Outline

- Types of Signals: Analog and Digital Signals
- Modulation and Demodulation: Principles of Amplitude and Frequency Modulations
- Communication systems: Radio, TV, Mobile, Microwave, Satellite and Optical Fiber (Block diagram approach only)

Signals

- Signals are variables that carry information.
- It is described as a function of one or more independent variables.
- Basically it is a physical quantity.
- Signals can be one dimensional or multidimensional.

Types of Signal

- Signals can be either Analog or Digital.

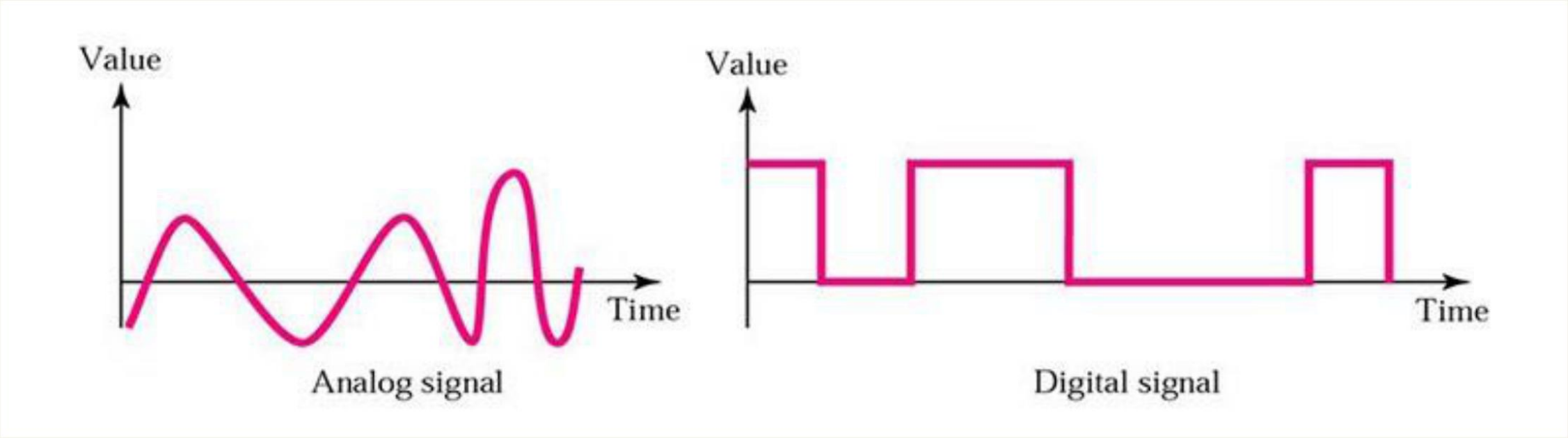
- An analog signal has infinitely many levels of intensity over a period of time.

- As the wave moves from value A to value B, it passes through and includes an infinite number of values along its path.

■ A digital signal, on the other hand, can have only a limited number of defined values.

■ Although each value can be any number, it is often as simple as 1 and 0.

Analog and Digital Signals



Comparison

Analog Signal	Digital Signal
Continuous	Discrete
Infinite range of values	Finite range of values (2)
More exact values, but more difficult to work with.	Not as exact as analog, but easier to work with.

Introduction of Communication

- Communication is a process of transmitting, receiving and processing of information.

- In a process of communication, transmitter, channel and receiver are involved.

- The channel is a media through which information signal travels in the form of electrical analog signal, electromagnetic radiation or digital signal.

■ Communication can be classified as analog communication and digital communication, wired communication and wireless communication.

Basic communication system

- It is required to accomplish the process of communication.

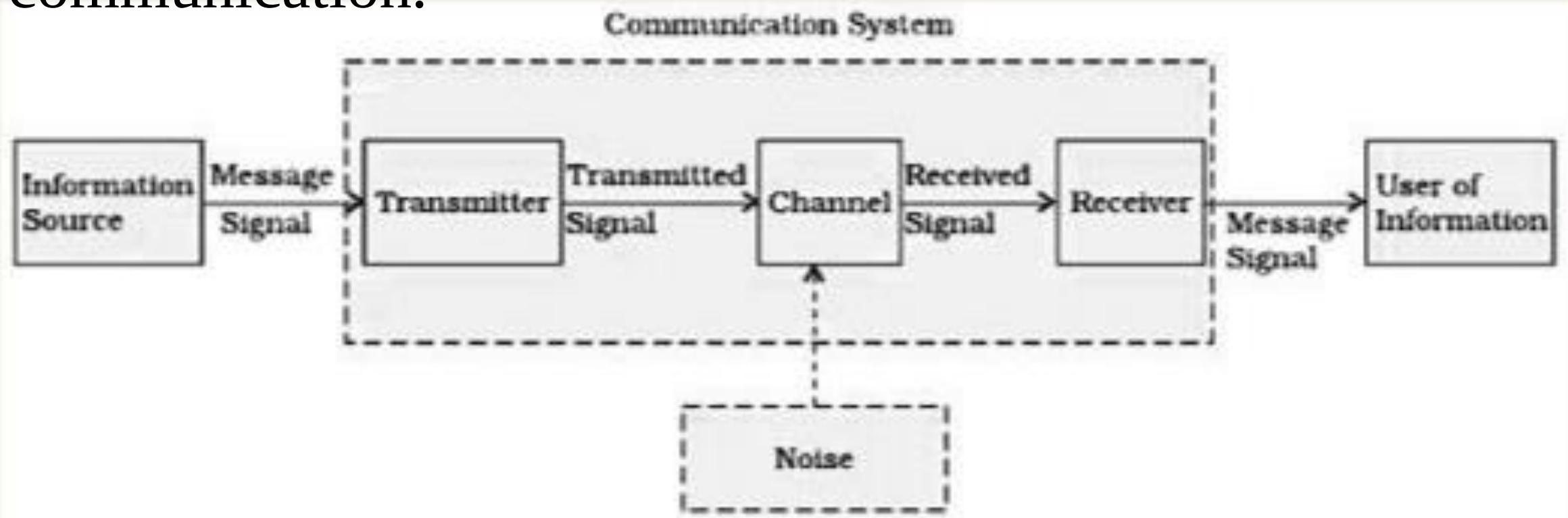


FIGURE 15.1 Block diagram of a generalised communication system.

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- Information source: It may be human speech, picture, video, text or coded information source. Information can be in analog or digital form.

- Transmitter: In a transmitter, modulation process takes place.

- Channel: Basically channel refers to the frequency range allocated for transmission. Signal propagates through a channel. It is the source of noise in the process of communication.

- Receiver: Modulated signal get demodulated at the receiver. It means that original information signal is extracted from the combination of modulating signal, noise and carrier signal.

Contd.

- Although transmission of digital signal is preferred, it is not always feasible to transmit in digital form because it requires channel of high bandwidth having low pass characteristics.

- On the other hand, an analog transmission requires lower bandwidth having band pass characteristics.

- The process involved in analog transmission is known as modulation, which requires manipulation of one or more of

the parameters of the carrier that characterizes the analog signal.

Modulation

- Modulation is a process by which amplitude, frequency or phase of some high frequency signal is varied in accordance with low frequency information signal.

- It is required because low frequency audio signal can not travel large distance by itself.

Amplitude Modulation (AM)

- This is the simplest form of modulation where the amplitude of the carrier wave is modulated by the analog signal known as the modulating signal.

- A signal to be modulated (modulating signal), a carrier and the modulated signal are shown in Fig. (next slide)

Modulating Signal

AM output

Carrier Signal

Modulated Signal

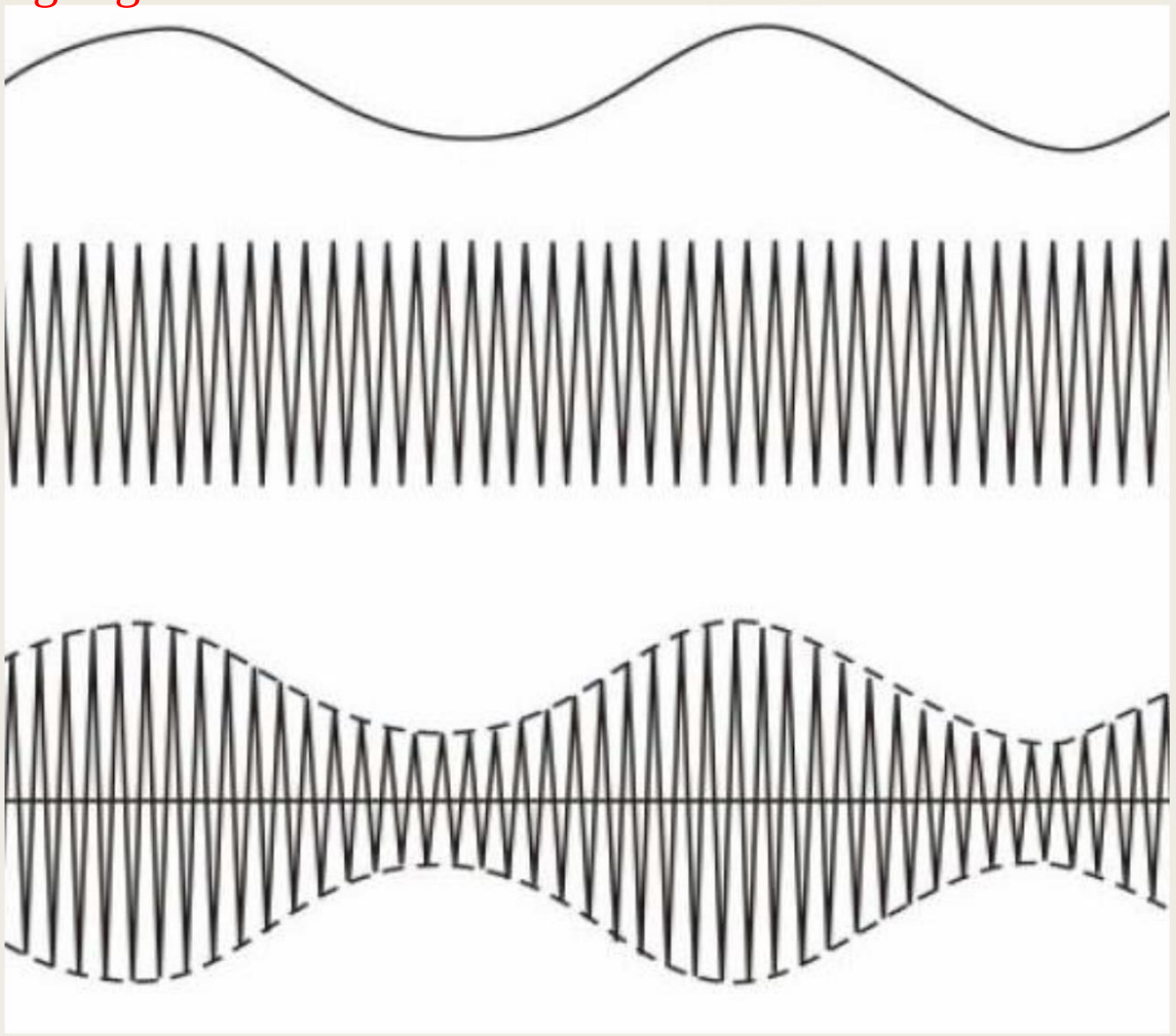

Figure 2.5.4 *(a) Envelope of the signal 1+m em(t) for m < 1*

Contd.

This is the simplest form of modulation where the amplitude of the carrier wave is modulated by the analog signal known as the *modulating signal*. A signal to be modulated, a carrier and the modulated signal are shown in Fig. 2.5.3. Let the modulating waveform is given by $e_m(t) = E_m \cos(2\pi f_m t)$ and the carrier signal is given by $e_c(t) = E_c \cos(2\pi f_c t + \Phi_c)$. Then the equation of the modulated signal is given by

$$s(t) = (E_c + E_m \cos 2\pi f_m t) \cos 2\pi f_c t$$

Modulation Index: The modulation index, represented by m, is given by

$$m = (E_{max} - E_{min}) / (E_{max} + E_{min}) = E_m / E_c,$$

where $E_{max} = E_c + E_m$,

$E_{min} = E_c - E_m$, and $s(t) = E_c (1 + m \cos 2\pi f_m t) \cos 2\pi f_c t$,

The envelope of the modulated signal is represented by $1+m\ e_m(t)$ for $m < 1$. The envelope of the modulated signal for different modulation index is shown in Fig. 2.5.4. Loss of information occurs when $m > 1$.

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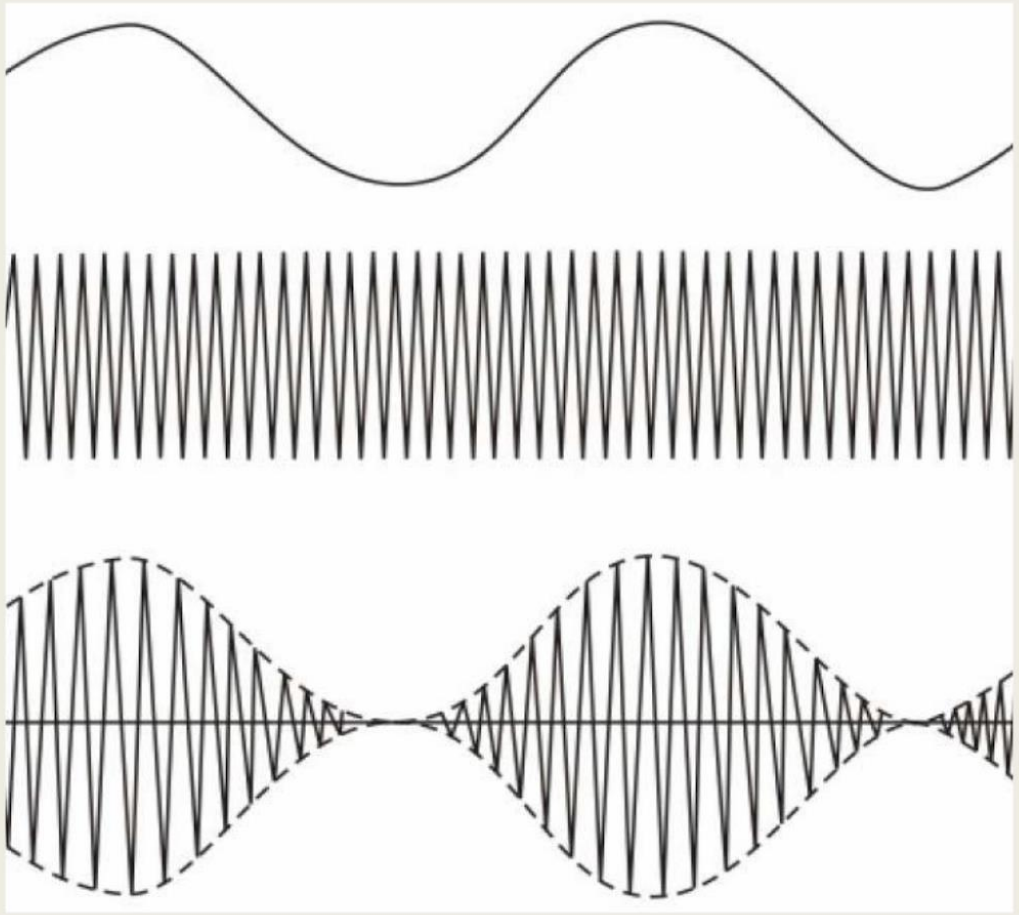


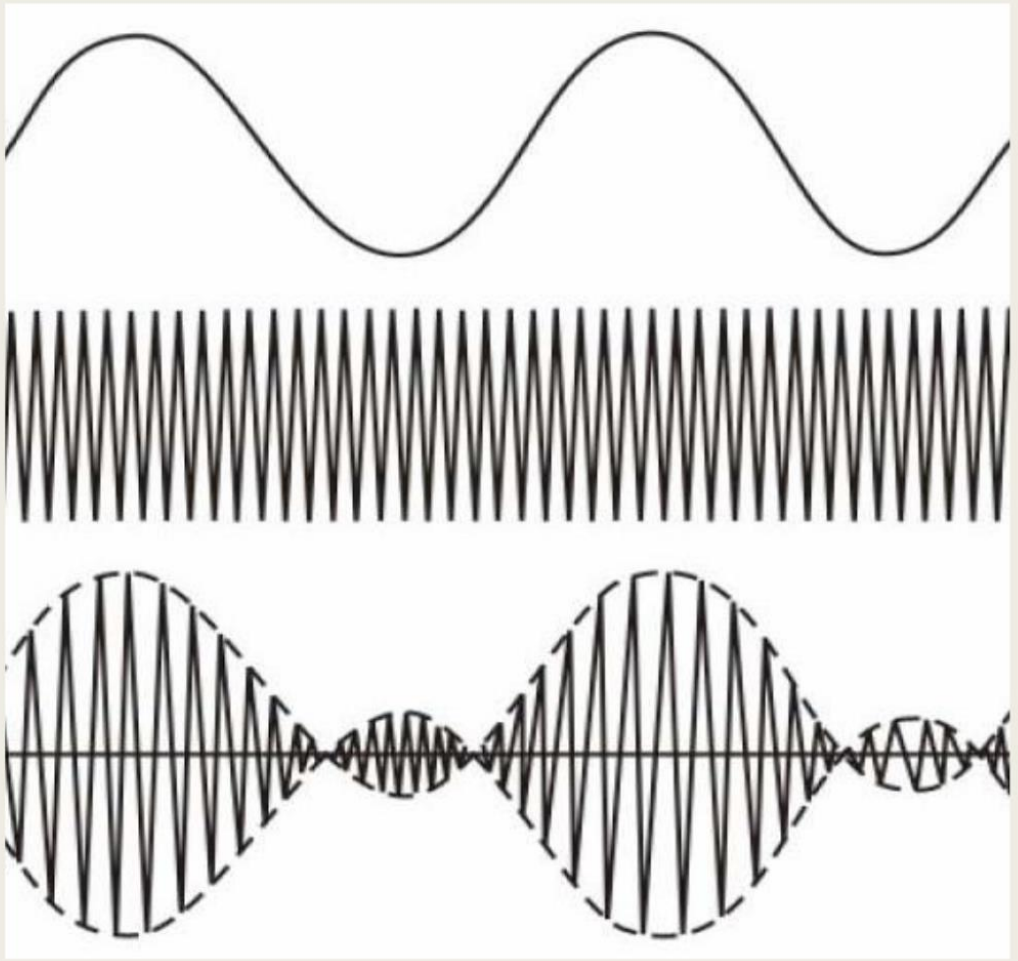


Figure 2.5.4 *(b) Envelope of the signal 1+m em(t) for m = 1*

Figure 2.5.4 *(c) Envelope of the signal 1+m em(t) for m > 1*

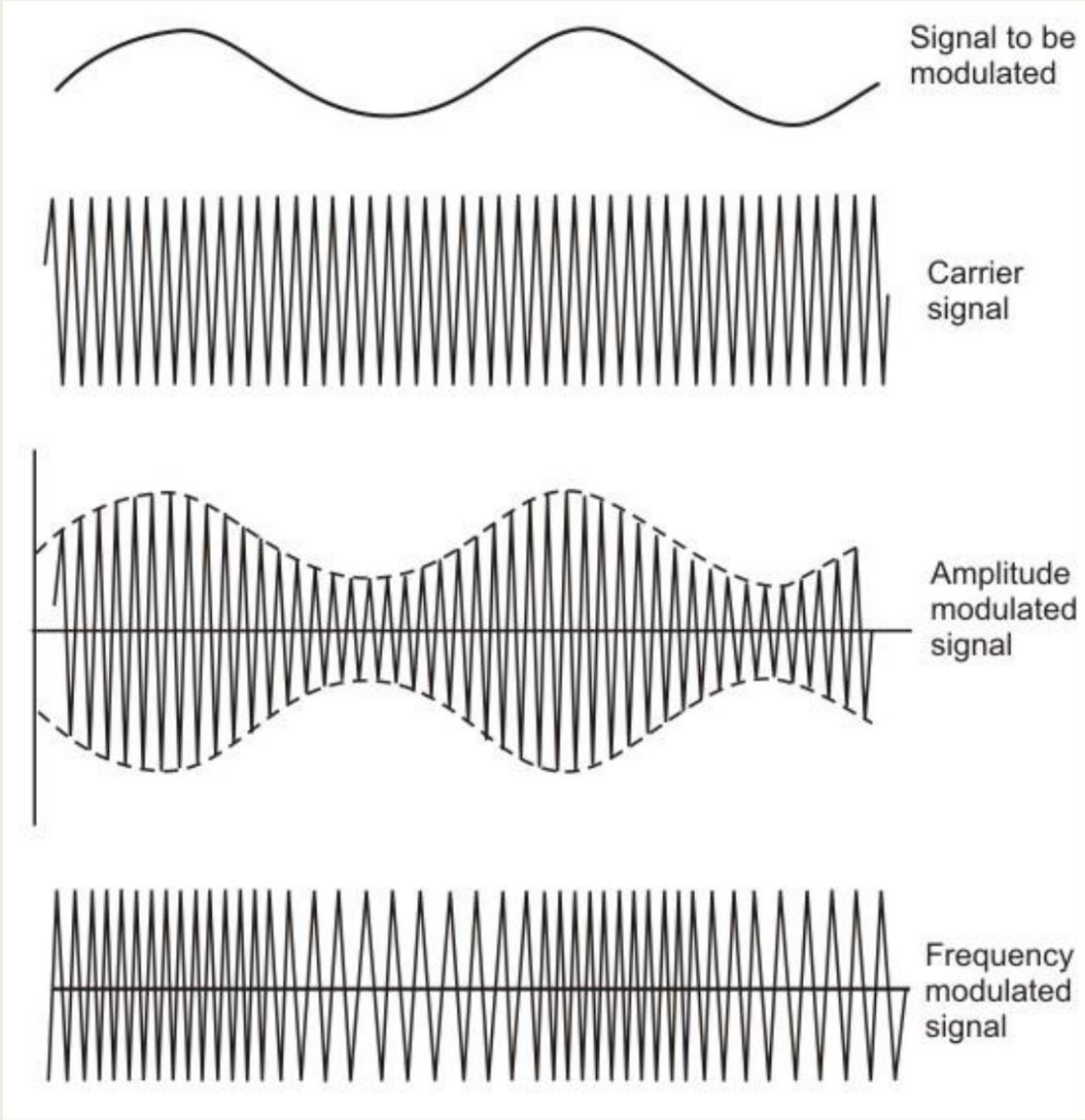
Frequency Modulation (FM)

- FM is a process in which frequency of the carrier signal is varied in accordance with instantaneous amplitude of modulating signal.

- In the process of frequency modulation, amplitude of carrier is kept constant.

- Information sent is in the form of frequency variation of carrier.

■ Hence, noise immunity of such system is more than amplitude modulated system.


Signal to be modulated
Carrier signal
Amplitude modulated signal
Frequency modulated signal

Advantages of FM

- It can limit the amplitude to remove unwanted noise signal as amplitude removal does not cause loss of information.

- This is not possible with AM. Since amplitude variation contains information signal.

Disadvantages of FM

- It requires complex transmitting and receiving equipments due to complex modulation and demodulation processes.

- Wider channel is required by the FM transmission.

Demodulation

- A demodulator is an electronic circuit that is used to recover the information content from the modulated carrier wave.

- There are many types of modulation so there are many types of demodulators.

- The signal output from a demodulator may represent sound, images or binary data.

- In a modem, which is a contraction of the terms modulator/demodulator, a demodulator is used to extract a serial digital data stream from a carrier signal which is used to carry it through a telephone line, coaxial cable, or optical fiber.

Communication Systems

- Radio
- TV
- Mobile
- Microwave

- Satellite
- Optical Fiber

Radio

- It uses..

– An antenna to capture radio waves,

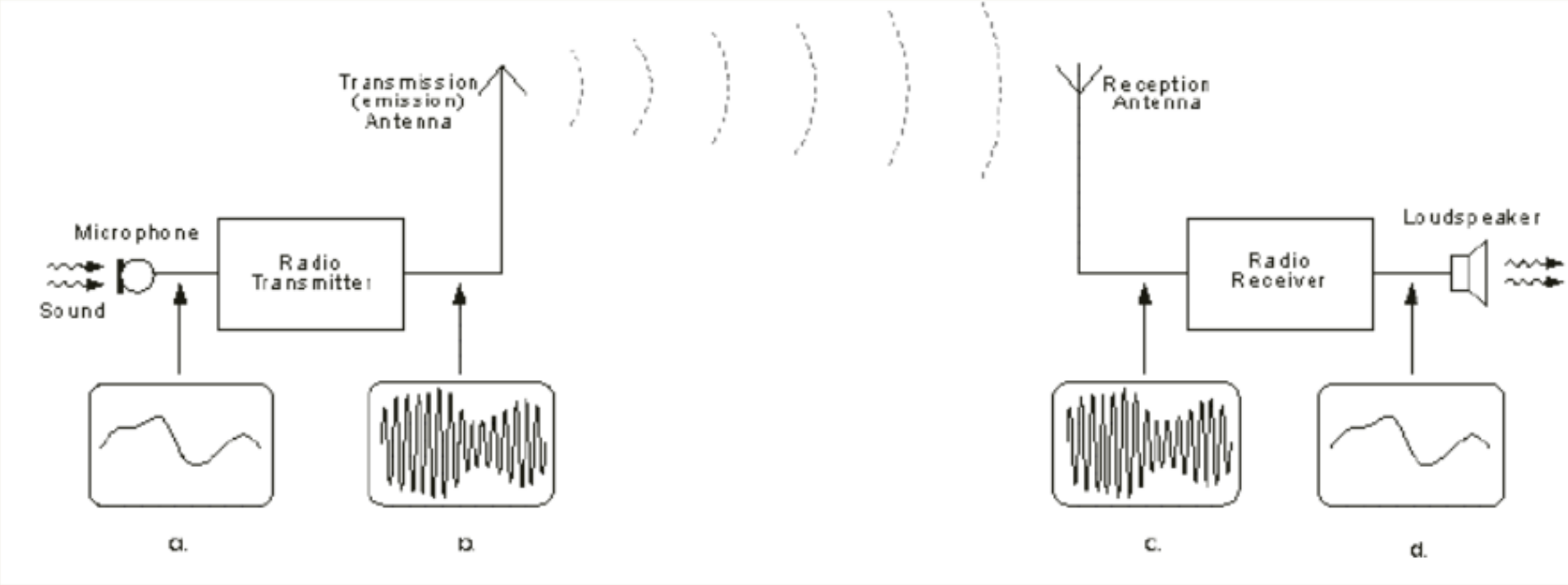
– Processes those waves to extract only those waves that are vibrating at the desired frequency,

– Extracts the audio signals that were added to those waves,

– *Amplifies the audio signals, and*

– *finally plays them on a speaker*

Block diagram



TV

■ The TV signal consists of two main parts: the sound and the picture.

■ The entire TV signal occupies a channel in the spectrum with a bandwidth of 6 MHz.

■ There are two carriers, one for picture and other for sound.

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- The sound carrier is at the upper end of the spectrum.
- Frequency modulation is used in sound signal.
- The picture information is transmitted on a separate carrier located 4.5 MHz lower in frequency.
- The video signal derived from a camera is used to amplitude modulate the picture carrier.

■ Different methods of modulation are used for both sound and picture information so that there is less interference between the picture and sound signals.

Microwave

- Microwaves are signals with a frequency greater than 1 GHz.

- The microwave region is generally considered to extend to 30 GHz.

- Operating in the microwave region solves many of the problems of the overcrowding in the radio spectrum.

- Currently, the microwave frequency spectrum is used primarily for telephone communications and radar.

- Many long distance telephone systems use microwave relay links for carrying telephone calls.

Contd.

- Another communication technique in the microwave region is radar.

- It is acronym for radio detection and ranging.

- It is a method of detecting the presence of a distant object and determining its distance and direction.

- Radar systems transmit a high frequency signal that is then reflected from the distant object: an airplane, a missile, a ship or any other object.

- The reflected signal is picked up by the radar unit and compared to the transmitted signal.

- The time difference between the two gives the distance to the object.

Modern Communication systems

■ Information in the form of voice messages, texts, pictures and digital data can be transmitted and received very fast using following systems.

– *Optical fiber Communication Systems*

– *Satellite Communication Systems*

– *Mobile Communication Systems*

■ Satellite communication is widely used in telephone systems, in broadcasting of television programs, in weather forecasting and remote sensing.

- They are also used for search and rescue operations.
- Optical fibres are used as physical media in telephone systems.
- They are also used as a physical media in computer networks.

Optical Fiber Communication Systems

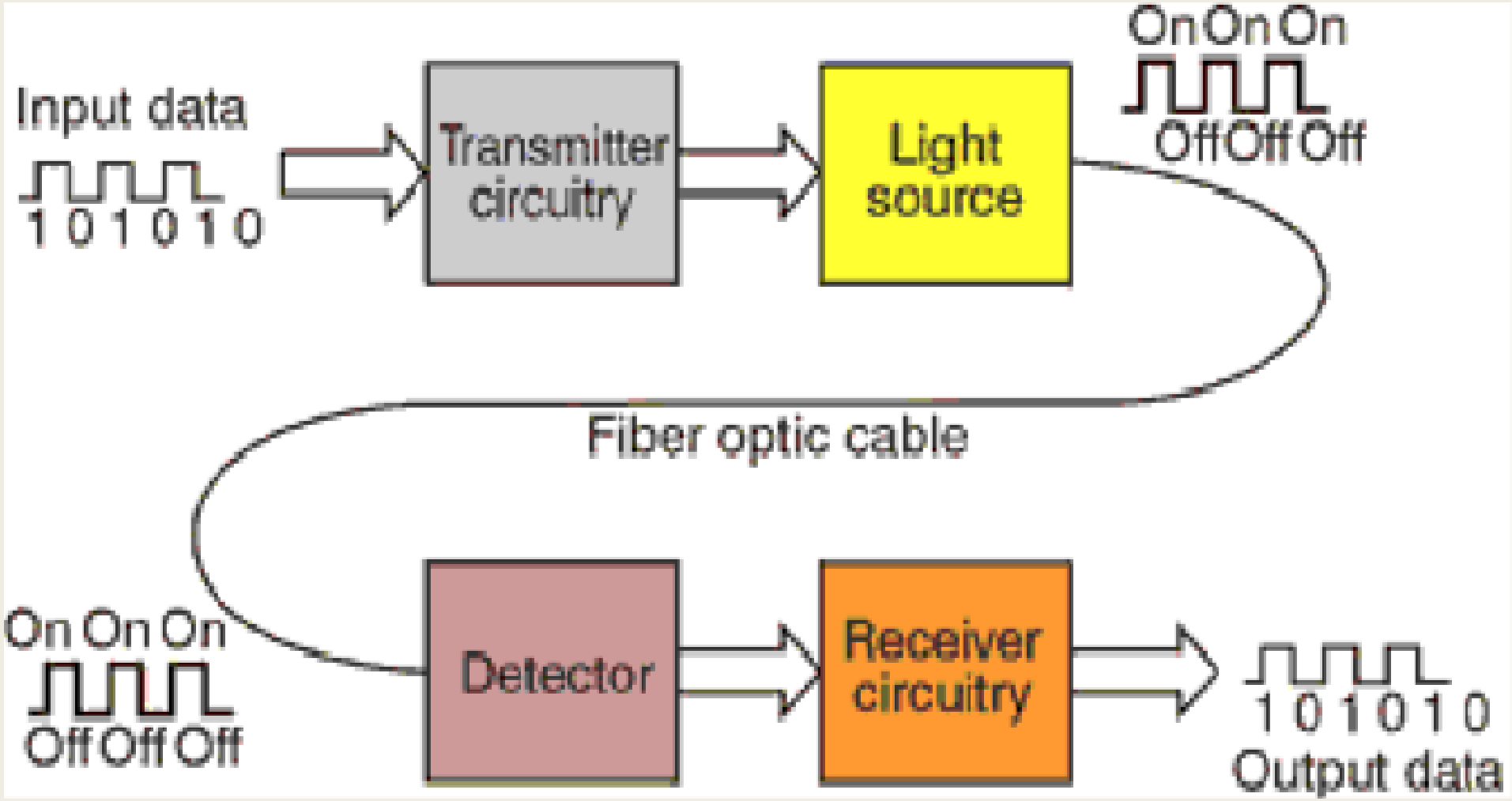
- It consists of optical transmitter, optical transmission line and an optical receiver.
- Generally, LED and Laser are used as source of light.
- Fiber optic cable is used as a transmission line and photodiode is used as light detector.
- Speech signals, for example a talk on telephone, are converted into electrical signal.
- The transmitter modulates light intensity of the source in accordance with electrical signal.

- The light signal is then transmitted through optical fiber cable.

- At the receiving end, photo diode detects and converts it into electrical signal.

- The receiving signal is amplified and given to the destination.

Basic block diagram of Optical Fiber Communication System



Advantages of Optical Fiber Communication systems

1. In this type of system, electromagnetic interference or radio frequency interference will not affect the transmitted signal.

2. Such systems can cover long distance without repeater.

3. It provides better security to transmitted signal, as interception by induction from light signal is not possible.

4. It has a large bandwidth hence can accommodate large number of channels simultaneously.

5. They are well suited for transmission of digital signals at high data rates.

Satellite Communication System

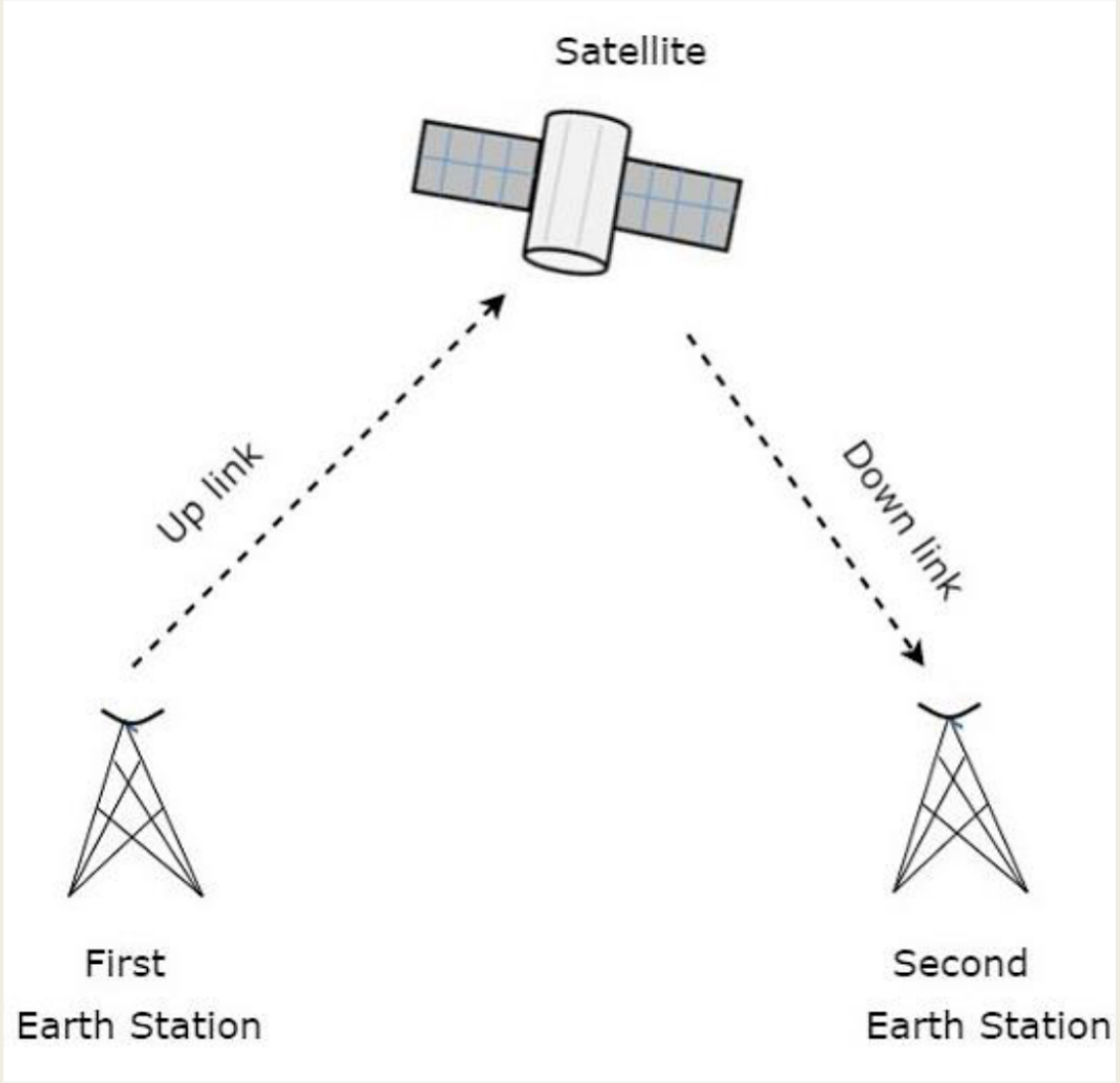
- Basic satellite communication system may consist of two or more earth stations and a satellite.

- An artificial satellite may be termed as a system placed in a space, in an orbit around the earth by means of launching vehicle.

- Centrifugal force caused by the rotation of the satellite around the earth exactly balances the earth’s gravitational pull and keeps it in a space.

- The closure the satellite to the earth, stronger the earth’s gravitational pull and so faster the satellite must travel in order to avoid falling on the earth.

Basic Satellite Communication



Contd.

- The satellite is equipped with both receiving and transmitting equipment.
- The combination is called transponder.
- The satellite uses different frequencies for receiving and transmission, otherwise a powerful transmitted signal would interfere with weak incoming signal.
- The transponder receives the signal, amplifies it, changes its frequency and retransmits.

- Satellite may have large number of such transponders to provide large numbers of two way channel.

Contd.

- Satellite receives energy for its operation from solar cells mounted on large panel boards mounted to it.

- These solar panel converts energy received from the sun into electrical power.

- This process provides necessary energy to all the equipments on the satellite.

- Each station consists of large dish shaped antenna, which points at the satellite.

■ Most of the earth stations transmit and receive the communication signal with fix antenna.

Contd.

- At least one earth station performs task of controlling satellite.

- Transmission link between satellite and earth stations use microwave link.

■ The transmission from an earth station to satellite is known as uplink and that from the satellite to earth station is known as down link.

Mobile Communication System

- Mobile communication via mobile phones has become common today.
- Mobile internet access has become reality today.
- Communication in all form can be done very fast.
- Mobile communication has revolutionized telephone communication systems.

■ To send message at any place on the earth at any time has become possible.

Cellular concept

- Cellular system can be characterized as system with high capacity land mobile system.
- In the system available frequency spectrum is partitioned into discrete channels.
- These channels are assigned groups to the geographical cells.
- These cells cover a geographic service area.

- The discrete channels are reused in the different cells within the service area.

- Thus, the principle of cellular system is to divide a large geographic service area into cells with diameter from 2 KM to 50 KM.

Contd.

- Each of the cells is allocated a number of radio frequency channels.

- Transmitter in each adjacent cell operates on different frequency to avoid interference.

- Generally, a fixed amount of frequency spectrum is allocated to a cellular system.

■ Multiple access techniques are deployed so that many users can share the available spectrum in efficient manner.

Contd.

- Multiple access system specifies how signals, from different sources can be combined efficiently for a transmission over given RF band.

- It is then separated at destination without mutual interference.

- There basic techniques are used.

1. Frequency Division Multiple Access (FDMA)

2. Time Division Multiple Access (TDMA)

3. Code Division Multiple Access (CDMA)