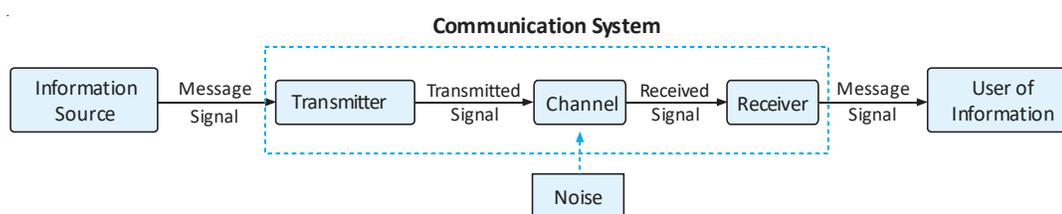# COMMUNICATION SYSTEM

Communication :

Definition : Communication is the act of transmission of information.

Communication System : It is a set up used to achieve communication. It transmits information from source to receiver.

Elements Of Communication System :

Every communication system has three elements namely :

(i) Transmitter **(ii)** Medium/Channel **(iii)** Receiver

Communication System

| Information Source | Message Signal | Transmitter | Transmitted Signal | Channel | Received Signal | Receiver | Message Signal | User of Information |

Noise

Block diagram of a generalized communication system

Two basic modes of Communication :

Block diagram of a generalized communication system :

(i) The channel is the physical medium that connects the transmitter and the receiver. The signal from the transmitter is carried to the receiver by the communication channel.

(ii) Depending upon the type of communication system, a channel may be in the form of wires or cables connecting the transmitter and the receiver or it may be wireless.

(iii) When a transmitted signal propagates along the channel, it may get distorted due to channel imperfection. Moreover, noise also adds to the transmitted signal.

Two Basic Modes of Communication :

(i) **Point to Point Communication Mode :** Communication takes place over a link between a single transmitter and receiver.

Example : telephony, coaxial cable, optical fibre.

(ii) **Broadcast Mode :** There are a large number of receivers corresponding to a single transmitter.

Example : Radio and *T.V.*

Basic Terminology Used In Electronic Communication Systems :

1. **Transducer :** A device that converts one form of energy into another form.

Eg : Microphone

An electrical transducer may be defined as a device that converts some physical variable (pressure, displacement, force, etc.) into corresponding variations in the electrical signal at its output.

2. **Signal :** Information converted in electrical form and suitable for transmission is called signal. It can be of 2 types:

➤ *Analog Signals* : Are continuous variations of current or voltage. Sine wave is an analog signal. Sound and Picture signal in T.V. are analog. It is represented by $m(t)$ where $m(t) = A_m \, sin \, (\omega_m \, t)$

                                                                     Amplitude   Angular frequency

➤ *Digital Signal* : Are signals which can take only discrete stepwise values. Digital communication use coding schemes like BCD (binary coded decimal) or ASCII (American Standard Code for Information Interchange).

3. **Noise :** Noise refers to the unwanted signals that tend to disturb the transmission and processing of message signals in a communication system.

4. **Transmitter :** A transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.
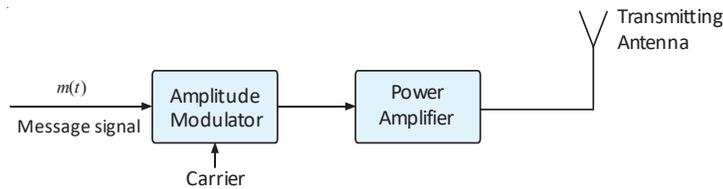
Block diagram of a Transmitter

5. **Receiver :** A receiver extracts the desired message signals from the received signals at the channel output.
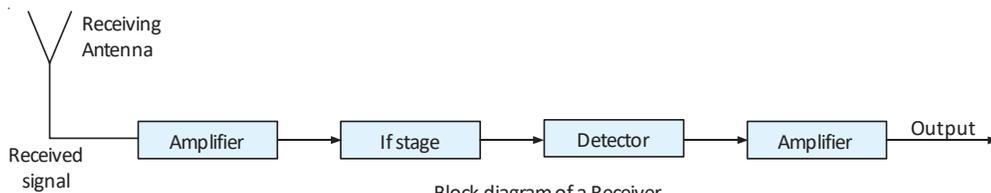
Block diagram of a Receiver

Received signal is first amplified and then carrier frequency is changed to lower frequency by intermediate frequency. i.e IF stage followed by detection. Detection or demodulation is done by detector or demodulator. The detected signal if weak is further amplified by amplifier.

6. **Attenuation :** The loss of strength of a signal while propagating through a medium is known as attenuation.

7. **Amplification :** It is the process of increasing the amplitude (and consequently the strength) of a signal using an electronic circuit called the amplifier. Amplification is necessary to compensate for the attenuation of the signal in communication systems.

8. **Range :** It is the largest distance between a source and a destination upto which the signal is received with sufficient strength.

9. **Bandwidth :** Bandwidth refers to the frequency range over which an equipment operates or the portion of the spectrum occupied by the signal.

10. **Modulation :** Modulation is the process of superimposing message signal on the carrier wave. It is the process by which some characteristic of high frequency carrier wave is altered in accordance with instantaneous value of message signal.

11. **Demodulation :** The process of retrieval of information from the carrier wave at the receiver end is termed as demodulation. This is the reverse process of modulation.

12. **Repeater :** A repeater is a combination of a receiver and a transmitter. A repeater, picks up the signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. Repeaters are used to extend the range of a communication system.

Bandwidth of Signals :

Message Signal	Bandwidth Required for transmission
Audio Signals	Approx. 20 kHz (20 Hz - 20 kHz)
Speech signals in telephonic comm.	2800 Hz (3100 Hz - 300 Hz)
Video signals for transmission of pictures	4.2 MHZ
TV signals (Voice & Picture)	6 MHz

MORE TO KNOW

A digital signal is in the form of a rectangular wave which can be decomposed into a superposition of sinusoidal waves of frequency V_0, $2V_0$, $3V_0$.....∞. Also in particle, if bandwidth is large enough to accommodate few harmonics, the info is not lost because Higher the harmonic, lesser is its contribution to wave form.

Bandwidth of Transmission Medium : Some Important wireless communication Frequency Bands :

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	TV
	174-216 MHz	UHF (ultra high frequencies)
	420-890 MHz	TV
Cellular Mobile Radio	896-901 MHz	Mobile to base station
	840-935 MHz	Base station to mobile
Satellite	5.925-6.425 GHz	Uplink
Communication	3.7-4.2 GHz	Downlink

Propagation of Electromagnetic Waves : There are 3 modes of electromagnetic wave propagation :

1. Surface wave propagation by Ground waves
2. Sky wave propagation by Sky waves
3. Space wave propagation by Space waves

1. **Ground Waves :** A radio wave that can travel directly from one point to another following the surface of earth is called a ground wave.

   At low frequency, i.e. for waves having longer wavelengths, the antennas have large physical size (Antenna should have size comparable to λ (at least $\sim \lambda/4$) and are located on or very near to the ground. Ground wave Propagation is possible only when the transmitting and receiving antenna are close to the surface of the earth. Propagation of ground waves is guided along with the earth's surface and follows the curvature of earth.

   This mode of propagation is called surface wave propagation and wave glides over the surface of earth. A wave induces current in the ground over which it passes and it is attenuated as a result of absorption of energy by the earth eg : A.M. Broadcast.

   Max range of ground wave propagation depends on two factors :
   (i) The frequency of the transmitted wave
   (ii) The power of the transmitter

2. **Sky Waves :** The radio waves having frequency range from few *MHz* upto 30 *MHz* to 40 *MHz* are reflected back to earth by ionosphere and are known as sky waves.

Ionosphere consists of large number of ions or charged particles. It extends 65 *km* - 400 *km* above earth's surface. Ionisation occurs due to the absorption of ultraviolet and other high energy radiation coming from the sun by air molecules. Ionosphere consists of F_1, F_2, E and D layers. Density of atmosphere decreases with height. Ionisation is low at great heights and close to earth. However at some intermediate height, there occurs a peak of ionization density. This ionospheric layer acts as a reflector.

Sky waves are reflected by ionosphere; due to the phenomenon of total Internal reflection. Propagation of radio waves by reflection back to earth by ionosphere is called sky wave propagation. Electromagnetic waves of frequencies higher than 30 *MHz* penetrate ionosphere and escape so sky wave propagation is not possible for such waves.

e.g. : Short wave Broadcast service
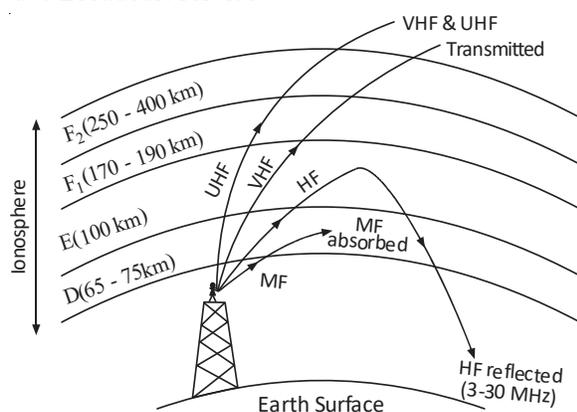
> **MORE TO KNOW**
> At great heights, the solar radiation is intense but there are few molecules to be ionised. Close to earth, even though molecular concentration is very high, the radiation intensity is low so ionisation is again law.

3. **Space Wave :** For electromagnetic waves having frequencies above 40 *MHz*, propagation via Ground wave propagation and Sky wave propagation is not possible. The high frequency waves with frequency more than 40 *MHz* called space waves.

Space waves are used for line-of-sight (LOS) communication as well as satellite communication.

LOS Communication : In this mode of propagation, a radiowave travels in a straight line from transmitting antenna and directly reaches the receiving antenna. The range of LOS propagation is limited by

(a) The line of sight distance *i.e.* the distance at which the transmitting and receiving antenna can see each other.
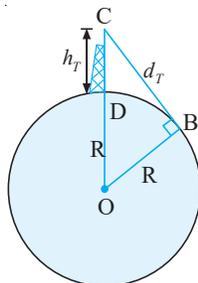
(b) The curvature of earth. Consider a transmitting antenna of height h_T. Let us calculate distance d_T upto which *T.V.* signal can be received from transmitting antenna.

R is radius of earth,

As $\quad h_T << R$ so, $CB = DB = d_T$

In right angled triangle COB

$$CO^2 = OB^2 + CB^2$$

$$\left(R + h_T\right)^2 = R^2 + d_T^2$$

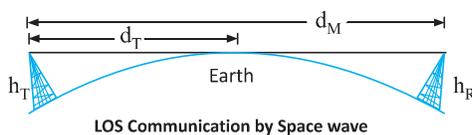$$R^2 + h_T^2 + 2Rh_T = R^2 + d_T^2$$

$$d_T = \sqrt{2Rh_T} \qquad\qquad \text{(Neglecting } h_T^2 \text{ as } h_T \ll R)$$

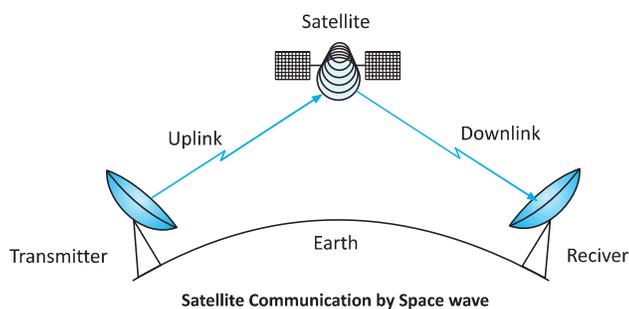Thus, distance to horizon $d_T = \sqrt{2Rh_T}$

The maximum line of sight distance d_M between transmitting & receiving antennas having height h_T and h_R above earth is given by $d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$

where h_R is the height of receiving antenna.

LOS Communication by Space wave

Satellite Communication by Space wave

Need of Modulation :

(a) Size of the Antenna : Modulation helps in transmission with reasonable antenna lengths. For transmitting a signal, we require an antenna atleast $\lambda/4$ in dimension [where λ is the wavelength of signal under transmission]. A message signal of frequency 20 KHz has $\lambda = 15$ km, so a long antenna is required which is not possible to construct and operate. If transmission frequency is high then length of antenna required is reasonable for *e.g.* If $v = IMHz$, $\lambda = 300$ m, so antenna length = 300/4 m = 75 m.

(b) Effective Power Radiated by an Antenna : Power radiated is proportional to $(1/\lambda)^2$ [l : length of linear antenna], so power radiated increases with decreasing wavelength, i.e. increasing frequency. By modulating the wave, we are transmitting at a high frequency so power radiated is high.

(c) Mixing up of Signals from Different Transmitters : If all the message signals are transmitted with same frequency then message signals will get mixed up and there is no way to distinguish between different message signals. To solve this problem of mixing up of signals, communication is done by modulating and allotting a band of frequencies to each message signal for its transmission.

Types of Modulation :

In sinusoidal wave modulation, both message signal and carrier waves are sinusoidal. But in Pulse Modulation, message signal is sinusoidal but carrier wave is in the form of pulses.

A sinusoidal carrier wave can be represented as : $c(t) = A_c \, sin(\omega_c t + \phi)$

During the process of modulation, any one of the three parameters, viz A_c, ω_c and ϕ, of the carrier wave can be controlled by the message or information signal.
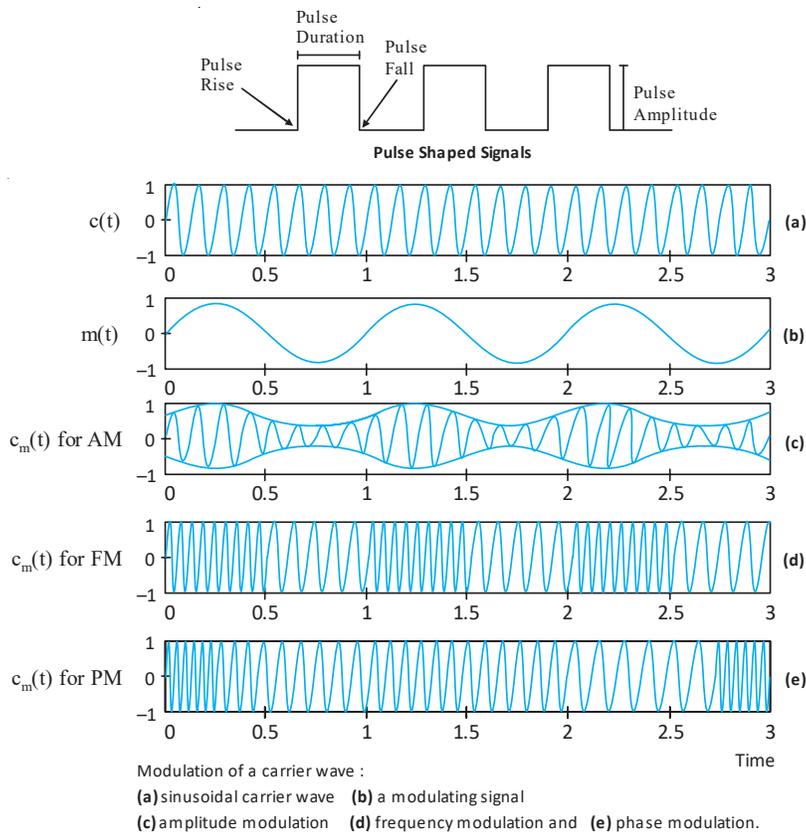
This results in three types of modulation :

AM or Amplitude Modulation - is modulation process in which amplitude (A_c) of carrier wave is varied in accordance with message signal m (t).

FM or Frequency Modulation - is modulation process in which frequency (ω_c) of carrier wave is varied in accordance with message signal m (t).

PM or Phase Modulation - is modulation process in which phase angle of carrier wave is varied in accordance with message signal m (t).

Different types of pulse modulation are :

$\qquad$ PAM – Pulse Amplitude Modulation

$\qquad$ PPM – Pulse Position Modulation

$\qquad$ PDM – Pulse Duration Modulation

$\qquad$ PWM – Pulse Width Modulation

Modulation of a carrier wave :
(a) sinusoidal carrier wave (b) a modulating signal
(c) amplitude modulation (d) frequency modulation and (e) phase modulation.

Amplitude Modulation :

In amplitude modulation, the amplitude of the carrier wave is varied in accordance with the information signal. Here we explain amplitude modulation process using a sinusoidal signal as the modulating signal.

Let $c(t) = A_c \sin \omega_c t$ represent carrier wave and $m(t) = A_m \sin \omega_m t$ represent the message or the modulating signal where $\omega_m = 2f_m$ is the angular frequency of the message signal. The modulated signal $c_m(t)$ can be written as

$$c_m(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t \quad \Rightarrow \quad c_m(t) = A_c \left(1 + \frac{A_m}{A_c} \sin \omega_m t \right) \sin \omega_c t \qquad \ldots.(i)$$

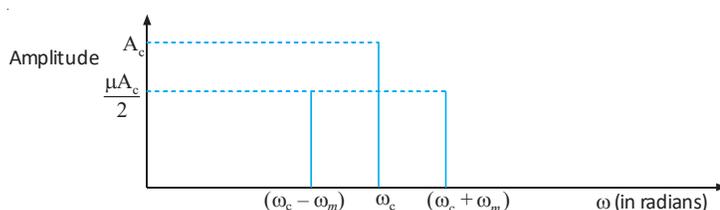Note that the modulated signal now contains the message signal.

$$\Rightarrow \qquad c_m(t) = A_c \sin \omega_c t + \mu A_c \sin \omega_m t \sin \omega_c t \qquad \ldots.(ii)$$

Here, $\mu = A_m/A_c$ is the modulation index. In practice, μ is kept ≤ 1 to avoid distortion.

Using the trigonometric relation $\sin A \sin B = \dfrac{1}{2} [\cos(A - B) - \cos(A + B)]$, we can write $c_m(t)$ of equation (ii) as

$$c_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} \cos(\omega_c - \omega_m) t - \frac{\mu A_c}{2} \cos(\omega_c + \omega_m)t \qquad \ldots.(iii)$$

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

A plot of amplitude versus ω for an amplitude modulated signal

MORE TO KNOW
As long as the broadcast frequencies (carrier waves) are sufficiently spaced out so that side bands do not overlap, different station can operate without interfering with each other.

Production of Amplitude Modulated Wave :
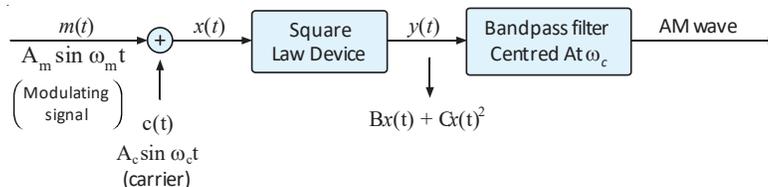
Block diagram of simple modulator for obtaining an AM signal

Here the modulating signal $A_m \sin \omega_m t$ is added to the carrier signal $A_c \sin \omega_c t$ to produce the signal $x(t)$. This signal $x(t) = A_m \sin \omega_m t + A_c \sin \omega_c t$ is passed through a square law device which is a non-linear device which produces an output $y(t) = Bx(t) + Cx^2(t)$.

where B and C are constants. Thus,

$$y(t) = BA_m \sin \omega_m t + BA_c \sin \omega_c t + C \left[A_m^2 \sin^2 \omega_m t + A_c^2 \sin^2 \omega_c t + 2A_m A_c \sin \omega_m t \sin \omega_c t \right]$$

$$= BA_m \sin \omega_m t + BA_c \sin \omega_c t + \frac{C A_m^2}{2} + \frac{C A_c^2}{2} - \frac{C A_m^2}{2} \cos 2\omega_m t - \frac{C A_c^2}{2} \cos 2\omega_c t$$

$$+ C A_m A_c \cos(\omega_c - \omega_m)t - C A_m A_c \cos(\omega_c + \omega_m)t$$

In equation, there is a dc term $\dfrac{C}{2}\left(A_m^2 + A_c^2 \right)$ and sinusoids of frequencies $\omega_m, 2\omega_m, \omega_c, 2\omega_c, \omega_c - \omega_m$ and $\omega_c + \omega_m$.

As shown in figure, this signal is passed through a band pass filter that now allows only frequency now ω_c to pass through, which rejects dc and the sinusoids of frequencies $\omega_m, 2\omega_m$ and $2\omega_c$ and retains the frequencies $\omega_c, \omega_c - \omega_m$ and $\omega_c + \omega_m$.

Helps to Understand That :

(i) The modulating signal is added to the carrier signal to produce their resultant which is passed through a square law device.

(ii) The dc components of the signal are eliminated using a band pass filter.

(iii) The output of the band pass filter is further amplified by a power amplifier and then transmitted.

Detection of Amplitude Modulated Wave :

➤ AM detection is the process of recovering the modulating signal or message signal from an AM waveform and is carried out by using a rectifier and an envelop detector.
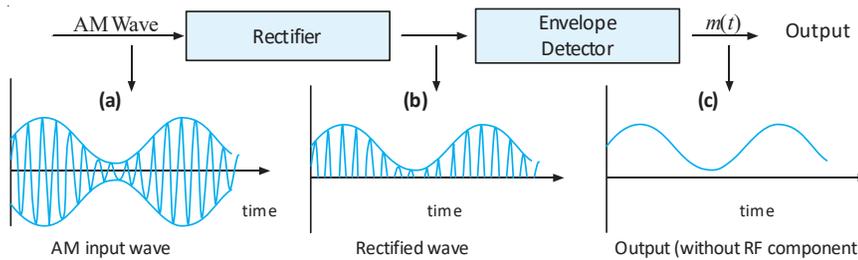
Block diagram of a detector for AM signal. The quantity on y-axis can be current or voltage

➤ A demodulator or detector first rectifies the modulated wave i.e. negative half of the modulated wave is climinated with the help of a simple diode which works as a rectifier. This rectified modulated wave contains message signal and the carrier wave. The envelop of modulated wave is the message signal $m(t)$. In order to retrieve $m(t)$, the rectified modulated wave is passed through an envelop detector which consists of a simple RC filter circuit.

Illustration - 19   *Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for line-of-sight communication? A TV transmitting antenna is* 81m *tall. How much service area can it cover if the receiving antenna is at the ground level*?

SOLUTION :

Given, height of antenna $h = 81\,m$

Radius of earth $R = 6.4 \times 10^6\,m$

No, it is not necessary for line of sight communication. The two antennas may not be at the same height.

Area $= \pi d^2$

$\because$ Range, $d = \sqrt{2hR}$

$\therefore$ Service Area $= \pi \times 2hR$

$$= \frac{22}{7} \times 2 \times 81 \times 6.4 \times 10^6$$

$$= 3258.5 \times 10^6\,m^2 = 3258.5\,km^2$$

Illustration - 20   *A carrier wave of peak voltage* 12V *is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of* 75% ?

SOLUTION :

Given, peak voltage $V_0 = 12V$

Modulation index $\mu = 75\% = \frac{75}{100}$

We know that

Modulation index

$$(\mu) = \frac{\text{Peak votage modulating signal}\,(V_m)}{\text{Peak voltage}\,(V_0)}$$

So, peak voltage of modulating signal,

$$V_m = \mu \times \text{ Peak voltage}\,(V_0) = \frac{75}{100} \times 12 = 9V$$

Illustration - 21 *For an amplitude modulated wave, the maximum amplitude is found to be $10V$ while the minimum amplitude is found to be $2V$. Determine the modulation index, μ. What would be the value of μ if the minimum amplitude is $0V$?*

SOLUTION :

Given, maximum amplitude $A_{\max} = 10V$

Minimum amplitude $A_{\min} = 2V$

Let A_c and A_m be the amplitudes of carrier wave and signal wave.

$\therefore \qquad A_{\max} = A_c + A_m = 10V \qquad ....(i)$

and $\qquad A_{\min} = A_c - A_m = 2V \qquad ....(ii)$

Adding equations (i) and (ii), we get :

$$2A_c = 12 \quad \text{or} \quad A_c = 6V$$

and $\qquad A_m = 10 - 6 = 4V$

Modulation index $\mu = \dfrac{A_m}{A_c} = \dfrac{4}{6} = \dfrac{2}{3}$

When the minimum amplitude is zero, then

i.e., $\qquad A_{min} = 0$

$$A_c + A_m = 10 \qquad\qquad ....(ii)$$

$$A_c - A_m = 0 \qquad\qquad ....(iv)$$

By solving equations (iii) and (iv), we get :

$$2A_c = 10 \quad \text{or} \quad A_c = 5$$

and $\qquad A_m = 5$

Modulation index $\mu = \dfrac{A_m}{A_c} = \dfrac{5}{5} = 1$

Illustration - 22 *Two waves A and B of frequencies 2 MHz and 3 MHz, respectively are beamed in the same direction for communication via sky wave. Which one of these is likely to travel longer distance in the ionosphere before suffering total internal reflection?*
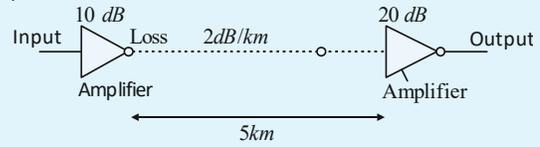
SOLUTION :

As the frequency of wave B is more than wave A, it means that the refractive index of wave B is more than refraction index of wave A (refractive index increases as frequency increases). For higher frequency waves (*i.e.*, higher refractive index) the angle of refraction is less *i.e.*, bending is less. So, wave B travels longer distance in the ionosphere before suffering total internal refraction.

Illustration - 23 *Why is an AM signal likely to be more noisy than a FM signal upon transmission through a channel ?*

SOLUTION :

In case of *AM*, the instantaneous voltage of carrier waves is varied by the modulating wave voltage. So, during the transmission, noise signals can also be added and receiver assumes noise as part of the modulating signal. In case of *FM*, the frequency of carrier waves is changed as the change in the instantaneous voltage of modulating waves. This can be done by mixing and not while the signal is being transmitted in channel. So, noise does not affect *FM* signal.

Illustration - 24 *Figure shows a communication system. What is the output when signal is of* $1.01 \, mW$? $\left(Gain \ in \ dB = 10\log_{10}\dfrac{P_o}{P_i}\right)$.

10 dB — Input — Loss — 2dB/km — 20 dB — Output, Amplifier, Amplifier, 5km

SOLUTION :

The distance travelled by the signal is $5 \, km$.

Loss suffered in path of transmission $= 2dB/km$

So, total loss suffered in $5 \, km = -2 \times 5 = -10dB$

Total amplifier gain $= 10dB + 20dB = 30dB$

According to the question, gain in $dB = 10\log_{10}\dfrac{P_o}{P_i}$

$\therefore \quad 20 = 10\log_{10}\dfrac{P_o}{P_i}$ or $\log_{10}\dfrac{P_o}{p_i} = 2$

Here $P_i = 1.01 \, mW$ and P_o is output power.

$\therefore \qquad \dfrac{P_o}{P_i} = 10^2 = 100$

$\Rightarrow \qquad P_o = P_i \times 100 = 1.01 \times 100$

or $\qquad P_o = 101 \, mW$

Thus, the output power is $101 mW$

Illustration - 25 *A* $50 \, MHz$ *sky wave takes* $4.04 \, ms$ *to reach receiver via retransmission from a satellite* $600 \, km$ *above earth's surface. Assuming retransmission time by satellite to be negligible, find the distance between source and receiver.*

If communication between the two was to be done by Line of Sight (LOS) method, what should size and placement of receiving and transmitting antennas be ?

SOLUTION :

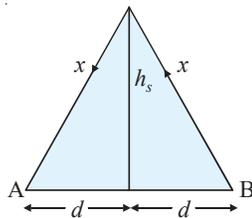Let the receiver be at point A and source is at B.

Velocity of waves $= 3 \times 10^8 \, m/s$

Time to reach a receiver $= 4.04 \, ms = 4.04 \times 10^{-3} \, s$

Let the height of satellite be $h_s = 600 \, km$

Radius of earth $= 6400 \, km$

Size of transmitting antenna $= h_T$

We know that

$\dfrac{\text{Distance travelled by wave}}{\text{Time}} = \text{Velocity of waves}$

$\dfrac{2x}{4.04 \times 10^{-3}} = 3 \times 10^8$

or $\quad x = \dfrac{3 \times 10^8 \times 4.04 \times 10^{-3}}{2} = 6.06 \times 10^5 = 606 \, km$

Using Phythagoras theorem,

$$d^2 = x^2 - h_s^2 = (606)^2 - (600)^2 = 7236$$

or $\quad d = 85.06 \, km$

So, the distance between source and receiver

$$= 2d = 2 \times 85.06 = 170 \, km$$

The maximum distance covered on ground from the transmitter by emitted Electromagnetic waves,

$d = \sqrt{2Rh_T}$

or $\qquad \dfrac{d^2}{2R} = h_T$

or $\qquad$ Size of antenna $h_T = \dfrac{7236}{2 \times 6400}$

$$= 0.565 \, km = 565 \, m$$

IN-CHAPTER EXERCISE-B

1. In which of the following remote-sensing technique is not used ?
    (A) Forest density
    (B) Pollution
    (C) Wetland mapping
    (D) Ground-water survey
    (E) Medical treatment

2. The distance of coverage of a transmitting antenna is 12.8 km. Then, the height of the antenna is : (Given that radius of earth = 6400 km)
    (A) 6.4 m
    (B) 12.8 m
    (C) 3.2 m
    (D) 16 m

3. A TV tower has a height of 150 m. What is the total population covered by the TV tower, if the population density around the TV tower is 10^3 km^{-2} ? Radius of the earth is $6.4 \times 10^6 m$.
    (A) 60.342 lakhs
    (B) 40.192 lakhs
    (C) 100 lakhs
    (D) 20.342 lakhs

4. A signal wave of frequency 12 kHz is modulated with a carrier wave of frequency 2.51 MHz. The upper and lower side band frequencies are respectively :
    (A) 2512 kHz and 2508 kHz
    (B) 2522 kHz and 2488 kHz
    (C) 2502 kHz and 2498 kHz
    (D) 2522 kHz and 2498 kHz

5. In frequency modulated wave :
    (A) frequency varies with time
    (B) amplitude varies with time
    (C) both frequency and amplitude vary with time
    (D) both frequency and amplitude are constant

6. An oscillator is producing FM waves of frequency 2 kHz with a variation of 10 kHz. What is the modulating index ?
    (A) 0.20
    (B) 5.0
    (C) 0.67
    (D) 1.5

7. The velocity of electromagnetic waves in a dielectric medium ($\varepsilon_r = 4$) is: (in metre/second)
    (A) 3×10^8
    (B) 1.5×10^8
    (C) 6×10^8
    (D) 7.5×10^7

8. For television broadcasting, the frequency employed is normally:
    (A) 30-300 GHz
    (B) 30-300 GHz
    (C) 30-300 kHz
    (D) 30-300 Hz

9. An `antenna' is:
    (A) inductive
    (B) capacitive
    (C) resistive above its resonant frequency
    (D) none of the above

10. The T.V. transmission tower in Delhi has a height of 240 m. The distance up to which the broadcast can be received (Taking the radius of earth to be 6.4×10^6 m) is (nearly) :
    (A) 100 km
    (B) 60 km
    (C) 55 km
    (D) 50 km

11. Broadcasting antennas are generally :
    (A) omnidirectional type
    (B) vertical type
    (C) horizontal type
    (D) none of these

12. The power in a two-wire transmission line travels :
    (A) inside the conductors
    (B) outside the conductors
    (C) both inside and outside the conductors
    (D) none of the above

13. If there were no atmosphere, the average temperature on the surface of earth would be:

   (A)   lower   (B)   higher   (C)   same as now   (D)   0°C

14. A transmtting antenna of height h and the receiving antenna of height 45 m are separated by a distance of 40 km for satisfactory communication in line of sight mode. Then the value of h, is : (Given radius of earth is 6400 km)

   (A)   10 m   (B)   15 m   (C)   20 m   (D)   25 m

15. Modem is a device used for :

   (A)   modulating digital signals

   (B)   converting analog signals to digital signals and *vice-versa*

   (C)   both of these

   (D)   none of the above

16. A modulated carrier wave has maximum and minimum amplitudes of 800 mV and 200 mV. The percentage modulation will be :

   (A)   60%   (B)   70%   (C)   40%   (D)   80%

17. In short wave communication, waves of which of the following frequencies will be reflected back by the ionospheric layer having electron density 10^{11} per m^3 ?

   (A)   2 MHz   (B)   10 MHz   (C)   12 MHz   (D)   18 MHz

18. An AM wave has modulation index of 75%. If the carrier is suppressed, the percentage power saving will be:

   (A)   78%   (B)   50%   (C)   40%   (D)   55%

19. In amplitude modulation, the band width is :

   (A)   twice the audio signal frequency   (B)   thrice the audio signal frequency

   (C)   thrice the carrier wave frequency   (D)   twice the carrier wave frequency

20. Identify the incorrect statement from the following :

   (A)   AM detection is carried out by using a rectifier and an envelop detector

   (B)   Pulse position denotes the time of rise or fall of the pulse amplitude

   (C)   Modulation index μ is kept ≥ 1, to avoid distortion

   (D)   Facsimile (FAX) scans the contents of the document to create electronic signals