

Communication System

EXERCISE

20.0 : Introduction

Q.1. What is communication? How was communication made in ancient times?

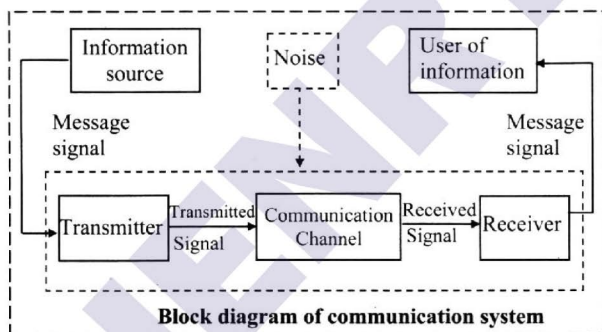
- Ans:** i. The process of sending and receiving information is known as communication. Example: Radio, T.V, fax, mobile, etc. Human beings convey their thoughts, ideas and feelings to one another by means of communication.
- ii. In ancient times, communication was made possible by messengers who used to travel on foot or horseback. In some cases, communication was made possible by waving hands, lighting fires, beating drums, etc.

20.1 : Elements of a communication system

Q.2. Define communication system. With a block diagram, explain elements of a communication system.

Ans: Definition:

The set up used to send and receive information from one place to another is called communication system.



Elements of a communication system:

i. Transmitter:

- It converts the message signal produced by the source of information into a form suitable for transmission through a channel and subsequent reception.
- If the output of the information source is a non-electrical signal like a voice signal, a transducer is used which

converts it into electrical form before giving it as an input to the transmitter.

ii. Communication channel:

- It is the medium that bridges the information source to destination. Example: pair of wires, co-axial cables, laser beam etc.
- Every channel introduces some amount of transmission loss or attenuation, therefore signal power in the transmission channel progressively decreases.

iii. Receiver:

- It is a device which extracts the original signal from the modulated signal.
- It consists of a pick up antenna to pick up signal, demodulator, an amplifier and the transducer.
- The receiver reconstructs a recognizable form of the original message signal for delivering it to the user of information.

Q.3. Draw a neat, labelled block diagram for a generalised communication system.

[Oct 14]

Ans: Refer Q.2 (Diagram)

Q.4. Explain the terms:

- Transmitter and
- Receiver in communication system.

[Mar 14]

Ans: i. Transmitter:

- It converts the message signal produced by the source of information into a form suitable for transmission through a channel and subsequent reception.
- If the output of the information source is a non-electrical signal like a voice signal, a transducer is used which converts it into electrical form before giving it as an input to the transmitter.

iii. Receiver:

- It is a device which extracts the original signal from the modulated signal.

- b. It consists of a pick up antenna to pick up signal, demodulator, an amplifier and the transducer.
- c. The receiver reconstructs a recognizable form of the original message signal for delivering it to the user of information.

Q.5.State two basic modes of communications.

Ans: Two basic modes of communications are as follow:

i. Point-to-point communication:

In this mode, communication takes place over a link between a single transmitter and a receiver.

Example: Telephony

ii. Broadcast:

In this mode, there are large number of receivers corresponding to a single transmitter.

Example: Radio, Television etc.

Q.6.What is signal? Explain different types of information signals.

Ans: Signal:

A signal is a single-valued function of time that carries the information.

Usually, it is in electrical form and is suitable for transmission.

Types of signals:

i. Analog signal:

Analog signal is the physical manifestation of a physical quantity that varies continuously with time.

Example: Sound and picture signals in T.V

ii. Digital signal:

Those signals which can take only discrete step-wise values are called digital signals. In digital signal, amplitude of wave is discontinuous. Examples: BCD(Binary Coded Decimal), ASCII (American Standard Code for Information Interchange).

Q.7.Explain the following terms.

- i. Transducer
- ii. Amplification
- iii. Noise
- iv. Repeater

Ans: i. Transducer:

- a. A transducer is a device, which converts one form of energy into another.

- b. An electrical transducer is one, which converts some physical variable, such as displacement, pressure, force, temperature, etc into corresponding variations in the electrical signals at its output.

ii. Amplification:

- a. Amplification is the process of increasing the strength of the signal by making use of an amplifier.
- b. As the signal propagates, its strength decreases. As a result, the signal received at the destination may not be of adequate strength so as to be efficiently reproduced.
- c. To compensate for the loss of strength of the signal, its amplification has to be done using an electronic circuit, called amplifier.

iii. Noise:

- a. Noise is a form of amplitude variations in the signal.
- b. The source of noise is usually due to atmospheric electricity, fluctuations of electric power in industries, etc.
- c. Noise produces unwanted signals, which accompany the original signal.

iv. Repeater:

- a. Repeater is a combination of receiver and transmitter placed along the path of signal so as to extend the range of the communication system.
- b. When the distance of destination from the transmitter is very large or the transmitted signal is obstructed by mountains, repeaters are installed along the path of the signal.
- c. It picks up the signal, amplifies it and then again transmits it to the receiver.

Q.8.Define the following terms.

- i. Range
- ii. Attenuation
- iii. Demodulation
- iv. Carrier waves

Ans: i. Range:

The maximum (largest) distance between a source and a destination upto which a signal is received with sufficient strength is called as range.

ii. Attenuation:

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

iii. Demodulation:

The process of recovering of information from a modulated carrier wave at the receiver is known as demodulation.

iv. Carrier waves:

The high frequency waves on which the signals to be transmitted are superimposed are called carrier waves.

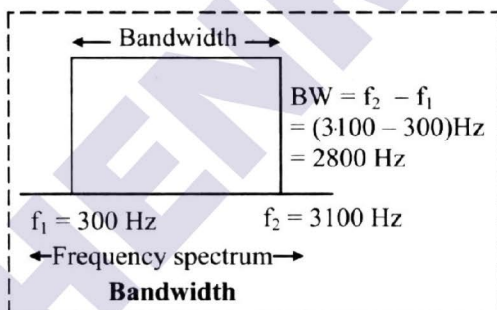
20.2 : Bandwidth of signals

Q.9. What is meant by 'bandwidth'?

- Ans:** i. Bandwidth is the portion of electromagnetic spectrum occupied by a signal.
- ii. It is the frequency range over which an information signal is transmitted or over which a receiver or other electronic circuit operates.

Q.10. Write a note on bandwidth of signals.

- Ans:** i. Bandwidth is the frequency range over which an information signal is transmitted or over which a receiver or other electronic circuits operate
- ii. In a communication system, the message signal can be voice, music, picture or computer data; each having a different ranges of frequencies. The type of communication system for given signal depends on the band of frequencies.
- iii. Bandwidth is the difference between the upper and lower frequency limits of the signal or the equipment operation range.



- iv. The bandwidth of speech (voice) frequency range from 300 to 3100 Hz. Therefore, speech signal requires a bandwidth of 2800 Hz (3100--300) for commercial telephonic communication.
- v. To transmit music, an approximate bandwidth of 20 kHz is required because of

the high frequencies produced by the musical instruments. The audible range of frequencies ranges from 20Hz to 20kHz.

- vi. Video signals require bandwidth about 4.2 MHz to transmit pictures. As TV signal contains both voice and picture, it is allocated 6 MHz of bandwidth for transmission.

Q.11. State the frequency range of different waves in AM band and FM band.

Ans: Frequency range of amplitude modulation (AM) band:

High Frequency (HF)	3 MHz to 30 MHz
Very High Frequency (VHF)	30 MHz to 300 MHz
Ultra High Frequency (UHF)	300 MHz to 3000 MHz
Super High Frequency (SHF)	3 GHz to 30 GHz (80 to 108 MHz)

Frequency range of amplitude modulation (FM) band:

Extra High Frequency (EHF)	30 GHz to 300 GHz
----------------------------	-------------------

Q.12. Why is a high bandwidth (20 kHz) required to transmit music signal?

Ans: To transmit music signal, a high bandwidth approximately 20 kHz is required because of high frequency produced by the musical instruments.

Note:

Various frequency bands:

Extremely Low Frequency (ELF)	30 Hz to 300 Hz
Voice Frequency (VF)	300 Hz to 3000 Hz
Very Low Frequency (VLF)	3 kHz to 30 kHz
Low Frequency (LF)	30 kHz to 300 kHz
Medium Frequency (MF)	300 kHz to 3000 kHz

20.3 : Bandwidth of transmission medium

Q.13. Explain bandwidth of transmission media.

- Ans:** i. Different types of transmission media offer different band widths. The commonly used transmission media are wire, free space and fibre optic cable.
- ii. Coaxial cable is a widely used wire medium, which offers a bandwidth of approximately 750 MHz. Such cables are normally operated below 18 GHz.

- iii. Communication through free space using radio waves takes place over a very wide range of frequencies from a few hundreds of kHz to a few GHz.
- iv. The frequency range of 1 THz to 1000 THz (i.e. from microwave to ultraviolet region) is used in communication using fibre optic cables. The band width of such optic fibre is more than 100 GHz.

Note:

Some important wireless communication frequency bands are as follows:

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	T.V
	174 - 216 MHz	UHF(Ultra High Frequencies)
	420 - 890 MHz	T.V

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

Q.14. In which frequency range optical communication through fibre is performed?

Ans: Optical communication through optical fibre is performed through the frequency range of 1 THz to 1000 THz (microwaves to ultraviolet)

Q.15. State 'different types of guided media.

Ans: Different types of guided media:

- i. Parallel wire
- ii. Twisted pair
- iii. Co-axial cable
- iv. Fibre optic cable

20.4 : Need for modulation

Q.16. What do you mean by base band signals?

- Ans:**
- i. The message signals which designate (mark-out) the band of frequencies representing the original signal, as directed by the source of information are called base band signals.
 - ii. No signal is a single frequency sinusoid, but it spreads over a range of frequencies called

the signal band width.

Q.17. State the factors which affect the transmission of electronic signal in the audio frequency range.

Ans: Following factors affect the transmission of electronic signal in the audible frequency range.

- i. Size of the antenna or aerial.
- ii. Effective power radiated by an antenna.
- iii. Mixing up of signals from different transmitters.

Q.18. How 'does size of the antenna affect direct transmission of baseband signal?

Ans: i. For transmitting a signal, we need an antenna or an aerial. This antenna should have length comparable to the wavelength of the signal (at least $\lambda/4$) so that the antenna properly senses the time variation of signal.

- ii. For an electromagnetic wave of frequency 20 kHz, wavelength λ is 15 km. Obviously, vertical antenna of this size is impracticable. Hence, direct transmission of such baseband signals is not practical.

Q.19. How does power radiation affect the transmission of baseband signals?

Ans: i. The power radiated is proportional to $(l/\lambda)^2$. This implies that for the same antenna length, the power radiated increases with decreasing λ , i.e. increasing frequency.

- ii. Hence, the effective power radiated by a long wavelength baseband signal would be small.
- iii. For a good transmission, we need high power and hence this also points out the need of using high frequency transmission.

Q.20. Why can audio signal not be transmitted directly into space?

Ans: i. All sound is concentrated within the range from 20 Hz to 20 kHz. So all signals from the different sources would inseparably mixed up.

- ii. In any city, the broadcasting stations alone would completely blanket the "air" and yet they represent a very small proportion of the total number of transmitters in use.

Q.21. What is modulation? State different types of modulation.

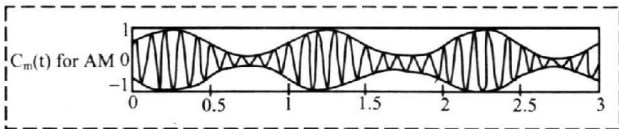
Ans: The process of superimposing a low frequency signal on a high frequency wave, which acts as a carrier wave for long distance transmission is

known as modulation.

There are three types of modulation.

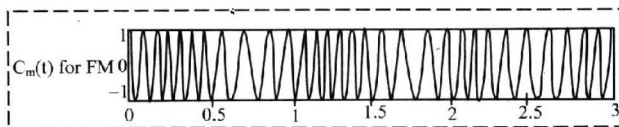
i. Amplitude modulation (AM):

When the amplitude of carrier wave is varied in accordance with the modulating signal, the process is called amplitude modulation.



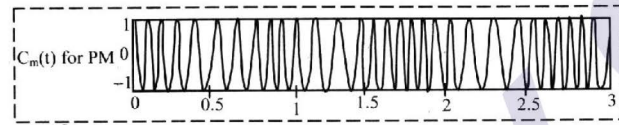
ii. Frequency modulation (FM):

When the frequency of carrier wave is varied in accordance with the modulating signal, the process is called frequency modulation.



iii. Phase modulation (PM):

When the phase angle of the carrier wave is varied in accordance with the modulating signal, the process is called phase modulation.



Q.22. Explain need for modulation.

Ans: Need for modulation:

- i. An unmodulated carrier has a constant amplitude, a constant frequency and a constant phase relationship with respect to some reference.
- ii. A message consists of ever-varying quantities. Speech, for instance is made up of rapid and unpredictable variations in amplitude (volume) and frequency (pitch).
- iii. Since it is impossible to represent these two variables by a set of three constant parameters, an unmodulated carrier cannot be used to convey information.
- iv. The above discussion suggests that there is a need for translating the original low frequency base band signal or information message into high frequency wave before transmission such that the translated signal continues to possess the information

contained in the original signal.

Q.23. Explain different types of carrier waves.

- Ans:**
- i. High frequency waves on which signals to be transmitted are superimposed are called carrier waves.
 - ii. Carrier waves are either in the form of continuous (sinusoidal) or pulses as shown in figure.

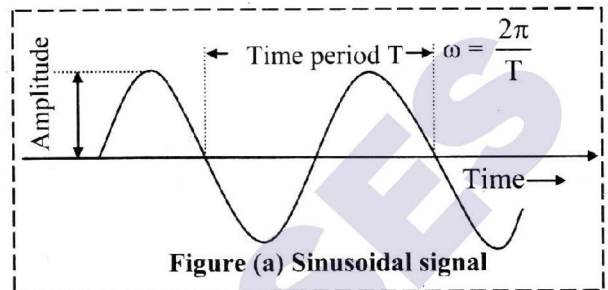


Figure (a) Sinusoidal signal

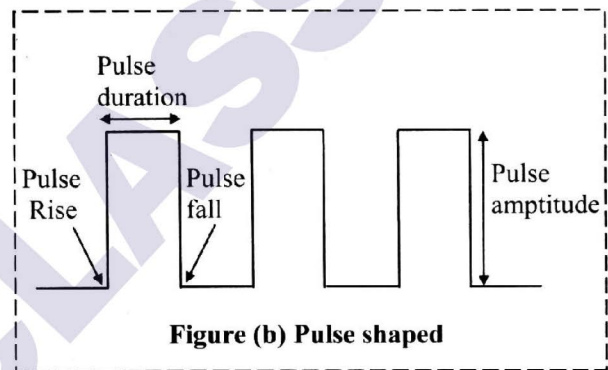


Figure (b) Pulse shaped

- iii. A sinusoidal carrier wave can be represented as,

$$c(t) = A_c \sin(\omega_c t + \phi)$$
 where, $c(t)$ is the signal strength (voltage or current), A_c is the amplitude, $\omega_c (= 2\pi f_c)$ is the angular frequency and ϕ is the initial phase of carrier wave.
- iv. During the process of modulation, any of the three parameters viz. A_c , ω_c and ϕ of the carrier wave can be controlled by the message or information signal resulting into three types of modulation namely, amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM).

Q.24. What is amplitude modulation?

- Ans:**
- i. In amplitude modulation, the amplitude of the carrier wave is varied in accordance with the information (modulating) signal.
 - ii. To explain this, consider a sinusoidal signal as the modulating signal.

Let $c(t) = A_c \sin \omega_c t$ represent a carrier wave and $m(t) = A_m \sin \omega_m t$ represent the message or the modulating signal where, $\omega_m = 2\pi f_m$ is the angular frequency of the message signal.

iii. The modulated signal $c_m(t)$ can be written as,

$$\begin{aligned} c_m(t) &= [c(t) + m(t)] \sin \omega_c t \\ &= [A_c + A_m \sin \omega_m t] \sin \omega_c t \\ &= A_c \left(1 + \frac{A_m}{A_c} \sin \omega_m t \right) \sin \omega_c t \end{aligned}$$

Thus, the modulated signal contains the message signal.

iv. Equation (i) can be written as,

$$\begin{aligned} c_m(t) &= A_c \sin \omega_c t + \\ &\mu A_c \sin \omega_m t \cdot \sin \omega_c t \quad \dots(ii) \end{aligned}$$

where $\mu = \frac{A_m}{A_c}$ is the modulation index.

(or modulating factor or 'degree of modulation')

In practice, μ is kept ≤ 1 to avoid distortion.

v. By using, $\sin A \cdot \sin B$

$$= \frac{1}{2} [\cos(A - B) - \cos(A + B)],$$

equation (ii) can be written as,

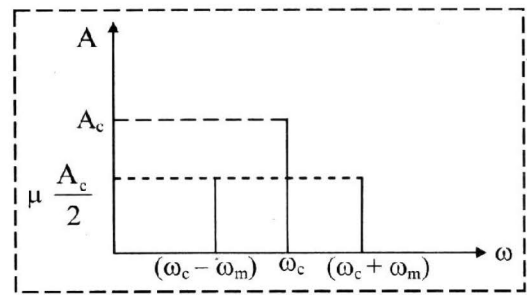
$$\begin{aligned} c_m(t) &= A_c \sin \omega_c t + \mu A_c \cos(\omega_c - \omega_m)t \\ &\quad - \frac{\mu A_c}{2} \cos(\omega_c + \omega_m)t \end{aligned}$$

Here, $(\omega_c - \omega_m)t$ and $(\omega_c + \omega_m)$ are called the lower side and upper side frequencies respectively.

vi. The modulated signal consists of the carrier wave, of frequency ω_c plus two sinusoidal waves each with a frequency slightly different from ω_c , known as side bands.

Q.25. Plot amplitude versus ω curve for an amplitude modulated signal.

Ans: A plot of amplitude versus ω of an amplitude modulated signal is as shown in figure.



$(\omega_c - \omega_m)$ and $(\omega_c + \omega_m)$ are respectively called the lower side and upper side frequencies.

Q.26. What is modulation index?

Ans: i. The modulation index (μ) of an AM wave is the ratio of the amplitudes of the modulating signal (A_m) and carrier wave (A_c).

ii. Modulation index, $\mu = \frac{A_m}{A_c}$

iii. A moderate value of modulation index is desirable so as to avoid distortion in the wave form.

Note:

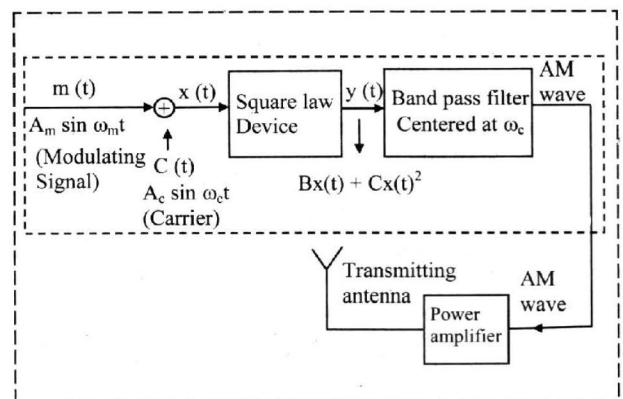
- The antenna works efficiently when its size is greater than $\frac{\lambda}{4}$.
- The length of an antenna is such that it acts as a resonant circuit at the frequency of operation.

20.5 : Production and detection of an amplitude modulated wave

Q.27. With a neat labelled diagram, explain the production of amplitude modulation.

Ans: Production of amplitude modulation:

i. The block diagram depicts a simple method of the production of AM waves.



- ii. The modulating signal $A_m \sin \omega_m t$ is superimposed on the carrier wave $A_c \sin \omega_c t$ to get a signal given by the equation,
 $x(t) = A_m \sin \omega_m t + A_c \sin \omega_c t$
- iii. This signal is now passed through a square law device (a non-linear device) which produces a wave given by the equation,
 $y(t) = Bx(t) + Cx^2(t)$
 where, B and C are constants

$$\therefore y = B[A_m \sin \omega_m t + A_c \sin \omega_c t] + C[A_m \sin \omega_m t + A_c \sin \omega_c t]^2$$

$$\therefore y = BA_m \sin \omega_m t + BA_c \sin \omega_c t + CA_m^2 \sin^2 \omega_m t + CA_c^2 \sin^2 \omega_c t + 2CA_m A_c \sin \omega_m t \sin \omega_c t \quad \dots (i)$$

iv. But, $\sin^2 \omega t = \frac{1 - \cos 2\omega t}{2}$

and $2 \sin \omega_m t \sin \omega_c t = \cos(\omega_c - \omega_m)t - \cos(\omega_c + \omega_m)t$

Therefore, equation (i) can be written as,

$$y = BA_m \sin \omega_m t + BA_c \sin \omega_c t + \frac{CA_m^2}{2} - \frac{CA_m^2 \cos 2\omega_m t}{2} + \frac{CA_c^2}{2} - \frac{CA_c^2 \cos 2\omega_c t}{2} + CA_m A_c \cos(\omega_c - \omega_m)t - CA_m A_c \cos(\omega_c + \omega_m)t$$

$$\therefore y = BA_m \sin \omega_m t + BA_c \sin \omega_c t + \frac{C}{2}(A_m^2 + A_c^2) - \frac{C}{2}(A_m^2 \cos 2\omega_m t + A_c^2 \cos 2\omega_c t) + CA_m A_c [\cos(\omega_c - \omega_m)t - (\omega_c + \omega_m)t] \quad \dots (ii)$$

- iv. Equation (ii) consists of the following terms:
- a. d.c term $\frac{C}{2}(A_m^2 + A_c^2)$
 - b. Sinusoidal a.c terms of angular frequencies $\omega_m, \omega_c, 2\omega_m, 2\omega_c$
 - c. Sinusoidal terms of angular frequencies $(\omega_c - \omega_m)$ and $(\omega_c + \omega_m)$
 - v. This signal is passed through a band pass filter which is centred at ω_c . The band pass

- filter provides the following function:
- a. It rejects d.c.
 - b. It rejects a.c terms of angular frequencies $\omega_m, 2\omega_m, 2\omega_c$.
 - c. It passes : the frequencies $\omega_c, \omega_c - \omega_m, \omega_c + \omega_m$.
 - vi. The output of the band pass filter is the amplitude modulated wave.
 - vii. The AM wave is amplified by passing it through a power amplifier and sent to the transmitting antenna.

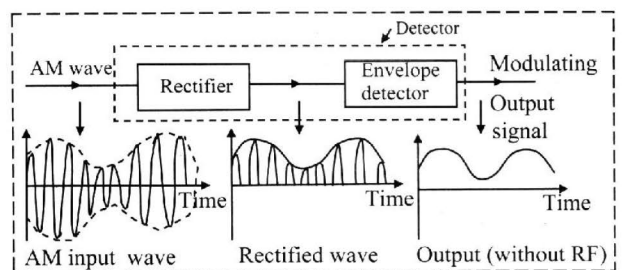
Q.28. Explain the detection of amplitude modulated wave.

OR

Explain demodulation of AM wave.

Ans: Detection of amplitude modulated wave:

- i. Once the amplified AM wave is radiated out of the transmitting antenna, it gets attenuated while propagating through the channel, The receiving antenna is followed by amplifier and a detector which picks up the weak signals and passes it to the amplifier.
- ii. The amplifier amplifies the signal and sends it to intermediate frequency (IF) stage. The function of intermediate frequency stage is to decrease the frequency of the carrier wave. This helps in the detection of the modulating signal.
- iii. The main function of demodulation is carried out in the detector. Here, the modulating signal(message signal) is separated from the carrier wave. The modulated wave sent to the detector has the following frequencies:
 $\omega_c, \omega_c - \omega_m, \omega_c + \omega_m$



- iv. The AM wave is passed through a rectifier. The modulating signal is retrieved from the rectified wave in the envelope detector which may consist of a simple R.C circuit.

Q.29. State applications of AM.**Ans: Applications of AM:**

- i. AM-radio broadcasting
- ii. TV picture (video)
- iii. Two way radio
 - a. Aircraft
 - b. Amateur radio (SSB)
 - c. Citizen's band radio
 - d. Military
- iv. Digital data transmissions
- v. Computer modems (used in combination with phase modulation)
- vi. NIST time signals

Q.30. What are the drawbacks of amplitude modulation?**Ans: Drawbacks of amplitude modulation:**

- i. The efficiency of amplitude modulation is low (20 to 30 % is useful).
- ii. AM signal is easily affected by external atmosphere and electrical disturbances.
- iii. Operating range is small.
- iv. The allowed AM bandwidth is only 10 kHz and for transmission of all audio frequencies, about 3D kHz bandwidth is required which affects fidelity. Due to limited bandwidth, stereotype transmission is not possible.

20.6 : Space communication**Q.31. What do you mean by space communication?**

- Ans:**
- i. The communication process in which space acts as the communication channel, is called space communication. Example: Radio, television and satellite communication etc.
 - ii. Space waves are useful for the transmission of information (i.e. messages, speech, music etc.) from one place to another without the help of wires or the material medium between the two places.
 - iii. The signals which are to be transmitted are first converted into electrical signals, then superimposed on a high frequency oscillating current flowing through transmitted antenna. This antenna radiates corresponding radio waves in the atmosphere.
 - iv. When the radio waves are intercepted by receiving antenna at the receiving station, a small varying e.m.f is induced in the antenna. This e.m.f is amplified and decoded to obtain

the information contained in the original signal.

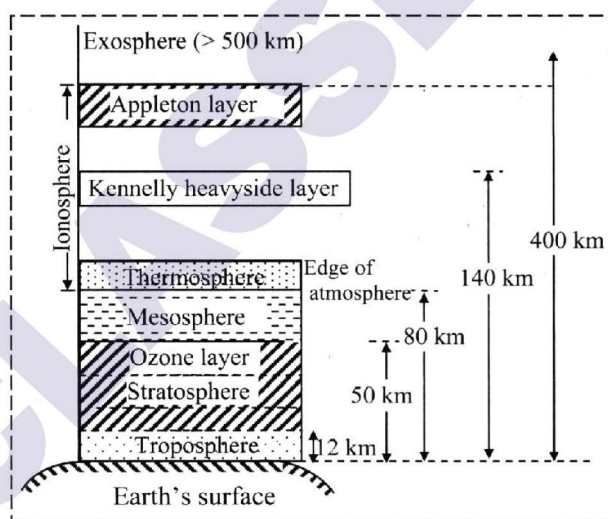
Q.32. Give the limitations of space wave communication.

Ans: In space wave communication, range of transmission is limited both by the curvature of the earth's surface and partial absorption of signal by it.

Q.33. Explain in brief idea of structure of atmosphere.

Ans: The gaseous envelope surrounding the earth is called earth 's atmosphere.

The earth's atmosphere is broadly divided into various layers as shown in figure.

**i. Troposphere:**

- a. The lowest region of atmosphere extending upto 12 km from surface of the earth is called Troposphere.
- b. Its density varies from 1 kg m^{-3} to 0.1 kg m^{-3} . It contains all the water vapours of the atmosphere. The temperature of this layer decreases with the height from 290 K to 200 K.
- c. This layer is responsible for all the weather phenomenon like clouds formation, rain, fog, etc. Electromagnetic waves of FM transmitter and T.V transmitter propagate through this layer.

ii. Stratosphere:

- a. The region of atmosphere extending from 12 km to 50 km is called stratosphere.
- b. The density in this region varies from

0.1 kg m^{-3} to $10^{-3} \text{ kg m}^{-3}$ and temperature varies from 220 K to 280 K.

- c. In the lower region from 30 km to 50 km there is a layer of ozone. Ozone layer absorbs large amount, of ultraviolet radiations radiated by the sun and thus protects life on the earth from its harmful effects. The ozone layer is also called ozonosphere.

iii. Mesosphere:

- a. The region of the earth's atmosphere between 50 km to 80 km from the surface of the earth is called Mesosphere.
- b. Mesosphere has temperature varying from 290 K to 180 K. The density of this layer varies from $10^{-3} \text{ kg m}^{-3}$ to $10^{-5} \text{ kg m}^{-3}$.

iv. Ionosphere:

The region of the atmosphere extending between 80 km to 400 km from the earth's surface is called Ionosphere. This is the outermost part of the earth's atmosphere. The temperature of the layer between 80 km to 110 km varies from 180 K to 700 K and the density of this layer varies from $10^{-5} \text{ kg m}^{-3}$ to $10^{-10} \text{ kg m}^{-3}$. This layer is further classified into three sub-layers.

a. Thermosphere:

The region which extends from 80 km to 110 km from the earth's surface is called thermosphere. It receives energy directly from the solar radiation produced by ultraviolet radiation and X-rays from the sun. As a result, the concentration of electrons and positive ions is very large in this region and for this reason, it is called ionosphere. The ionised ions are present along with thermal energy. Because of ionised particles it plays an important role in communication. It transmits radio waves round the curved earth's surface.

b. Kennelly Heavyside layer (E layer):

At about 90 km from earth's surface, the electron concentration becomes very high and extends vertically upto 140 kilometers approximately.

This layer of electrons is known as Kennelly heavyside layer (E layer).

c. Appleton layer (F layer):

In this layer, electron and positive ion concentration is average. This layer receives maximum energy from the sun and hence positive and negative (electron) ions are produced due to low pressure. This layer extends upto 400 km.

v. Exosphere:

The Exosphere ($> 500 \text{ km}$) is a transitional zone between the Earth's atmosphere and inter planetary space. The pressure in this region is very low

Note:

Density of gases of earth's atmosphere remain same upto height 100 km above sea level.

Q.34. For long distance radio broadcast, we use short wave band only. Why?

Ans: Because ionosphere easily reflects the waves in this band.

20.7 : Propagation of electromagnetic waves in atmosphere

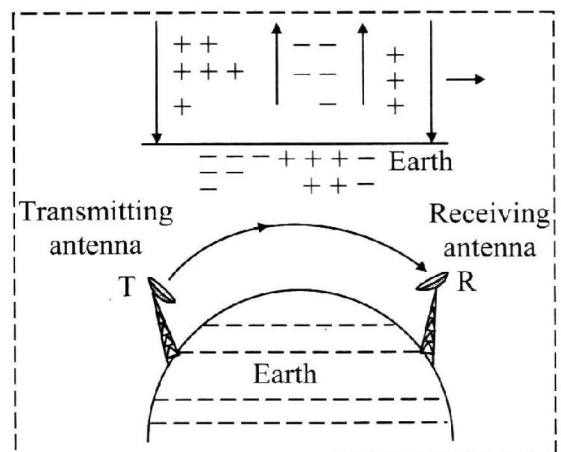
Q.35. Define and explain ground wave propagation.

Ans: Definition:

When the electromagnetic waves (radiowaves) from the transmitting antenna propagate along the surface of the earth so as to reach the receiving antenna, the wave propagation is called ground wave propagation (surface wave propagation).

Explanation:

- i. Ground waves are the radiowaves which propagate along the surface of the earth.



- ii. The electromagnetic waves which are

vertically polarised, can travel along the surface of earth. The horizontal component of electric field in contact with earth is short circuited. The electric field vector of the wave induces charge in the earth as shown in figure.

- iii. There is loss of power in a signal during its propagation on the surface of the earth due to partial absorption of energy by ground. Loss of energy is also due to diffraction effect. The absorption of energy is high for high frequency. Hence ground wave propagation is suitable for low frequency and medium frequency. It is used for local broadcasting. For examples: ship, communication, radio navigation.
- iv. Ground wave propagation is possible only when the transmitting and receiving antenna are close to the earth's surface.

Q.36. On what factors does the maximum range of ground wave propagation depend?

Ans: The maximum range of ground wave propagation depends on:

- i. the frequency of the radio waves and
- ii. power of the transmitter.

Q.37. Why are T.V and FM signals not transmitted by using ground wave propagation?

- Ans:**
- i. T.V and FM waves are high frequency signals. They do not use ground wave propagation because at high frequency, the strength of the ground wave signal gets reduced by absorption.
 - ii. Because of this, it virtually becomes useless beyond an area of a few kilometers around the transmitting antenna.

Q.38. Define space wave. State the main components of space wave.

Ans: Definition:

The radiowaves which travel directly from the transmitting antenna to the receiving antenna are called the space waves.

Components of space wave:

There are three components of space waves.

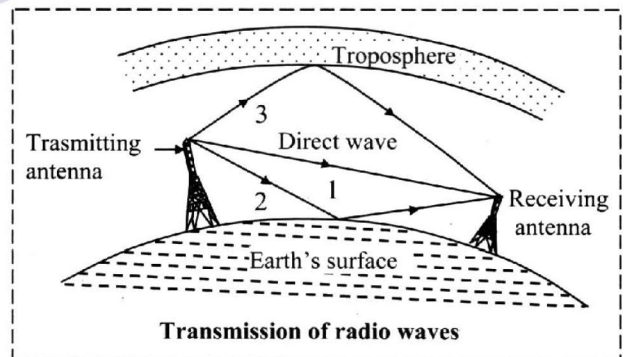
- i. **Direct wave:** Radiowaves reach receiving antenna directly.
- ii. **Ground reflected wave:** Radiowaves reach the receiving antenna after reflection from ground.
- iii. **Tropospheric wave:** Radiowaves reach

the receiving antenna after reflection from troposphere.

Q.39. What is space wave propagation? Draw a neat labelled diagram to show space wave propagation. [Oct 08]

Ans: Space wave propagation:

- i. When the radio waves from the transmitting antenna reach the receiving antenna either directly or after reflection from the ground or from troposphere, the wave propagation is called space wave propagation or tropospheric wave propagation or line of sight propagation.
- ii. The T.V signals, FM radio, radar are in the range 100 MHz to 200 MHz and these can be transmitted only by space wave propagation. In this, the receiving antenna directly intercepts the signal sent out by the transmitter.
- iii. But the earth is spherical, so long distance transmission is not possible. Therefore, the height of the antenna should be as large as possible or repeater transmission stations are necessary.
- iv. The range for line of sight propagation is given by, $d = \sqrt{2Rh}$ which is of the order of few km where 'R' is radius of earth and 'h' is height of antenna.



Q.40. What is space wave propagation? State its three components. [Feb 2013]

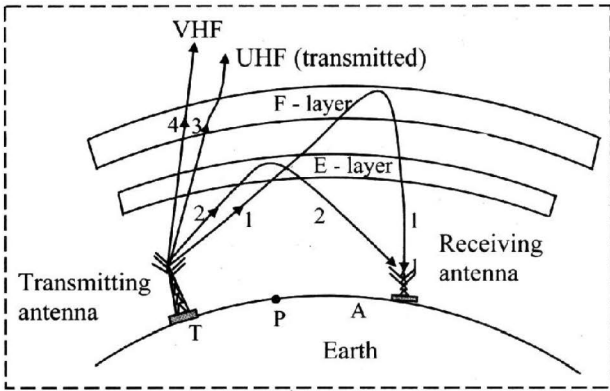
Ans: Refer Q. 39 and Q. 38

Q.41. Explain sky wave propagation. [Mar 09]

Ans: Sky wave propagation:

- i. When the radiowaves from the transmitting antenna propagate through sky so as to reach the receiving antenna after reflection in the ionosphere, the wave propagation is called sky wave propagation or ionospheric

wave propagation.



- ii. The transmitting waves go up in the sky and are reflected from ionosphere as shown in figure.
- iii. The refractive index of ionosphere is less than that of free space. R.I of each layer decreases with height. Hence, radio waves from ground station undergo total internal reflection towards earth.
- iv. Because of diurnal and seasonal variation in thickness of E or F layer and concentration of charge in each layer, sky wave propagation is least reliable.

Q.42. Explain with neat labelled diagram ground wave propagation and sky wave propagation. [Oct 11]

Ans: Refer Q.35 and Q.41

Q.43. What is line of sight communication?

Ans: Line of sight communication:

- i. The radio waves having frequency less than 3 MHz are absorbed in the ionosphere, whereas those having frequency greater than 30 MHz pass through ionosphere with small deviation.
- ii. The radio waves from 3 MHz to 30 MHz undergo multiple reflections between the earth and ionosphere. Thus they can be transmitted over large distances called line of sight communication.
- iii. It is given by, $d = \sqrt{2Rh}$
 where, R = radius of curvature of earth
 h = height of transmitting antenna
 Range of line of sight communication is of the order of few km.

Q.44. What is the line of sight distance in communication system?

Ans: It is the distance between transmitting antenna

and receiving antenna at which they can see each other.

Q.45. Define the following terms.

- i. **Angle of radiation**
- ii. **Critical frequency**

Ans: i. Angle of radiation:

The maximum angle made by transmitted radio waves with the horizontal, above which the radio waves are no longer reflected back by ionosphere is called angle of radiation.

ii. Critical frequency:

The maximum frequency of transmitted radio waves, above which the radio waves are no longer reflected back by ionosphere is called critical frequency.

It is given by, $f_c = g\sqrt{N_{max}}$

where, N_{max} is maximum electron density of ionosphere.

Q.46. Define the following terms.

- i. **Sky waves**
- ii. **Fading**

Ans: i. Sky waves:

The radiowaves having frequency between 3 MHz to 30 MHz are called sky waves.

ii. Fading:

The disappearance of the signals for short time due to variations in the height and density of ionisation of ionosphere is called fading.

Note:

- 1. If ' h_t ' and ' h_r ' be the height of transmitting and receiving antenna respectively, then range of signal is given by,

$$d = \sqrt{2R} (\sqrt{h_t} + \sqrt{h_r}).$$

where, R = radius of curvature of the earth

- 2. Sky waves are called short waves due to its high frequency.
- 3. Frequency range of sky wave propagation varies from 3 MHz to 30 MHz. This region is called short wave band.
- 4. If the frequency of radio wave is more than critical frequency f_c , then it will cross the ionosphere and do not return back to earth.
- 5. The critical frequency ranges approximately from 5 MHz to 10 MHz.

Q.47. Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for line of sight communication?

- Ans:** i. For line of sight communication, the receiving antenna must intercept the transmitted signal.
- ii. If the signal is to be received beyond horizon, the receiving antenna must be high enough to intercept the transmitted signal.
- iii. Therefore, it is not necessary for a transmitting antenna to be at the same height as that of the receiving antenna.

Q.48. What is the factor which limits the covering range of T.V transmission?

Ans: The T.V transmission by T.V tower use space wave. The covering range of space wave is limited by the curvature of the earth.

Q.49. What are radio waves?

Ans: The electromagnetic waves of frequency ranging from a few kilo hertz to about few hundred mega hertz (i.e. wavelength 0.3 m and above) are called radio waves.

Q.50. Write three differences between AM and FM.

Ans:

No.	AM	FM
i.	Alternation in amplitude of the desired signal amounts to marked distortion	Noise can be easily minimised in FM system.

ii.	In AM, use of an excessively large modulating signal may result in distortion because of over modulation.	No restriction is placed on the modulation index. The instantaneous frequency deviation is proportional to the instantaneous magnitude of the signal.
iii.	The average power in amplitude modulated wave is greater than that contained in unmodulated wave.	The average power in frequency modulated wave is the same as that contained in the unmodulated wave.

Q.51. What are T.V signals? How can they be received?

- Ans:** i. T.V signals are those signals which have frequency range 80 MHz to 200 MHz.
- ii. Since these waves neither follow the curvature of the earth nor get reflected by

ionosphere, their reception is possible either by using communication geostationary satellite which reflects the T.V signals back to earth or by using tall antennas which may directly intercept the signals.

Q.52. Why does conductivity of earth's atmosphere increases with altitude?

- Ans:** i. Due to low pressure at high altitude, ionisation is produced by ultra-violet radiation and X-rays from the sun.
- ii. As a result, the concentration of electrons and positive ions is very large. For this reason, it is called ionosphere.
- iii. At about 90 km from earth's surface, the electron concentration becomes very large and extends vertically up to 140 km approximately.
- iv. This layer of electrons is known as Kennelly Heavyside layer.

Summary :

1. Communication is the basic process of exchanging information.
2. A communication system acts as a messenger. It consists of a transmitter, communication channel and a receiver.
3. Bandwidth is the portion of electromagnetic spectrum occupied by a signal.
4. Modulation is necessary for a good transmission, efficient radiation and reception of signals without interference.
5. In amplitude modulation, the amplitude of carrier wave is varied according to information signal.
6. Detection (or demodulation) is the process of recovering the modulating signal from the modulated carrier wave.
7. Earth's atmosphere is a gaseous envelope which surrounds the earth. Various regions of earth's atmosphere are troposphere, stratosphere, mesosphere, ionosphere.
8. Space waves are the electromagnetic waves which travel in free space. These are used for line of sight communication.
9. Space communication refers to the sending, receiving and processing of information through space. With space communication, the information can be passed on from one place to

another on the surface of earth in extremely Short interval of time.

10. Depending on factors like frequency of operation of radio waves, distance between two communication stations etc., the radio waves can be sent via the following modes of propagation:
 - i. Ground wave propagation
 - ii. Sky wave propagation
 - iii. Space wave propagation
11. The radio waves which travel through atmosphere following the surface of the earth are known as ground waves and their propagation is called ground wave propagation.
12. Sky waves are the electromagnetic waves which

are capable of reflecting (returning) back from the ionosphere. These are used for transmission over large distances.

Theoretical Board Questions

1. Write a short note on space wave propagation. [Oct 08]
2. Explain in brief, types of wave propagation in space communication. [Mar 09]
3. State different types of wave propagation. Describe sky wave propagation in brief. [Mar 11]
4. Explain the need for modulation related to the size of antenna (aerial).

Multipal Choice Questions

1. Basic components of a transmitter are
 - a) message signal generator and antenna
 - b) modulator and antenna
 - c) signal generator and modulator
 - d) message signal generator, modulator and antenna
2. For T.V broadcasting, the frequency employed normally is
 - a) 30 – 300 MHz
 - b) 30 – 300 GHz
 - c) 30 – 300 kHz
 - d) 30 – 300 Hz
3. The process of changing some characteristics of a carrier wave in accordance with the incoming signal-is called
 - a) amplification
 - b) modulation
 - c) rectification
 - d) demodulation
4. A device that converts one form of energy into another form is termed as
 - a) transducer
 - b) transmitter
 - c) amplifier
 - d) receiver
5. The process of regaining of information from carries wave at the receiver is called _____
 - a) modulation
 - b) transmission
 - c) propagation
 - d) demodulation
6. Troposphere reflects the waves having frequencies from
 - a) 100 MHz to 200 MHz
 - b) 2 MHz to 30 MHz
 - c) 0 Hz to 20 KHz
 - d) 20 Hz to 20 KHz
7. The outermost layer of the earth's atmosphere is
 - a) stratosphere
 - b) mesosphere
 - c) troposphere
 - d) ionosphere
8. Frequencies in the very high frequency range normally propagate by means of
 - a) ground waves
 - b) space waves
 - c) sky waves
 - d) surface waves
9. Frequencies in the UHF range normally propagate by means of
 - a) ground waves
 - b) sky waves
 - c) surface waves
 - d) space waves
10. Tropospheric line-of-sight mode of propagation is used for the carrier frequencies
 - a) less than 30 MHz
 - b) less than 1600 kHz
 - c) greater than 30 MHz
 - d) less than 100 kHz
11. Range of communication can be increased by
 - a) increasing the heights of transmitting and receiving antennas.
 - b) decreasing the heights of transmitting and receiving antennas.
 - c) increasing height of transmitting antenna and decreasing the height of receiving antenna:
 - d) increasing height of receiving antenna only.
12. Ionosphere contains
 - a) only neutral molecules
 - b) only positive ions
 - c) only free electrons
 - d) mixture of, neutral molecules, positive ions and equal number of free electrons.

13. The reflected waves from the ionosphere are
a) ground waves
b) sky waves
c) space waves
d) very high frequency waves
14. Communication is the process of
a) keeping in touch
b) exchanging information
c) broadcasting
d) entertainment
15. The message fed to the transmitter are generally
a) radio signals b) audio signals
c) both a) and b) d) optical signals
16. Space wave propagation is suitable for radiowaves of frequency
a) above 30 MHz
b) upto 2 MHz
c). from 2 MHz to 30 MHz
d) from 2 KHz to 30 MHz
17. Line of sight propagation is also called as _____ propagation.
a) skywave b) ground wave
c) sound wave d) space wave
18. In space communication, the information can be passed from one place to another at a distance of 100 km in
a) 1s b) 0.5 s
c) 0.003 s d) none of these
19. Ground wave is propagated over long distance for the frequencies from
a) 100 Hz to 300 kHz
b) 30 kHz to 1600 kHz
c) 30 kHz to 300 kHz
d) 30 MHz to 300 MHz
20. VHF radio signals are propagated
a) via ionosphere
b) through troposphere
c) along the ground
d) via stratosphere
21. The original electrical information signal to be transmitted is called as
a) modulating signal b) base band signal
c) carrier signal d) source signal
22. UHF is used in scatter.
a) tropospheric b) stratospheric
c) ionospheric d) mesospheric
23. The ozone layer in the atmosphere absorbs
a) only the radiowaves
b) only the visible light
c) only the y rays
d) X-rays and ultraviolet rays
24. Height of ionosphere from ground surface is
a) 12 km b) 20 km
c) 400 km d) 50 km
25. Primary constants of a transmission line are
a) resistance and inductance
b) capacitance and conductance
c) both a) and b)
d) neither a) nor b)
26. In which region does, temperature decrease with height?
a) Troposphere b) Ionosphere
c) Stratosphere d) Ozone layer
27. Modern communication systems consist of
a) electronic systems b) electrical system
c) optical system d) all of these
28. What determines the absorption of radiowaves by the atmosphere?
a) Frequency b) Polarisation
c) Interference d) Distance of receiver
29. The portion of the atmosphere closest to the earth's surface is
a) troposphere b) stratosphere
c) mesosphere d) ionosphere
30. An antenna behaves as resonant circuit only when its length is
a) $A/2$
b) $A/4$
c) A
d) integral multiple of $A/2$
31. Space wave travels through
a) ionosphere b) mesosphere
c) troposphere d) stratosphere
32. Transmission lines start radiating
a) at low frequencies
b) at high frequencies
c) at both high and low frequencies
d) none of the above
33. Modulation is used to
a) reduce the bandwidth used.
b) separate the transmissions of different users.
c) ensure that intelligence may be transmitted to long distances
d) allow the use of practical antennas.
34. The maximum distance upto which TV transmission from a TV tower of height 'h' can

be received is proportional to

- a) $h_1/2$ b) h
c) $h_3/2$ d) h_2

35. Which of the following frequency/frequencies will be suitable for beyond the horizon communication using sky waves?

- a) 10 kHz b) 10 MHz
c) 1 GHz d) 1000 GHz

36. If ' h_t ' and ' h_r ' are height of transmitting and receiving antennae and 'R' is radius of the earth, the range of space wave is

- a) $\sqrt{2R} (h_t + h_r)$
b) $2R\sqrt{(h_t + h_r)}$
c) $\sqrt{2R(h_t + h_r)}$
d) $\sqrt{2R} (\sqrt{h_t} + \sqrt{h_r})$

37. In a communication system, noise is most likely to affect the signal

- a) at the transmitter
b) in the transmission medium
c) in the information source
d) at the destination

38. What is the modulation index of an over modulated wave?

- a) 1 b) Zero
c) < 1 d) > 1

39. In which frequency range, space waves are normally propagated?

- a) HF b) EHF
c) UHF d) SHF

40. If f_a and f_f represent the carrier wave frequencies for amplitude and frequency modulations respectively, then

- a) $f_a > f_f$ b) $f_a < f_f$
c) $f_a \approx f_f$ d) $f_a \geq f_f$

Answer Keys

1. d)	2. a)	3. b)	4. a)	5. d)	6. a)	7. d)	8. b)	9. d)	10. c)
11. a)	12. d)	13. b)	14. b)	15. b)	16. a)	17. d)	18. d)	19. b)	20. b)
21. a)	22. a)	23. d)	24. c)	25. c)	26. a)	27. d)	28. a)	29. a)	30. d)
31. c)	32. b)	33. a)	34. a)	35. b)	36. d)	37. b)	38. d)	39. c)	40. b)