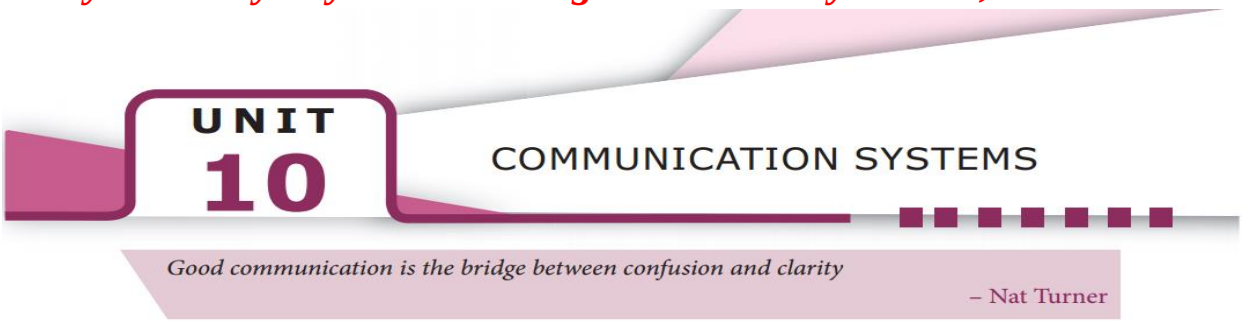

1. **Give the factors that are responsible for transmission impairments.**

Increasing distance:

The attenuation of the signal depends on

1. power of the transmitter
2. frequency of the transmitter, and
3. condition of the earth surface.

Absorption of energy by the Earth:

- When the transmitted signal in the form of EM wave is in contact with the Earth, it induces charges in the Earth and constitutes a current.
- Due to this, the earth behaves like a leaky capacitor which leads to the attenuation of the wave.

Tilting of the wave: As the wave:

- As the wave progresses, the wave front starts gradually tilting according to the curvature of the Earth.
- This increase in the tilt decreases the electric field strength of the wave. Finally, at some distance, the surface wave dies out due to energy loss.

2. **Distinguish between wireline and wireless communication? Specify the range of electromagnetic waves in which it is used**

Wireline communication	Wireless communication
➢ It is a point-point communication uses mediums like wires, cables and optical fibers.	➢ It uses free space as a communication medium.
➢ These systems cannot be used for long distance transmission as they are connected physically.	➢ The signals are transmitted in the form of electromagnetic waves with the help of a transmitting antenna. Hence wireless communication is used for long distance transmission.
➢ Examples are telephone, intercom and cable TV.	Examples are mobile, radio or TV broadcasting, and satellite communication.

3. **What is called centre frequency or resting frequency?**

- When the frequency of the baseband signal is zero (no input signal), there is no change in the frequency of the carrier wave.
- It is at its normal frequency and is called as centre frequency or resting frequency. Practically 75 kHz is the allotted frequency of the FM transmitter.

4. **What is mean by RADAR?**

RADAR basically stands for Radio Detection And Ranging System. ¬ It is one of the important applications of communication systems and is mainly used to sense, detect, and locate distant objects like aircraft, ships, spacecraft, etc.

5. **What do you mean by Internet of Things?**

Using Internet of Things (IoT), it is made possible to control various devices from a single device. (e.g.) Home automation using a mobile phone.

6. **What is called modulation? Give its types.**

For long distance transmission, the low frequency base band signal (input signal) is superimposed on to a high frequency carrier signal (radio signal) by a process called modulation. 1. Amplitude (AM) 2. Frequency Modulation (FM) 3. Phase Modulation (PM)

7. **What is the necessity of modulation?**

- When the information signal of low frequency is transmitted over a long distances, there will be information loss occurs.
- As the frequency of the carrier signal is very high, it can be transmitted to long distances with less attenuation.
- Thus in the modulation process, carrier signal of very high frequency signal (radio signal) is used to carry the baseband signal(information)

8. **Define amplitude modulation (AM)**

If the amplitude of the carrier signal is modified according to the instantaneous amplitude of the baseband signal, then it is called amplitude modulation (AM)

9. **Give the advantages and limitations of amplitude modulation (AM)**

Advantages of AM:

- Easy transmission and reception
- Lesser bandwidth requirements
- Low cost

Limitations of AM:

- Noise level is high
- Low efficiency
- Small operating range

10. **Define frequency modulation (FM)**

If the frequency of the carrier signal is modified according to the instantaneous amplitude of the baseband signal then it is called frequency modulation (FM)
Here amplitude and phase does not modified for carrier wave.

11. **Give the advantages and limitations of frequency modulation (FM)**

Advantages of FM:

- Large decrease in noise. This leads to an increase in signal-noise ratio.
- The operating range is quite large.
- The transmission efficiency is very high as all the transmitted power is useful.

- FM bandwidth covers the entire frequency range which humans can hear. Due to this, FM radio has better quality compared to AM radio.

Limitations of FM:

- FM requires a much wider channel.
- FM transmitters and receivers are more complex and costly.
- In FM reception, less area is covered compared to AM.

12. **Define phase modulation (PM)**

The instantaneous amplitude of the baseband signal modifies the phase of the carrier signal keeping the amplitude and frequency constant is called phase modulation

13. **Give the advantages of phase modulation (PM)**

- FM signal produced from PM signal is very stable.
- The centre frequency called resting frequency is extremely stable.

14. **Compare FM and PM?**

Comparison between FM and PM:

- PM wave is similar to FM wave.
- PM generally uses a smaller bandwidth than FM.
- In other words, in PM, more information can be sent in a given bandwidth.
- Hence, phase modulation provides high transmission speed on a given bandwidth.

15. **What is called base band signals?**

Information can be in the form of a sound signal like speech, music, pictures, or computer data. The electrical equivalent of the original information is called the baseband signal.

16. **Define band width.**

The frequency range over which the baseband signals or the information signals such as voice, music, picture, etc. is transmitted is known as band width.

Bandwidth gives the difference between the upper and lower frequency limits of the signal.

If ν1 and ν2 are lower and upper-frequency limits of a signal, then the bandwidth,

$$BW = \nu_2 - \nu_1$$

17. **Define the size of the antenna.**

- Antenna is used at both transmitter and receiver end.
- Antenna height is an important parameter to be discussed. The height of the antenna must be a multiple of $\frac{\lambda}{4}$. i.e.

$$h = \frac{\lambda}{4} = \frac{c}{4\nu}$$

18. **What are the three modes of propagation of electromagnetic waves through space.**

Ground wave propagation (or) surface wave propagation (nearly ***2 kHz to 2 MHz***)
Sky wave propagation (or) ionospheric propagation (nearly ***3 MHz to 30 MHz***)
Space wave propagation (nearly ***30MHz to 400GHz***)

19. **Write a note on Ground Wave Propagation.**

- If the electromagnetic waves transmitted by the transmitter glide over the surface of the earth to reach the receiver, then the propagation is called ground wave propagation.
- The corresponding waves are called ground waves or surface waves.
- It is mainly used in local broadcasting, radio navigation, for ship-to-ship, ship to-shore communication and mobile communication.

20. **Define Sky Wave Propagation.**

The mode of propagation in which the electromagnetic waves radiated from an antenna, directed upwards at large angle gets reflected by the ionosphere back to earth is called sky wave propagation or ionospheric propagation. The corresponding waves are called sky waves

21. **Define skip distance.**

The shortest distance between the transmitter and the point of reception of the sky wave along the surface is called as the skip distance

22. **Define skip zone.**

There is a zone in between where there is no reception of electromagnetic waves neither ground nor sky, called as skip zone or skip area.

23. **What is Space Wave Propagation?**

The process of sending and receiving information signal through space is called space wave communication. The electromagnetic waves of very high frequencies above 30 MHz are called as space waves.

24. **Define Fibre Optical Communication.**

The method of transmitting information from one place to another in terms of light pulses through an optical fiber is called fiber optic communication. It works on the principle of total internal reflection.

25. **Write a note on Mobile Communication and give its applications.**

Mobile Communication:

- Mobile communication is used to communicate with others in different locations without the use of any physical connection like wires or cables
- It enables the people to communicate with each other regardless of a particular location like office, house, etc.
- It also provides communication access to remote areas.

Applications:

- It is used for personal communication and cellular phones offer voice and data connectivity with high speed.
- Transmission of news across the globe is done within a few seconds.
- Using Internet of Things (IoT), it is made possible to control various devices from a single device.
- Example: home automation using a mobile phone.
- It enables smart classrooms, online availability of notes, monitoring student activities etc. in the field of education.

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26. **Write a note on Internet and give its applications.**

Internet:

- Internet is a fast-growing technology in the field of communication system with multifaceted tools.
- Internet is the largest computer network recognized globally that connects millions of people through computers.
- It finds extensive applications in all walks of life.

Applications:

1. Search engine:

The search engine is basically a web-based service tool used to search for information on World Wide Web.

2. Communication:

It helps millions of people to connect with the use of social networking: emails, instant messaging services and social networking tools.

3. E-Commerce:

Buying and selling of goods and services, transfer of funds are done over an electronic network.

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27. **What are called noises?**

It is the undesirable electrical signal that interfaces with the transmitted signal. Noise attenuates or reduces the quality of the transmitted signal. It may be man-made (automobiles, welding machines, electric motors etc.) or natural (lightning, radiation from sun and stars and environmental effects).

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28. **Write a note on Global Positioning System.**

Global positioning system:

- GPS stands for Global Positioning System. It is a global navigation satellite system that offers geo location and time information to a GPS receiver anywhere on or near the Earth.
- GPS system works with the assistance of a satellite network. Each of these satellites broadcasts a precise signal like an ordinary radio signal.
- These signals that convey the location data are received by a low-cost aerial which is then translated by the GPS software.

- The software is able to recognize the satellite, its location, and the time taken by the signals to travel from each satellite.
- The software then processes the data it accepts from each satellite to estimate the location of the receiver.

Applications:

Global positioning system is highly useful many fields such as (1) fleet vehicle management (for tracking cars, trucks and buses), (2) wildlife management (for counting of wild animals) and (3) engineering (for making tunnels, bridges etc).

29. **Define Range.**

It is the maximum distance between the source and the destination up to which the signal is received with sufficient strength.

30. **What are repeaters?**

- Repeaters are used to increase the range or distance through which the signals are sent. It is a combination of transmitter and receiver.
- The signals are received, amplified, and retransmitted with a carrier signal of different frequency to the destination.
- The best example is the communication satellite in space.

31. **Define attenuation.**

The loss of strength of a signal while propagating through a medium is known as attenuation.

32. **What is bandwidth of transmission system**

The range of frequencies required to transmit a piece of specified information in a particular channel is called channel bandwidth or the bandwidth of the transmission system.

33. Why mostly used fibre optic of communication in communication system?

Fiber optic cables provide the fastest transmission rate compared to any other form of transmission. It can provide data speed of 1 Gbps for homes and business. Multimode fibers operate at the speed of 10 Mbps. Recent developments in optical communication provide the data speed at the rate of 25 Gbps

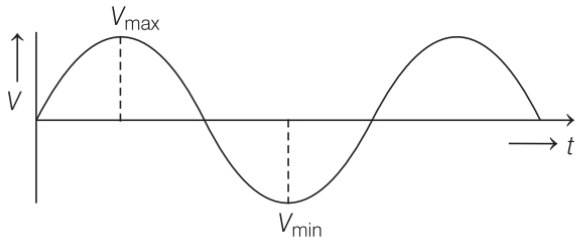
34. What are the applications of RADAR?

Radars find extensive applications in almost all fields. A few are mentioned below.

- In military, it is used for locating and detecting the targets.
- It is used in navigation systems such as ship borne surface search, air search and missile guidance systems.
- To measure precipitation rate and wind speed in meteorological observations, Radars are used.
- It is employed to locate and rescue people in emergency situations.

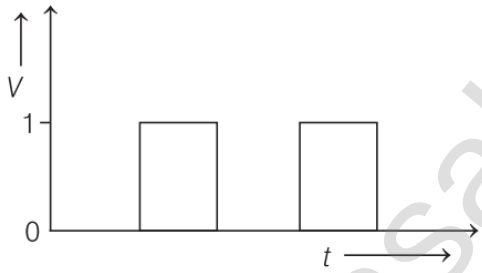
35. What is analog signal?

Analog Signal A signal in which current or voltage changes its magnitude continuously with time, is called an analog signal.



36. What is digital signal?

Digital Signal A signal in which current or voltage have only two values, is called a digital signal.



37. What is demodulation?

The process of separating of audio signal from modulated signal is called demodulation.

38. Various transmission media used for communication with their range listed below

Services	Frequency bands	Remarks
Standard AM broadcast	540-1600 kHz	Radio broadcast
FM broadcast	88-108 MHz	Music channel
Television	54-72 MHz	VHF (Very High Frequencies)
	76-88 MHz	TV
	174-216 MHz	UHF (Ultra High Frequencies)
	420-890 MHz	TV
Cellular	896-901 MHz	Mobile to base station
Mobile radio	840-935 MHz	Base station to mobile
Satellite	5.925-6.425 GHz	Uplink
Communication	3.7-4.2 GHz	Downlink

39. Frequency range and wavelength range of radio waves with its uses

S. No.	Frequency band	Frequency range	Wavelength range	Main use
1.	Very-Low Frequency (VLF)	3 kHz to 30 kHz	10 km to 100 km	Long distance point to point communication
2.	Low Frequency (LF)	30 kHz to 300 kHz	1 km to 10 km	Marine and navigational purposes
3.	Medium Frequency (MF)	300 kHz to 3 MHz	100 m to 1 km	Marine and broadcasting purposes
4.	High Frequency (HF)	3 MHz to 30 MHz	10 m to 100 m	Communication of all types
5.	Very-High Frequency (VHF)	30 MHz to 300 MHz	1 m to 10 m	T V Radar and air navigation
6.	Ultra-High Frequency (UHF)	300 MHz to 3000 MHz	10 cm to 1 m	Radar and microwave communication
7.	Super-High-Frequency (SHF)	3 GHz to 30 GHz	1 cm to 10 cm	Radar, Radio relays and navigation purposes
8.	Extremely-High-Frequency (EHF)	30 GHz to 300 GHz	1 mm to 1 cm	Optical fibre communication

40. Earth's atmosphere

The gaseous envelope surrounding the earth is called earth's atmosphere. It contains the following layers.

(i) **Troposphere** This region extends upto a height of 12 km from earth's surface.

(ii) **Stratosphere** This region extends from 12 km to 50 km. In this region, most of the atmospheric ozone is concentrated from 30 to 50 km. This layer is called ozone layer.

(iii) **Mesosphere** The region extends from 50 km to 80 km.

(iv) **Ionosphere** This region extends from 80 km to 400 km.

In ionosphere the electron density is very large in a region beyond 110 km from earth's surface which extends vertically for a few kilometres. This layer is called **Kennelly Heaviside layer.**

41. Skip distance

Skip Distance The minimum distance from the transmitter at which a sky wave of a frequency but not more than critical frequency, is sent back to the earth.

$$\text{Skip distance } (D_{skip}) = 2h\sqrt{\left(\frac{\nu_{max}}{\nu_c}\right)^2 - 1}$$

where h is height of reflecting layer of atmosphere,
ν_{max} is maximum frequency of electromagnetic waves and
ν_c is critical frequency.

5Mark Question and Answer

1. **Write a note on internet and give its applications.**

Internet is a fast-growing technology in the field of communication system with multifaceted tools. Internet is the largest computer network recognized globally that connects millions of people through computers. It finds extensive applications in all walks of life.

Applications: Search engine:

The search engine is basically a web-based service tool used to search for information on World Wide Web.

Communication:

It helps millions of people to connect with the use of social networking: emails, instant messaging services and social networking tools.

E-Commerce:

Buying and selling of goods and services, transfer of funds are done over an electronic network.

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2. **Write a note on Global positioning system. Global positioning system:**

- GPS stands for Global Positioning System. It is a global navigation satellite system that offers geo location and time information to a GPS receiver anywhere on or near the Earth. **GPS system works with the assistance of a satellite network. Each of these satellites broadcasts a precise signal like an ordinary radio signal.**
- These signals that convey the location data are received by a low-cost aerial which is then translated by the GPS software.
- The software is able to recognize the satellite, its location, and the time taken by the signals to travel from each satellite. The software then processes the data it accepts from each satellite to estimate the location of the receiver.

Applications:

Global positioning system is highly useful many fields such as

(1) Fleet vehicle management (for tracking cars, trucks and buses),

(2) Wildlife management (for counting of wild animals) and

(3) Engineering (for making tunnels, bridges etc.).

---

3. **What do you mean by Internet of Things?**

Using Internet of Things (IOT), it is made possible to control various devices from a single device. (e.g.) Home automation using a mobile phone.

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4. **Distinguish between wire-line and wireless communication?**

Wire line communication:

Specify the range of electromagnetic waves in which it is used. Wire line communication. It is a point-point communication) uses mediums like wires, cables and optical fibers. These systems cannot be used for long distance transmission as they are connected physically. Examples are telephone, intercom and cable TV.

Wireless communication

It uses free space as a communication medium. The signals are transmitted in the form of electromagnetic waves with the help of a transmitting antenna. Hence wireless communication is used for long distance transmission. Examples are mobile, radio or TV broadcasting, and satellite communication.

---

5. **What are called noises?**

It is the undesirable electrical signal that interfaces with the transmitted signal. Noise attenuates or reduces the quality of the transmitted signal. It may be man-made (automobiles, welding machines, electric motors etc.) or natural (lightning, radiation from sun and stars and environmental effects).

---

6. **Explain the amplitude modulation(AM) with necessary diagrams. Give its advantages and limitations** If the amplitude of the carrier signal is modified in proportion to the instantaneous amplitude of the baseband , then it is called amplitude modulation.

- Here the frequency and the phase of the carrier signal remain constant.
- Amplitude modulation is used in radio and TV broadcasting.
- The signal shown in Figure (a) is the baseband signal that carries information.

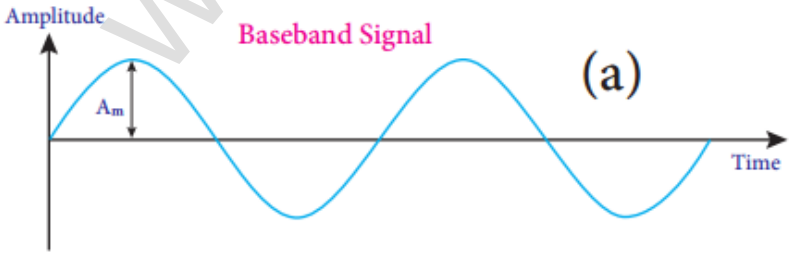
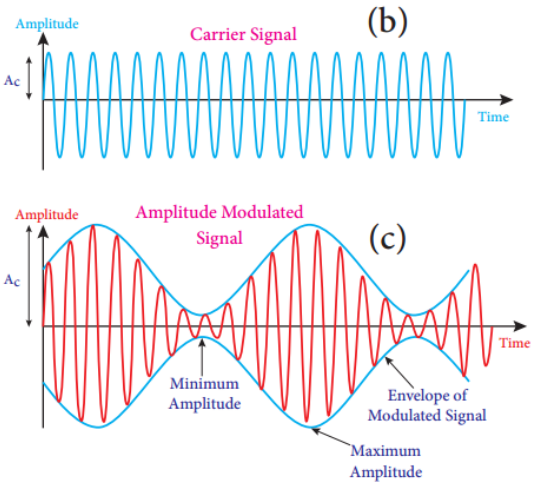


Figure (b) shows the high-frequency carrier signal and Figure (c) gives amplitude modulated signal.



We can see that amplitude of the carrier is modified in proportion to the amplitude of the baseband signal.

Advantages of AM

i) Easy transmission and reception
ii) Lesser bandwidth requirements
iii) Low cost

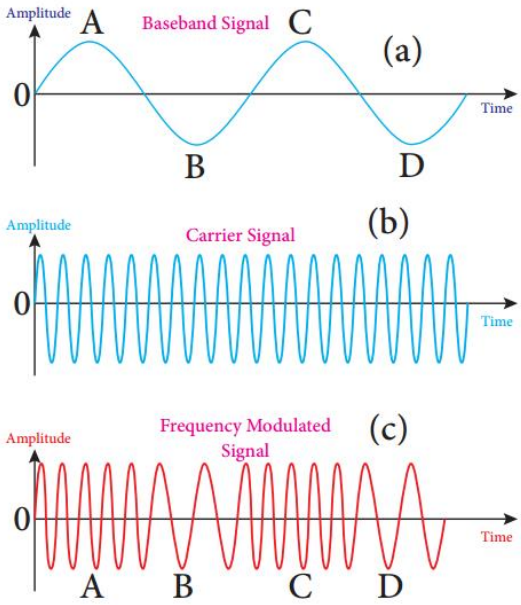
Limitations of AM

i) Noise level is high
ii) Low efficiency
iii) Small operating range

---

7. Explain the frequency modulation (FM) with necessary diagrams. Give its advantages and limitations

- **The frequency of the carrier signal is modified in proportion to the instantaneous amplitude of the baseband signal in frequency modulation.**
- Here the amplitude and the phase of the carrier signal remain constant.
- Increase in the amplitude of the baseband signal increases the frequency of the carrier signal and vice versa.



- When the amplitude of the baseband signal is zero in Figure (a), the frequency of the modulated signal is the same as the carrier signal.
- The frequency of the modulated wave increases when the amplitude of the baseband signal increases in the positive direction (A, C).
- The increase in amplitude in the negative half cycle (B, D) reduces the frequency of the modulated wave (Figure (c)).
- When the frequency of the baseband signal is zero (no input signal), there is no change in the frequency of the carrier wave.
- It is at its normal frequency and is called as **centre frequency or resting frequency.**
- Practically this is the allotted frequency of the FM transmitter.

Advantages of FM

(i) Large decrease in noise. This leads to an increase in signal-noise ratio.

(ii) The operating range is quite large.

(iii) The transmission efficiency is very high as all the transmitted power is useful.

(iv) FM bandwidth covers the entire frequency range which humans can hear. Due to this, FM radio has better quality compared to AM radio. **Limitations of FM**

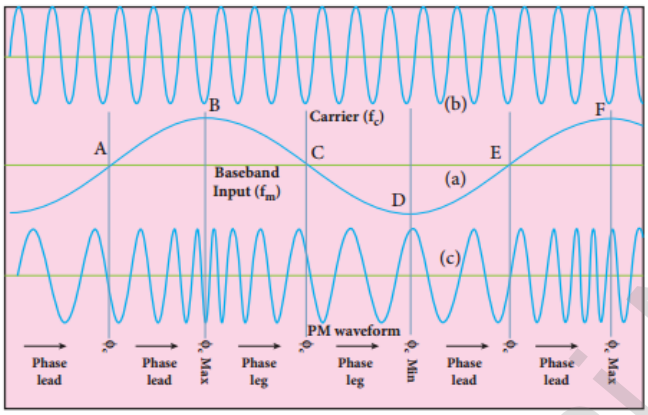
I) FM requires a much wider channel.

ii) FM transmitters and receivers are more complex and costly.

iii) In FM reception, less area is covered compared to AM.

8. Explain the phase modulation (PM) with necessary diagrams. Give its advantages and limitations

In phase modulation, the instantaneous amplitude of the baseband signal modifies the phase of the carrier signal keeping the amplitude and frequency constant



- The carrier phase changes according to increase or decrease in the amplitude of the baseband signal.
- When the modulating signal goes positive, the amount of phase lead increases with the amplitude of the modulating signal.
- Due to this, the carrier signal is compressed or its frequency is increased.
- On the other hand, the negative half cycle of the baseband signal produces a phase lag in the carrier signal.
- This appears to have stretched the frequency of the carrier wave.
- Hence similar to frequency modulated wave, phase modulated wave also comprises of compressions and rarefactions.
- When the signal voltage is zero (A, C and E) the carrier frequency is unchanged.
- The frequency shift in carrier wave frequency exists in phase modulation as well.

The frequency shift depends on

(i) amplitude of the modulating signal and

(ii) (ii) the frequency of the signal.

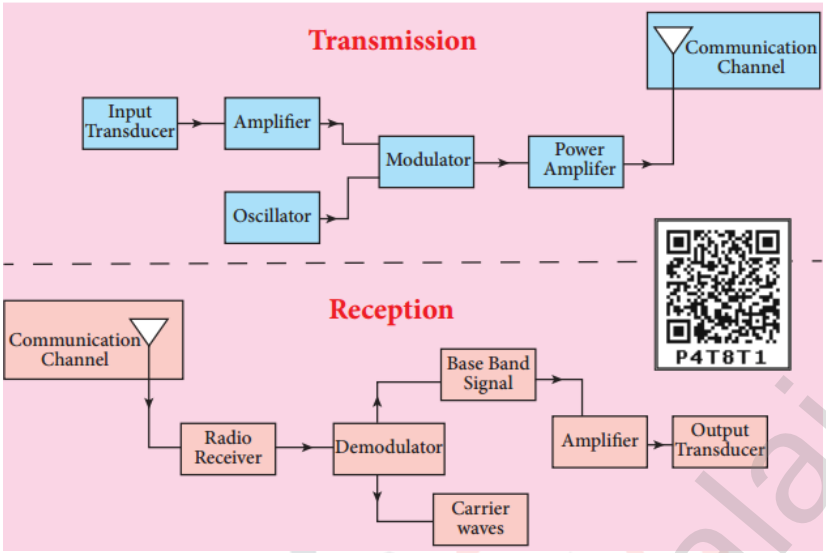
Advantages of PM

i) FM signal produced from PM signal is very stable.

ii) The centre frequency called resting frequency is extremely stable.

9. Explain the basic elements of communication system with the necessary block diagram.

The elements of the basic communication system are explained with the block diagram shown in Figure



1. Information (Baseband or input signal)

Information can be in the form of speech, music, pictures, or computer data. This information is given as input to the input transducer.

2. Input transducer

- A transducer is a device that converts variations in a physical quantity (pressure, temperature, sound) into an equivalent electrical signal or vice versa.
- **The electrical equivalent of the original information is called the baseband signal.**
- The best example for the transducer is the microphone that converts sound energy into electrical energy.

3. Transmitter

- It feeds the electrical signal from the transducer to the communication channel.
- It consists of circuits such as amplifier, oscillator, modulator and power amplifier.
- The transmitter is located at the broadcasting station.

Amplifier:

- The transducer output is very weak and is amplified by the amplifier.

Oscillator:

- It generates high-frequency carrier wave (a sinusoidal wave) for long distance transmission into space.
- As the energy of a wave is proportional to its frequency, the carrier wave has very high energy.

Modulator:

It superimposes the baseband signal onto the carrier signal and generates the modulated signal.

Power amplifier:

It increases the power level of the electrical signal in order to cover a large distance.

4. **Transmitting antenna**

   It radiates the radio signal into space in all directions. It travels in the form of electromagnetic waves with the velocity of light (3×10^8 ms^{-1}).

5. **Communication channel**

   Communication channel is used to carry the electrical signal from transmitter to receiver with less noise or distortion.

The communication medium is basically **of two types**:

- ***wireline communication and wireless communication.*** **Wireline communication** (point to point communication) uses mediums like wires, cables and optical fibers.
- These systems cannot be used for long distance transmission as they are connected physically.
- Examples are telephone, intercom and cable TV.
- **Wireless communication** uses free space as a communication medium.
- The signals are transmitted in the form of electromagnetic waves with the help of a transmitting antenna.
- Hence wireless communication is used for long distance transmission. Examples are mobile, radio or TV broadcasting and satellite communication.

6. Noise

- It is the undesirable electrical signal that interferes with the transmitted signal.
- Noise attenuates or reduces the quality of the transmitted signal. It may be man-made (automobiles, welding machines, electric motors etc.) or natural (lightning, radiation from sun and stars and environmental effects).
- Noise cannot be completely eliminated.
- However, it can be reduced using various techniques.

7. Receiver

- The signals that are transmitted through the communication medium are received by a receiving antenna which converts em waves into RF signals and are fed into the receiver.
- The receiver consists of electronic circuits like demodulator, amplifier, detector etc.
- The demodulator extracts the baseband signal from the modulated signal.
- Then the baseband signal is detected and amplified using amplifiers. Finally, it is fed to the output transducer.

8. Repeaters

- Repeaters are used to increase the range or distance through which the signals are sent.
- It is a combination of transmitter and receiver.
- The signals are received, amplified and retransmitted with a carrier signal of different frequency to the destination.
- The best example is the communication satellite in space.

9.Output transducer

- It converts the electrical signal back to its original form such as sound, music, pictures or data.
- Examples of output transducers are loudspeakers, picture tubes, computer monitor, etc.

10. Attenuation

- The loss of strength of a signal while propagating through a medium is known as attenuation.

11.Range

- It is the maximum distance between the source and the destination up to which the signal is received with sufficient strength.

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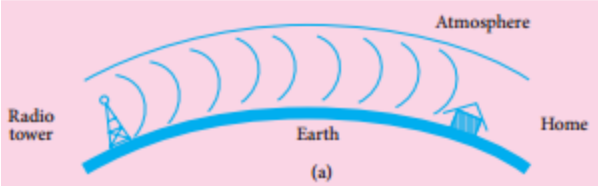
10. Explain the three modes of propagation of electromagnetic waves through space.

- The information signal modulated with the carrier wave (radio wave) is transmitted by an antenna.
- This travels through space and is received by the receiving antenna at the other end.
- The frequencies from 2 kHz to 400 GHz are transmitted through wireless communication.
- The electromagnetic wave transmitted by the transmitter travels in three different modes to reach the receiver according to its frequency range:
  • Ground wave propagation (or) surface wave propagation (nearly 2 Hz to 2 MHz)
  • Sky wave propagation (or) ionospheric propagation (nearly 3 MHz to 30 MHz)
  • Space wave propagation (nearly 30 MHz to 400 GHz)
- **<u>GROUND WAVE PROPAGATION (nearly 2 kHz to 2 MHz)</u>**

If the electromagnetic waves transmitted by the transmitter glide over the surface of the earth to reach the receiver, then the propagation is called ground wave propagation. The corresponding waves are called ground waves or surface waves.
The pictorial representation is shown in Figure (a).



Both transmitting and receiving antennas must be close to the earth.

The size of the antenna plays a major role in deciding the efficiency of the radiation of signals.

During transmission, the electrical signals are attenuated over a distance. Some reasons for attenuation are as follows:

•Increasing distance:

The attenuation of the signal with distance depends on

(i) power of the transmitter

(ii) frequency of the transmitter and

(iii)condition of the Earth surface.

•Absorption of energy by the Earth:

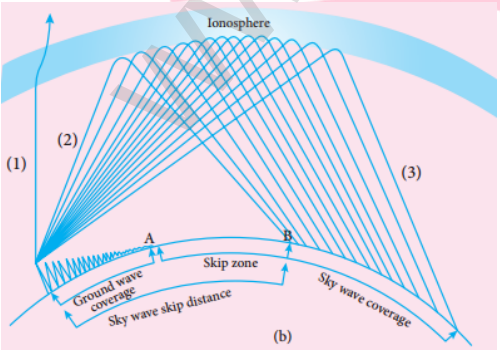
When the transmitted signal in the form of EM wave is in contact with the Earth, it induces charges in the Earth and constitutes a current. Due to this, the Earth behaves like a leaky capacitor which leads to the attenuation of the wave.

• Tilting of the wave:

- As the wave progresses, the wavefront starts gradually tilting according to the curvature of the Earth.
- This increase in the tilt decreases the electric field strength of the wave.
- Finally, at some distance, the surface wave dies out due to energy loss.
- The frequency of the ground waves is mostly less than 2 MHz as high frequency waves undergo more absorption of energy at the earth's atmosphere.

<u>• Sky wave propagation (or) ionospheric propagation (nearly 3 MHz to 30 MHz)</u>

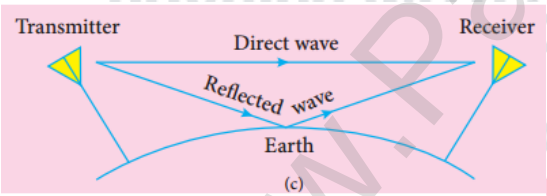
The mode of propagation in which the electromagnetic waves radiated from an antenna, directed upwards at large angles, gets reflected by the ionosphere back to earth is called sky wave propagation or ionospheric propagation. The corresponding waves are called sky waves (b).



- The frequency range of EM waves in this mode of propagation is 3 to 30 MHz.
- EM waves of frequency more than 30 MHz can easily penetrate through the ionosphere and does not undergo reflection.
- Extremely long-distance communication is also possible as the radio waves can undergo multiple reflections between the earth and the ionosphere.
- A single reflection helps the radio waves to travel a distance of approximately 4000 km. Ionosphere acts as a reflecting surface.
- It is at a distance of approximately 50 km and spreads up to 400 km above the Earth surface.
- The phenomenon of bending the radio waves back to earth is nothing but the total internal reflection.
- **The shortest distance between the transmitter and the point of reception of the sky wave along the surface is called as the skip distance** shown in Figure (b).
- If the angle of emission is increased further, the reception of sky waves starts at point B in the Figure (b).
- **There is a zone (in between A and B) where there is no reception of electromagnetic waves neither ground nor sky, called as skip zone or skip area.**

SPACE WAVE PROPAGATION

The process of sending and receiving information signal through space is called space wave communication (Figure (c)). The electromagnetic waves of very high frequencies above 30 MHz are called as space waves.

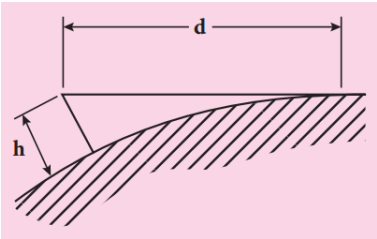


- The electromagnetic waves of very high frequencies above 30 MHz are called as space waves.
- These waves travel in a straight line from the transmitter to the receiver. Hence, it is used for a line of sight communication (LOS).
- ϖ The communication systems like television telecast, satellite communication and RADAR are based on space wave propagation.
- Microwaves having high frequencies (super high frequency band) are used against radio waves due to certain advantages:
- Larger bandwidth,
- High data rates,
- Better directivity,
- Small antenna size,

- Low power consumption, etc.
- The range or distance (d) of coverage of the propagation depends on the height (h) of the antenna given by the equation, $d = \sqrt{2Rh}$

Where R is the radius of the Earth and it is 6400 km.

The distance of coverage is shown pictorially in Figure below.



11. Fiber optic communication is gaining popularity among the various transmission media -justify.

- Fiber optic cables provide the fastest transmission rate compared to any other form of transmission.
- It can provide data speed of 1 Gbps for homes and business.
- Multimode fibers operate at the speed of 10 Mbps.
- Recent developments in optical communication provide the data speed at the rate of 25 Gbps.
- Fiber cables are very thin and weigh lesser than copper cables.
- This system has much larger band width. This means that its information carrying capacity is larger.
- Fiber optic system is immune to electrical interferences.
- Fiber optic cables are cheaper than copper cables.
- Hence, Fiber optic communication is gaining popularity among the various transmission media.

12. Applications of satellite communication

Satellites are classified into different types based on their applications. Some satellites are discussed below.

i) **Weather Satellites:**

They are used to monitor the weather and climate of Earth. By measuring cloud mass, these satellites enable us to predict rain and dangerous storms like hurricanes, cyclones etc.

ii) **Communication satellites:**

They are used to transmit television, radio, internet signals etc. Multiple satellites are used for long distances.

iii) **Navigation satellites:**

These are employed to determine the geographic location of ships, aircrafts or any other object.

13. Applications, merits and demerits of fibre optic communication

Applications

Optical fiber system has a number of applications namely, international communication, inter-city communication, data links, plant and traffic control and defense applications.

Merits

i) Fiber cables are very thin and weigh lesser than copper cables.
ii) This system has much larger band width. This means that its information carrying capacity is larger.
iii) Fiber optic system is immune to electrical interferences.
iv) Fiber optic cables are cheaper than copper cables.

Demerits

i) Fiber optic cables are more fragile when compared to copper wires.
ii) It is an expensive technology

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14. Applications of mobile communication

i) It is used for personal communication and cellular phones offer voice and data connectivity with high speed.
ii) Transmission of news across the globe is done within a few seconds.
iii) Using Internet of Things (IoT), it is made possible to control various devices from a single device. Example: home automation using a mobile phone.
iv) It enables smart classrooms, online availability of notes, monitoring student activities etc. in the field of education.

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15. Modulation helps to reduce the antenna size in wireless communication – Explain.

Antenna:

Antenna is used at both transmitter and receiver end. Antenna height is an important parameter to be discussed. The height of the antenna must be a multiple of $\frac{\lambda}{4}$.

Where $\lambda \rightarrow$ Wavelength $[\lambda = c\ v]$

$c \rightarrow$ Velocity of light and $v \rightarrow$ frequency of the signal.

Let us consider two baseband signals. One signal is modulated and the other is not modulated. The frequency of the original baseband signal (un-modulated) is taken as v = 10 kHz while the modulated signal is v = 1 MHz. The height of the antenna required to transmit the original baseband signal of frequency v = 10 kHz is

$$h_1 = \frac{\lambda}{4} = \frac{c}{4\,v} = \frac{3 \times 10^8}{4 \times 10 \times 10^3} = 7500 \text{ m}$$

The height of the antenna required to transmit the modulated signal of frequency v = 1 MHz is

$$h_2 = \frac{\lambda}{4} = \frac{c}{4\,v} = \frac{3 \times 10^8}{4 \times 1 \times 10^3} = 75 \text{ m}$$

We can infer that it is practically feasible to construct an antenna of height 75 m while the one with 7.5 km is not possible. It clearly manifests that modulated signals reduce the antenna height and are required for long distance transmission.