Communication Systems

- Communication is the act of transmission and reception of information.
- Elements of communication system:
  - Transmitter
  - Communication channel
  - Receiver
- Two important forms of communication system are: analogue and digital.

- Bandwidth − Bandwidth refers to the frequency range over which an equipment operates or the portion of the spectrum occupied by the signal.
- Bandwidth of an analogue signal − The range over which the frequencies in an analogue signal vary.

- Bandwidth of a digital signal - A digital signal is in the form of a rectangular wave. It is a superposition of sinusoidal waves of different frequencies. Bandwidth of a digital signal is infinite.

Bandwidth of Transmission Medium

- Wire, free space, and fibre optic cables are the commonly used transmission media.
- A coaxial cable offers a bandwidth of approximately 750 MHz.
- Free-space communication takes place over a wide frequency range of a few hundred kHz to a few GHz.
- An optical fibre offers a transmission bandwidth in excess of 100 GHz.

Propagation of Electromagnetic Waves

- An antenna at the transmitter radiates the electromagnetic waves, which travel through space and reach the receiving antenna at the other end.
- The transmitting antenna converts the electric signals to electromagnetic waves.
- The receiving antenna converts the electromagnetic waves into electric signals.
- Ground wave propagation − In this type of wave propagation, the radio waves from the transmitting antenna propagate along the surface of the earth to reach

the receiving antenna. Its frequency range is less than a few MHz.

- Sky waves − In this type of wave propagation, the radio waves from the transmitting antenna reach the receiving antenna after reflection from the ionosphere. Its frequency ranges from 30 to 40 MHz.
    - $d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$

$h_R \rightarrow$ Height of receiving antenna

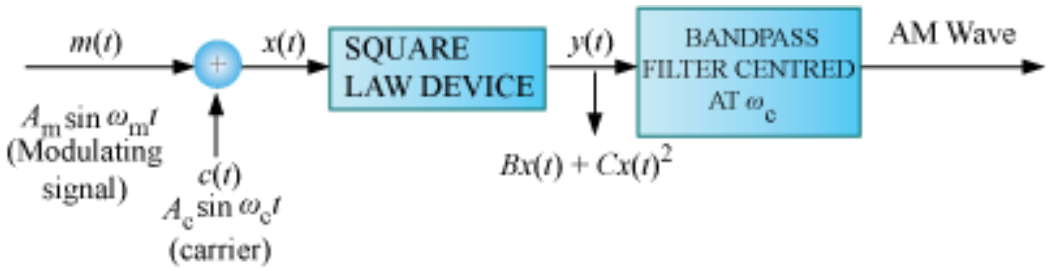
$d_M \rightarrow$ Maximum line of sight distance

- **Layers of the atmosphere**

- The troposphere extends up to a height of 12 km from the earth's surface. It contains most of the water vapour of the atmosphere.
- The stratosphere is the layer above the troposphere and extends from 10 km to 50 km from the surface of the earth. This region contains the ozone layer.
- The mesosphere is the layer above the stratosphere. It extends from 50 km to 80 km from the surface of the earth.
- The ionosphere extends from 80 km to thousands of km. It is composed of positive and negative ions that play an important role in radio and telecommunications.

- Factors which affect the transmission of an electronic signal in the audio frequency range over a long distance directly are:
    - Size of the antenna or aerial
    - Effective power radiated by an antenna
    - Mixing up of signals from different transmitters
- Low frequencies cannot be transmitted to long distances. Therefore, they are superimposed on a high-frequency carrier signal by a process known as modulation.
- In modulation, some characteristic of the carrier signal (like amplitude, frequency or phase) varies in accordance with the modulating or message signal. Correspondingly, they are called amplitude modulated (AM), frequency modulated (FM) or phase modulated (PM) waves.
- Amplitude modulated signal contains frequencies ($w_c - w_m$), wc and ($w_c + w_m$).
- For long-distance transmission, signals are radiated into space using devices called antennas. The radiated signals propagate as electromagnetic waves, and the mode of propagation is influenced by the presence of the earth and its atmosphere; near the surface of the earth, electromagnetic waves propagate as surface waves.

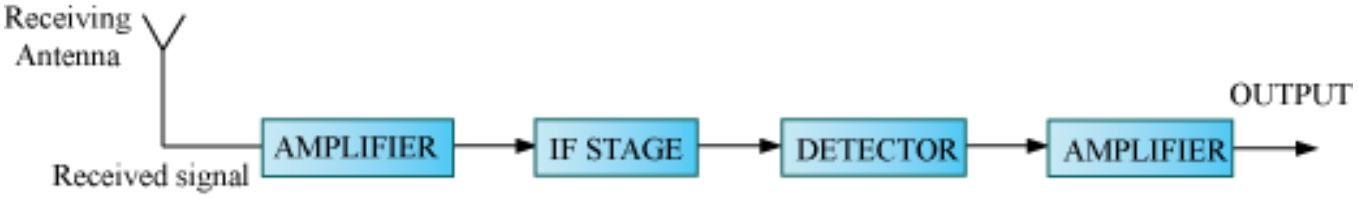
- **Production of Amplitude Modulated Wave**



- The modulator is followed by a power amplifier, which provides the necessary power. The modulated signal is then fed to an antenna of appropriate size for radiation.

Detection of Amplitude Modulated wave

- The transmitted message gets attenuated in propagating through the channel.



- The receiving antenna is followed by an amplifier and a detector, which are followed by an intermediate frequency (IF) stage to change the carrier frequency to lower frequency.

Applications of amplitude modulation

- AM radio broadcasting
- TV picture (video)
- Two way radio
- Aviation
- Citizen's band radio
- Military

Limitations of AM

- Low efficiency
- Noisy reception
- Small operating system

Comparsion between FM and AM:

- FM has high signal to noise ratio as compared to AM.
- FM broadcast is done in UHF and VHF where effect of noise is minimal whereas AM operates in MF and HF where effect of noise is very high.
- FM requires larger channel bandwidth for its transmission as compared to AM.
- FM transmission and receiving equipments are relatively costlier and complex as compared to AM equipments.