaxial cables.

Communication through free space using **radio waves varies over a wide range of frequencies from few hundred KHz to few GHz.** So, bandwidth of free space is few GHz.

Optical fibers work in the frequency range of microwave to ultraviolet. They offer a bandwidth of 100GHz.

Most of our broadcast is done through free space, the range of frequencies used are further divided and allocated for various services.

The allocation of frequencies is done by **International Telecommunication Union (ITU).**

Service	Frequency bands	Comments
Standard AM broadcast	540-1600 kHz	
FM broadcast	88-108 MHz	
Television	54-72 MHz	VHF (very high frequencies)
	76-88 MHz	TV
	174-216 MHz	UHF (ultra high frequencies)
	420-890 MHz	TV
Cellular Mobile Radio	896-901 MHz	Mobile to base station
	840-935 MHz	Base station to mobile
Satellite Communication	5.925-6.425 GHz	Uplink
	3.7-4.2 GHz	Downlink

THINK ABOUT THESE

- (i) **The following words specifically describe distinct physical quantities**
- (a) Transducer (b) frequency (c) signal (d) Attenuation
 (e) Bandwidth (f) Modulation (g) Amplification
- (ii) **Transmission of music and picture require higher bandwidth**
- (iii) **What are the bandwidths offered by coaxial cable, free space and optical fiber?**
- (iv) **What are the frequency range for services of FM broadcast, mobile phones and satellite communication?**

11. SUMMARY

In this module you have learnt

- A brief history of electronic communication
- Definitions of specific words used to describe electronic communication
- Brief knowledge of the electromagnetic radio wave spectrum used for electronic communication.

- (i) **FREQUENCY: It is** defined as no. of cycles per second or no. of waves per second.

- (ii) **TRANSDUCER:** These are the devices which converts one form of energy into another form of energy.
- (iii) **SIGNAL:** It is the information, modified into a form suitable for transmission. **Technically speaking**, a signal is a wave, amplitude or frequency of which varies with time. The signal can be analog or digital.
- (iv) **NOISE:** These are unwanted signals having same or similar frequency as that of required signal. **TRANSMITTER:** It is the device that converts the information (message) into a form suitable for transmission. In above example the online shopping company is the transmitter.
- (v) **RECEVIER:** It is the device that retrieves the information from received signal. In shopping example, you are the receiver.
- (vi) **ATTENUATION:** It refers to loss in strength of signal while propagating from transmitter to receiver.
- (vii) **AMPLIFICATION:** It is the process of increasing the strength of signal. Amplification compensates for attenuation. Amplification is done by electronic circuit.
- (viii) **RANGE:** It is the maximum distance that a signal can travel with sufficient strength.
- (ix) **BAND WIDTH:** It is the frequency range over which a system works. It is calculated as highest frequency – lowest frequency. For example, the human audio frequency range is 20 Hz to 20,000 Hz, so audio bandwidth = $20,000 - 20 = 19,980$ Hz
- (x) **MODULATION:** It is the process of superimposing a low frequency signal over a high frequency wave called carrier wave.
- (xi) **DEMODULATION:** It is the process of extracting the information from received signal. It is the reverse process of modulation. Obviously demodulation is done at receiver end.
- (xii) **REPEATER:** These are used to increase the range of communication system. **Communication satellites** are repeater stations in space. They receive signal from one ground station amplify it and transmit it to another ground station.
- (xiii) **ANTENNA:** It is the device through which transmission and receiving process are done. The dish connected to your TV set is an antenna in itself.

- (xiv) Speech signals require a bandwidth of 2800Hz, music require a bandwidth of 20,000Hz and video 6MHz.
- (xv) Coaxial cable offers a bandwidth of 750MHz, free space of some GHz and optical fiber 100GHz.