Unit 5

Syllabus

Fundamentals of Communication Engineering: Basics of signal representation and analysis, Electromagnetic spectrum Elements of a Communication System, Need of modulation and typical applications, Fundamentals of amplitude modulation and demodulation techniques. Introduction to **Wireless Communication:** Overview of wireless communication, cellular communication, different generations and standards in cellular communication systems, Fundamentals of Satellite & Radar Communication.

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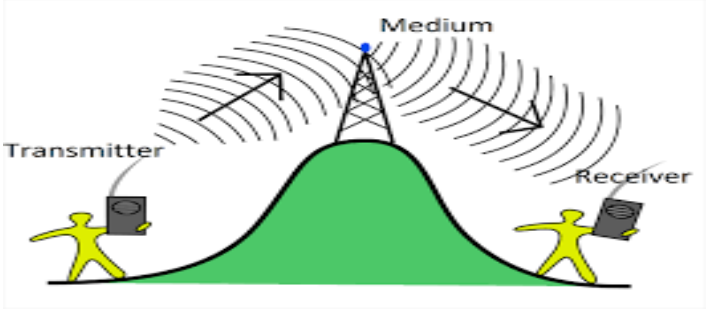
Block Diagram of Communication System

- Communication is the transfer of information from point A to point B using electricity or magnetism.

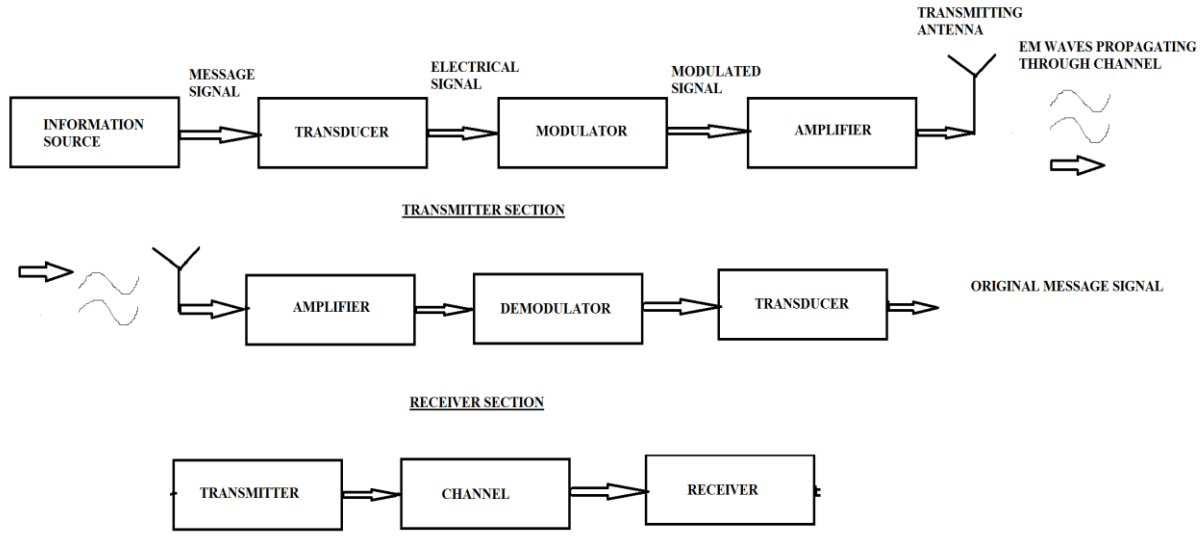


- Communication system can be divided into three parts:

(i) Transmitter

(ii) Channel(Medium)

(iii) Receiver



Information Source: It is used to generate message signal which may be in the form of audio, video or data.

Transducer: It is a device which converts one form of energy into

different form.

Modulator: Here message signal is superimposed on a high frequency carrier wave so that it can cover long distance.

Amplifier: This block is used to enhance the strength of the signal before transmission.

Transmitting Antenna: It is used to convert electrical signal into electromagnetic waves which can travel in the atmosphere.

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Channel Section

- The output of transmitter section travels through a path or medium to reach receiver. This path or medium is called channel.
- There are several types of channel such as:

  (i) Wired Channel: medium is physical i.e. optical fibre, co-axial cable etc.

  (ii) Wireless Channel: medium is air.

The receiver section consists of:

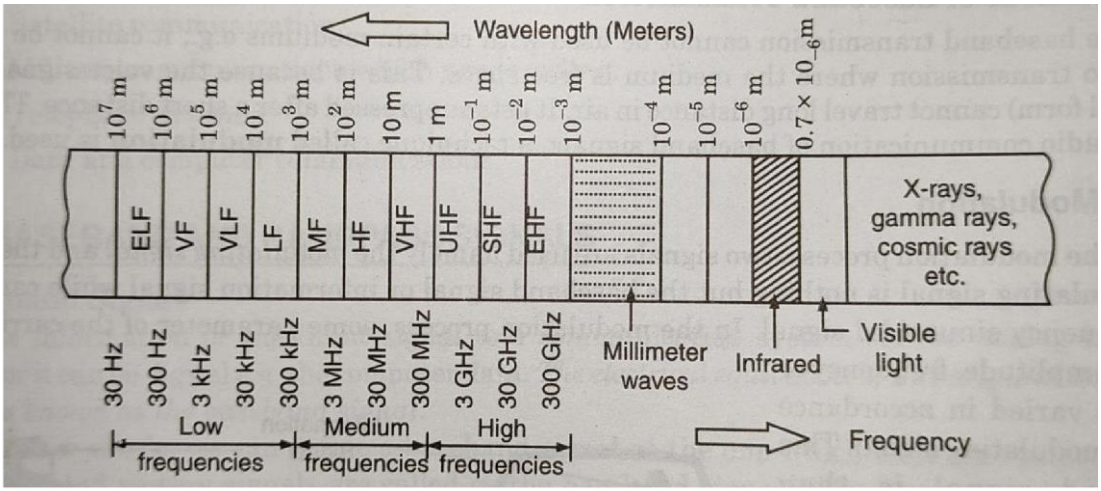
Receiving Antenna: It is used to convert desired electromagnetic waves in the atmosphere into the electrical signal.

Amplifier: The signal at the receiver suffered various types of losses and become weak. So, an amplifier is used to increase its strength.

Demodulator: Here carrier wave is separated from the message signal.

Transducer: To convert electrical signal into original message signal.

Electromagnetic Spectrum



Modulation

- **It is a process in which low frequency message signal is superimposed on the high frequency carrier wave**. In this process one of the parameters of the carrier varies according to the message signal.

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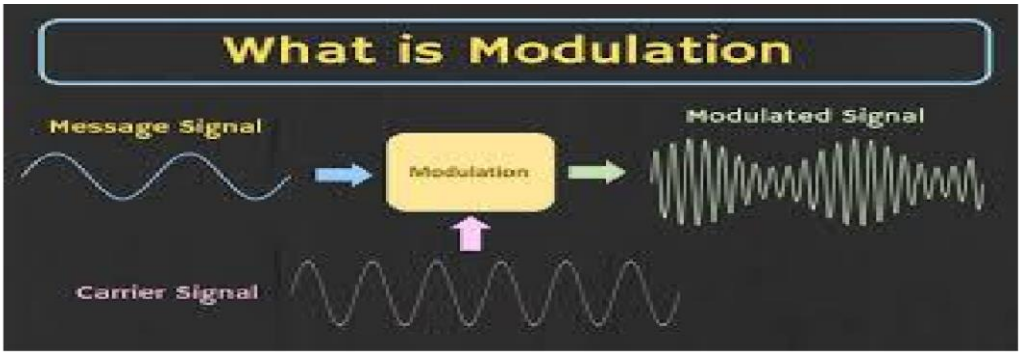


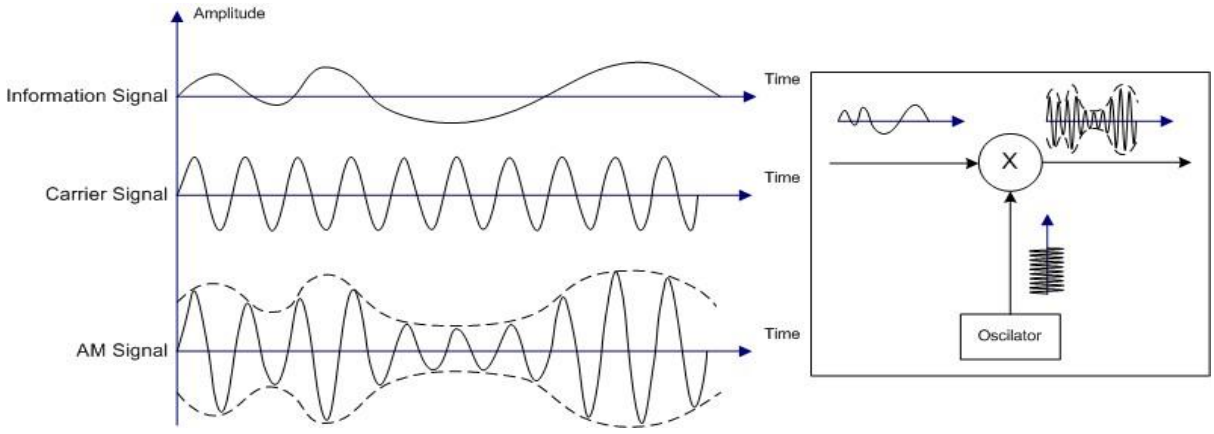
Need of Modulation

There are several factors due to which modulation is needed in communication:-

- **Interference or Mixing Problem:** As message signals are generally low frequency signals there is large probability of mixing with other signals of the same frequency range already present in the atmosphere. So, low frequency message signals are sent through high frequency carrier wave (modulation) to avoid such problems.
- **Height of Antenna:** Practical height of transmitting or receiving antenna = $\lambda/4$, where λ is the wavelength of the signal being used. If we use low frequency message signal without modulation the height of antenna is of the order of kilometres. Therefore to reduce the height of antenna modulation is needed.
- **Power Dissipation:** When an electromagnetic wave is travelling through atmosphere it suffers from various losses which are inversely proportional to the frequency of the signal. Thus low frequency signals are more prone to atmospheric losses and therefore modulation is used to reduce these losses.

Amplitude Modulation (AM)

In amplitude modulation the amplitude of the carrier signal is modulated according to the instantaneous amplitude of the message signal.



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$e_m(t) = E_m \cos \omega_m t$ — (1)

$e_c(t) = E_c \cos \omega_c t$ — (2)

$e_{AM}(t) = A \cos \omega_c t$ — (3)

$A = E_c + e_m(t)$

$A = E_c + E_m \cos \omega_m t$

$A = E_c \left(1 + \frac{E_m}{E_c} \cos \omega_m t\right)$

$\frac{E_m}{E_c}$ → modulation index 'm'

$A = E_c (1 + m \cos \omega_m t)$ — (4)

Put the value of A from eqn (4) in eqn (3)

$e_{AM} = E_c (1 + m \cos \omega_m t) \cos \omega_c t$

$= E_c \cos \omega_c t + m E_c \cos \omega_m t \cos \omega_c t$

$= E_c \cos \omega_c t + \frac{m E_c}{2} [2 \cos \omega_m t \cdot \cos \omega_c t]$

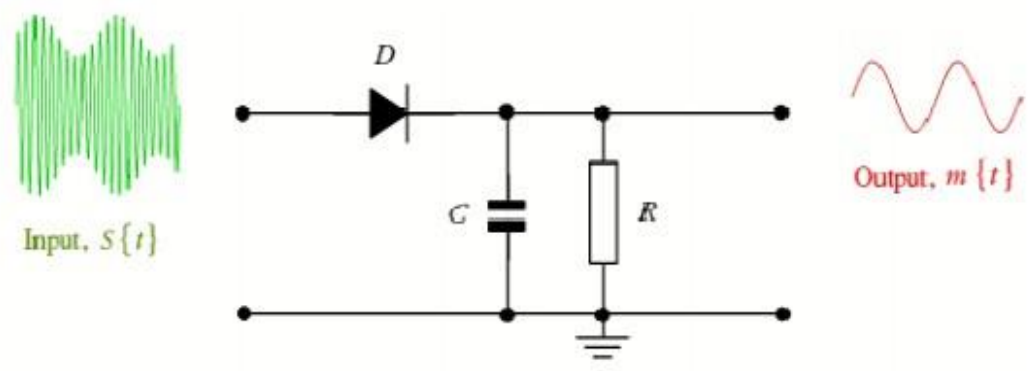
$= E_c \cos \omega_c t + \frac{m E_c}{2} [\cos(\omega_m + \omega_c) t + \cos(\omega_m - \omega_c) t]$

$e_{AM} = E_c \cos \omega_c t + \frac{m E_c}{2} \cos(\omega_m + \omega_c) t + \frac{m E_c}{2} \cos(\omega_m - \omega_c) t$

↓ Carrier Sig ↓ Upper side band ↓ Lower side band

AM Demodulator

- **Linear Diode Detector or Envelope Detector:**



- Here, diode is the main detecting device so it sometimes also called as Diode detector.
- In the positive half cycle diode conducts and capacitor charges to it peak value.
- During other half of the cycle diode gets reverse biased and capacitor discharge through a resistor R.
- Hence the output voltage across capacitor C is a spiky envelope of the AM wave, which is same as the amplitude variation of the modulating signal.

Advantages and Disadvantages of Amplitude Modulation

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Advantages	Disadvantages
Amplitude Modulation is easier to implement.	When it comes to power usage it is not efficie
Demodulation can be done using few components and a circuit.	It requires a very high bandwidth.
The receiver used for AM is very cheap.	Noise interference is highly noticeable.

APPLICATIONS OF NETWORKS

Some of the network applications in different fields are the following:- Marketing and sales

Financial services

Information services

Cellular telephone

Cable television

Teleconferencing

E-mail etc.

Communication facilities

EVOLUTION OF MOBILE COMMUNICATION

- Over recent years, the evolution of mobile wireless communication in the world has become more important after arrival of 5G technology.
- This evolution journey consists of several generations start with 1G followed by 2G, 2.5G,3G, 4G, and under research future generations 5G is still going on.

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FIRST GENERATION (1G)

- It uses analog radio signal which has frequency 150 MHz, only voice transmission call is done.
- This generation is unreliable.

It speeds up to 2.4Kbps

SECOND GENERATION (2G)

- The next generation of mobile networks, 2G uses **GSM technology**

(Global System for Mobile Communication).

- It used digital signal for transmission rather than analog.

Data speed up to 64Kbps

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3G

- 3G is the third generation of mobile phone standards and technology,
- 3G uses **CDMA technique** for data transmission.
- 3G transmits data up to 2 Mbps.

4G

- This generation provide wider bandwidth, high security and high speed internet access. This generation based on Long Term Evolution (LTE).
- The 4G is offering improved multimedia, video gushing, worldwide access, and around the world transportability through a wide range of gadgets.
- 4G transmits data up to 100 Mbps.

5G

- 5G networks are cellular networks, in which the service area is divided into small geographical areas called *cells*.
- The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds.
- 5G transmits data up to 10 gigabits per second (Gbit/s).

RADAR COMMUNICATION

- **Radar** is a detection system that uses radio waves to determine the range, angle, or velocity of objects.
- It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.

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- Radio waves are electromagnetic waves of frequency between

10 hertz (Hz) and 30000 megahertz (MHz).

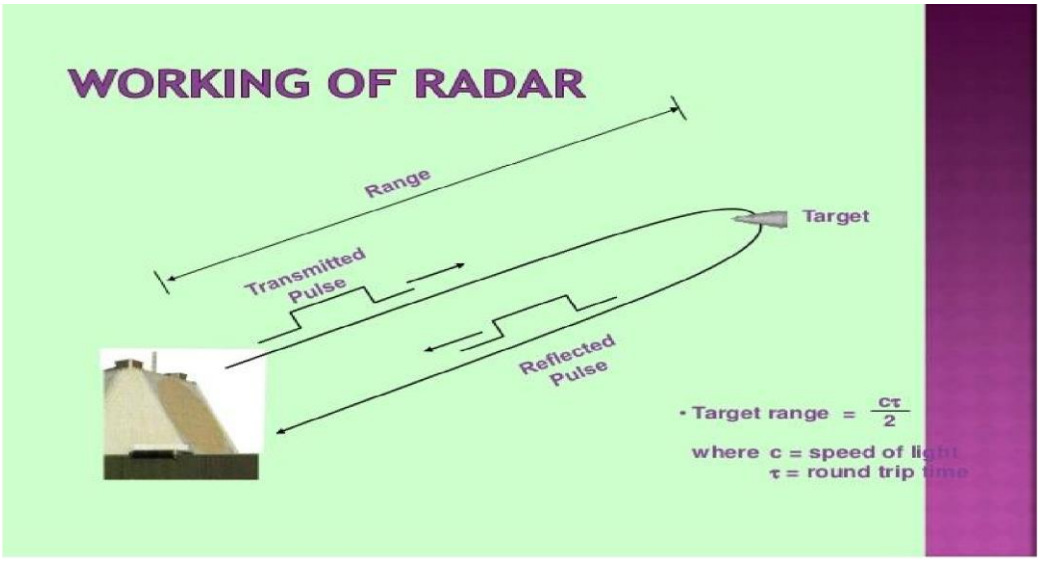
Elements of Radar Communication system:-

(i) Transmitter:- For transmitting signal.

(ii) Antenna:- used to transmit or receive signal

(iii) Receiver :- used to receive signal

(iv) Power supply:- used to provide power.



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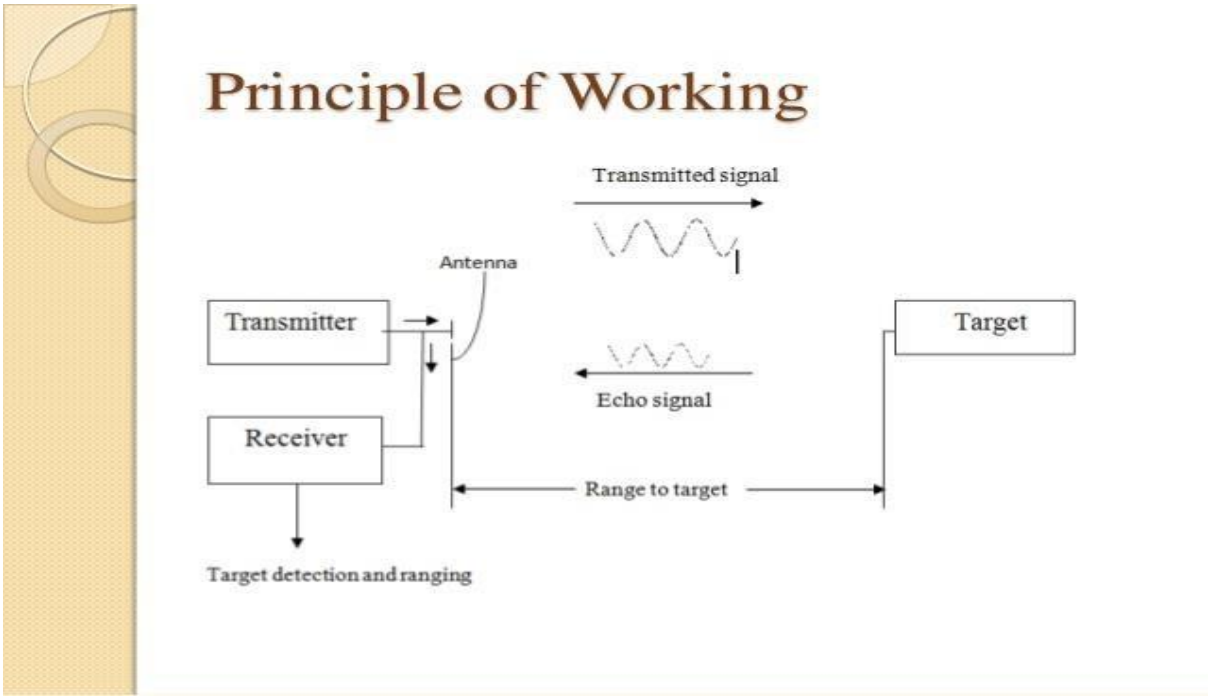

WORKING

- A radar system has a transmitter that emits radio waves known as *radar signals* in predetermined directions.
- When these signals contact an object they are usually reflected in many

directions.

- Radar signals are reflected by materials of considerable electrical conductivity— such as most metals, seawater, and wet ground.
- The radar signals that are reflected back towards the radar receiver are the desirable ones that make radar detection work.
- If the object is *moving* either toward or away from the transmitter, there will be a slight change in the frequency of the radio waves due to the Doppler effect.

SATELLITE COMMUNICATION

- A **Satellite** is a smaller object that revolves around a larger object in space. For example, moon is a natural satellite of earth.
- **Communication** refers to the exchange (sharing) of information

between two or more entities, through any medium or channel.

- Communication takes place between any two earth stations through

a satellite, then it is called as **satellite communication**.

- In this communication, electromagnetic waves are used as carrier signals. These signals carry the information such as voice, audio, video or any other data between ground and space and vice-versa.

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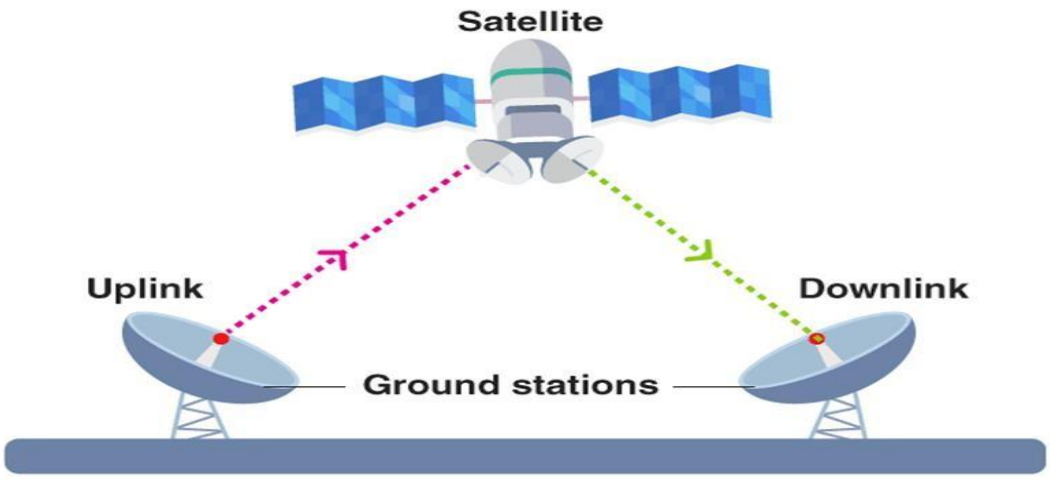

ELEMENTS OF SATELLITE COMMUNICATION

Basic Elements shown in the figure are:

- User
- Satellite
- Earth Station(Ground Station)

The user generates a signal which is transmitted to a satellite at the earth station.

The satellite consists of a large number of repeaters in the space that perform the reception of high frequency carrier from all the earth station.

Repeaters retransmits back to the Earth Station in the down link frequency spectrum.

In order to avoid the interference downlinks frequency spectrum should be different from uplink frequency spectrum.

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