4. COMMUNICATION SYSTEMS

SYNOPSIS

1. INTRODUCTION :

i) The exchange of information between a sender and receiver is called communication.

ii) The arrangement of devices to transfer the information is called the communication system.

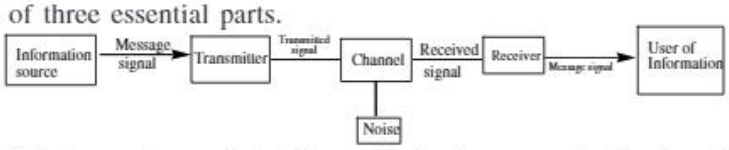
2. COMMUNICATION SYSTEM :

i) A communication system consists of three essential parts.

a) transmitter

b) medium or channel

c) receiver



ii) If the information is communicated between two points, this method of communication is called point to point mode.

iii) If the information is communicated from one point to several points, this method of communication is called Broad casting mode.

iv) **Message Signal :** The information converted into electrical form by a transducer, suitable for transmission is called message signal. Signals are of two types **analog** and **digital**.

a) ***Analog signal :*** Any physical variable is converted into continuous variations of current or voltage. These changes are analogous to the changes of the information. These changes are single valued functions of time.

b) ***Digital signal :*** The physical variables are converted into stepwise variations of current or voltages. Generally two steps of signals low level corresponds to zero and high level corresponds to 1.

v) **Transducers :** Any device that converts one form of energy into another form. An electrical transducer CONVERTS some physical variables into electrical variables or vice versa

a) Microphone - converts sound into electrical variables.

b) Speaker - converts electrical variables into sound.

vi) **Transmitter :** The transmitter processes the message and makes suitable for transmission through a channel.

vii) **Noise :** The unwanted signals which tend to disturb the transmission or processing of message signals are called Noise. These may generate inside or outside the system

viii) **Receiver :** The receiver extracts the message from the received signals at the channel out put.

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

x) **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 the attenuation of the signal in communication systems.

xi) **Range :** It is the largest distance between a source and destination up to which the signal is received with sufficient strength.

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

xiii) **Modulation :** The original low frequency message / information signal cannot be transmitted to long distances. Therefore, at the transmitter, information contained in the low frequency message signal is superimposed on a high frequency wave, which acts as a carrier of the information. This process is known as modulation.

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

3. BAND WIDTH OF SIGNALS :

In general a signal is the composition of number of frequencies. Hence the signal has a frequency range called band width

Analog signals Continuous variation	Frequency	Band width
Voice message telephonic communication	300 Hz to 3100 Hz	2800 Hz
Music	20 Hz to 20 kHz	20 kHz
Video Signals		4.2 MHz
TV Signals		6 MHz
Digital Signals Step wise Variation	As higher harmonics contribute less to signal wave	extends to GHz

4. BROADCASTING MODE OF COMMUNICATION ---PROPAGATION OF EM WAVES

i) This type of communication is also called as the wireless communication.

ii) The em waves (radio waves) are used for the transmission.

iii) The radio waves from transmitting antenna reach the receiving antenna through ground or through atmosphere.

iv) The earth atmosphere plays an important role in the propagation. Depending on the frequency of radio waves and the ranges, three modes of propagation exist.

v) The three modes of propagation are a) Ground wave propagation b) Sky wave propagation and c) Space wave propagation

5. LAYERS OF ATMOSPHERE :

i) Sky wave propagation takes place with the help of the layers in the atmosphere

ii) The gaseous enevelope of the earth is called the earth's atmosphere

iii) There is no sharp boundary for the atmosphere

iv) The earth's atmosphere is divided into several layers; depending on the temperature variation

Ground Wave	Sky Wave Propagation	Space Wave Propagation	Propagation
Channel	Ground	Layers of atmosphere	Line of sight communication
Method	Wave glides over the surface of earth difraction effect	Due to reflection of radio waves from the layers having higher electron density	The radio waves travel from transmitting antenna to receiving antenna along a straight line
Frequency	Depends on power and frequency Less than 2 MHz	3 MHz to 30 MHz	greater than 40 MHz
Uses	In medium wave Broad casting	Short wave broadcasting	FM broadcasting and Microwave links
Range	Depends on height of the Antenna and Curvature of earth	Depends on the angle of incidence on the ionos phere. 150 km to 3000 km	Due to curvature of the earth the waves are blocked at a point
Attenuation	Attenuation increases with frequency		

v) **Troposphere :**

a) The region extends from the surfaceapproximately 10 km above the surface.

b) This has large concentration of water vapour.

c) The temperature decreases upto 55^0C.

d) All climatic changes occur in this region.

vi) **Stratosphere :**

a) The region extends from 12 km to 50 km above the surface. The temprature remains constant upto 30 km

b) The upper part of thickness 20 km and 30 km to 50 km from the surface is called ozone layer Temperature increases from 55^0C to 65^0C.

c) This layer absorbs a large portion of UV radiations from Sun.

vii) **Mesosphere :**

The layer between 50 km to 80 km from the surface of earth is called Mesosphere temperature again decreases to -73^0 C.

viii) **Ionosphere :**

a) The region from a height of nearly 65 km to 400 km above the earth surface is called the Ionosphere. The temperature increases.

b) Ionosphere is mainly composed of free electrons and ions.

c) Ions are produced due to U.V. radiation and cosmic rays or X - ray

ix) **Different layers useful for Skywave Propagation.**

a) During day time ionosphere separates into three layers. D - layer, E layer and F - layer (F_1 & F_2)

b) D layer attenuates radio waves during day time.

c) The attenuation is maximum for lower frequencies.

d) Hence, HF waves are used for Sky wave propagation.

e) E layer of ionosphere reflects the radio waves of frequencies from 3 MHz to 30 MHz.

f) This reflection is similar to the total internal reflection of light.

g) This is used for a range upto 500 km.

h) The central part of E layer has maximum electron density. But it is less than the F layer.

i) Reflection takes place by E layer during day time.

j) This layer is highly variable in space and time.

k) F layer is the highest significant layer in the ionosphere.

l) During day time F layer splits into F_1 and F_2 layer.

m) F_2 layer has more electron density.

n) F_2 is stronger than F_1 layer in reflection.

o) The range is maximum for the F_2 layer. For reflection over 500 km range this layer is used.

p) Radio waves of frequency greater than 30 MHz penetrate through Ionosphere.

q) During night F_1 and F_2 layers combine and called F layer.

r) During night D and E layer disappear and the effective layer is only F layer.

6. KENNELY HEAVISIDE LAYER :

i) At 110 km above the surface of earth the concentration of electrons is very large. This layer is called Kennely Heaviside layer.

ii) The thickness of this layers is about a few km.

iii) Beyond this layer the electron concentration decreases upto 250 km

iv) From 250 km to 400 km, a layer of large concentration of electrons called Apple ton layer exists.

v) Above appleton layer, ie above Ionosphere the temperature is 927.6^0C.

7. FREQUENCY SELECTION :

Frequencies used for transmission

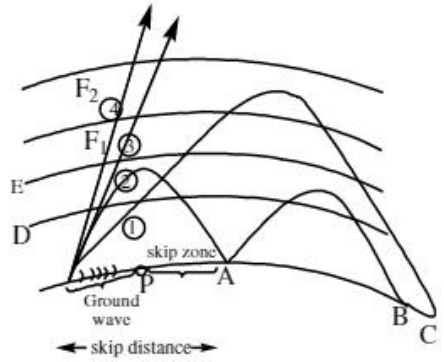
Medium Wave Broad cast	A.M. 0.54 MHz to 1.6 MHz
Short wave Broad cast	1.6 MHz to 30 MHzor 40 MHz Ionosphere reflected
FM Broad cast	88 MHz to 108 MHz
TV Broad cast	VHF 54 - 72 MHz 76 - 88 MHz UHF 174-216 MHz 420 - 890 MHz
Cellular Mobile	896 MHz - 901 MHz to Base 840 MHz-935 MHz Base to mobile
Satellite	5.925-6.425 GHz uplink 3.72 to 4.2 GHz down link

Medium and short wave Broad casting frequencies are called HF range.

i) Higher frequencies are used for longer ranges.

ii) The frequencies used during early morning, late afternoon and early evening must be less than those used at mid day transmission for the same range.

iii) During late night still lower frequencies are to be used.



iv) The radio waves which are radiated on a small vertical angle along path 1 is reflected by F_2 layer and reach the ground at a larger distance.

v) The radio waves of path 2 having greater vertical angle than path 1 is reflected by E layer.

vi) This has low range than path 1.

vii) It can be reflected by the earth and it lands at B after second hop.

viii) Using such hops the transmission can be made over the earth.

ix) As the vertical angle increases they can not be reflected back but they pass through the ionosphere.

x) The angle above which the radiations are not reflected by the ionospheric layer is called critical angle.

xi) The critical angle depends on the density of ionisation.

xii) However if the frequencies are greater than 30 MHz they pass through the ionosphere for any angle of incidence.

xiii) The distance from the transmitting tower 'O' to a point P is the Ground wave range.

xiv) From P, the point A at which the reflected ray from 'E' layer reaches the earth is called the skipzone. In this zone the reception is absent.

xv) The distance 'OA' is called the skip distance

8. DRAWBACKS :

i) The density of ionisation of layers change hour to hour.

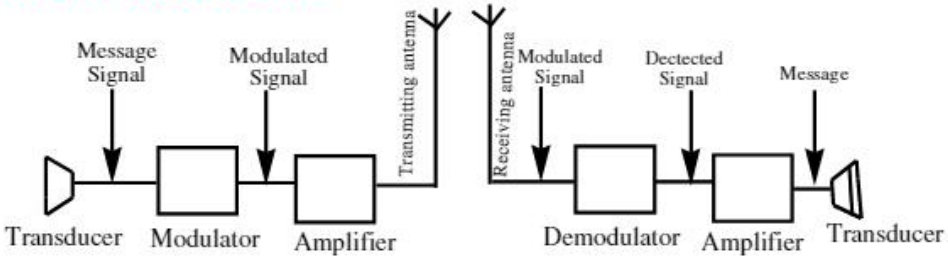
ii) The height of the layers change daily

iii) The height of layers change with season

iv) Further it changes in the sunspot activity

v) Due to these changes made the propagation is least reliable as sudden fade outs and disappearances of signals occur so often.

9. WORKING OF BROADCAST :



i) Transducer converts the information in, to continuous electrical variables in analog mode or step variables in digital mode

ii) Modulator super imposes the message signal on a carrier wave (Radio wave) which can be conveniently propagated with the velocity of light

iii) The modulated signal is amplified to a required level and radiated through Antenna called Transmitting antenna.

iv) The propagating signal is intercepted by the Receiving antenna and picks up the modulated signal.

v) Demodulator detects the message signal and separates it from the carrier wave

vi) The message signal is amplified by the Amplifier to a required level

vii) The transducer converts the message signal into proper information

10. ANTENNA :

i) For the propagation, Antenna plays an important role

ii) Different antenna's are designed for different wave lengths and different modes of propagation

iii) The linear size of the antenna must be the order of the wavelength and for effective transmission its length must be $\frac{\lambda}{4}$.

iv) For transmission the em waves of base band range (AF range) cannot be used directly because of its wave length.

a) The audio frequency range is <20 KHz

b) The wave length $\lambda = \frac{C}{f} = \frac{3 \times 10^8}{20 \times 10^3} = 15 \times 10^3 \text{ m} = 15 \text{ km}$

c) The length of the Antenna must be equal to $\frac{\lambda}{4}$.

d) For effective transmission of AF range radio waves. The length of Antenna must be $\frac{15000}{4} = 3750\ m$, which is not feasible

e) Hence the higher frequencies are opted for the transmission.

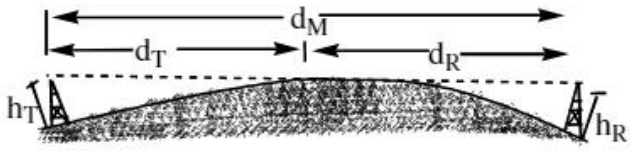
f) If the frequency of transmission is high the height of the antenna is of reasonable lengths.

g) Thus the HF transmission is prefered.

h) The HF range is 3MHz to 30 MHz

i) So the message contained by the base band signal is to be translated to a high radio frequencies before transmission.

v) Two antennas :



a) The distance between transmitting antenna and the horizon, $D_t = \sqrt{2Rh_t}$.

Where h_t = height of transmitting antenna R = Radius of the earth

b) The distance between receiving antenna and the horizon, $D_r = \sqrt{2Rh_r}$.

Where h_r = height of receiving antenna

c) The maximum distance between the transmitting antenna and receiving antenna D_m.

d) The maximum distance $D_m = D_r + D_t$

$D_m = \sqrt{2\,Rh_r} + \sqrt{2\,Rh_t}$ Where R is the radius of earth.

$h_r > h_t$ so then the receiving antenna intercepts the line of sight waves.

There is no need of receiving anteena to have same height as that of transmission anteena.

vi) Single antenna :

a) The radius "d" of the area covered by a single transmitting tower of height h is given by $d = \sqrt{2R_eh}$. Where R_e is the radius of the Earth.

b) If the Population density around the tower is given, the number of persons covered by the tower is = (Area covered by the tower) × Population density

No. of persons covered = πd^2 × Population density.

c) If the Antenna is vertical, vertically polarised EM wave is radiated.

Ex : TV Broad cast, Microwave links, Satellite communication.

11. MODULATION :

i) The message signals are also called base band signals which are in AF range (less than 20 kHz).

a) These AF signals can not be transmitted to a long distances because of attenuation (loss of energy).

b) For the transmission of AF range signals, the linear size (l) of the antenna should be large.

c) The effective power radiated by the transmitter is proportional to $(l/\lambda)^2$. Hence the size of the antenna is about 75 km which is not feasible.

d) When many transmitters are radiating base band signals simultaneously, they mix up and it is difficult to distinguish the required signal.

ii) The solution for the long distance transmission is the selection of the HF transmission.

iii) As HF radio waves are prefered for transmission, the message contained by the base band signal is to be translated on to a HF em wave.

iv) Messages are converted into electrical variations by a transducer.

v) These electrical variations are called signal.

vi) The sound waves are converted into electrical variations (either voltage or current) by the microphone (transducer).

vii) The signal wave is called modulating wave.

viii) The electrical variations are super imposed on the RF em wave called carrier wave (CW).

ix) The resultant wave is called Modulated wave.

x) This process is called Modulation.

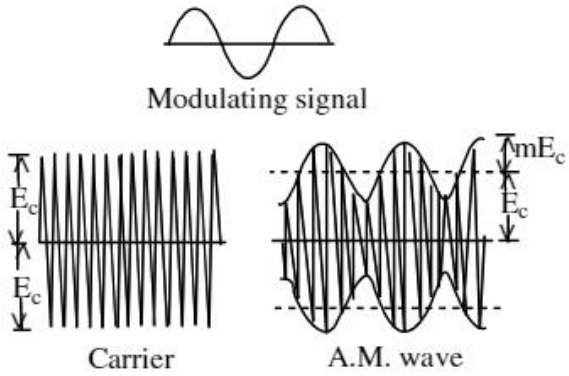
xi) During modulation one of the characterstics of the RF wave (CW) is to be changed in accordance with signal.

xii) Modulation is of three types

a) Amplitude modulation; b) Frequency modulation ; c) Phase modulation

12. AMPLITUDE MODULATION :

i) The amplitude of CW varies in accordance with the amplitude variations of the modulating signal. However the frequency and phase of CW wave remain same,

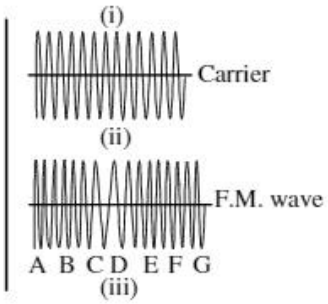


ii) The amplitude of carrier wave increases in accordance with the increase of the amplitude of the signal in the positive half cycle and decreases with the amplitude of the signal in the negative half cycle.

13 FREQUENCY MODULATION:

i) The frequency of the CW changes in accordance with the amplitude variation of the signal.

ii) The amplitude of the modulated wave does not change.



14. PHASE MODULATION :

i) The phase of the CW is changed in accordance with the amplitude variations of the signal.

ii) The amplitude and frequency of CW do not change.

iii) The modulated wave appears similar to the FM wave.

iv) It differs from FM wave in the definition and the modulation factor.

15. DEMODULATION :

i) The process of extracting the message from the modulated wave is called demodulation.

ii) This consists of detection and amplification of signal.

i) Power radiated

1. The effective power radiated by a given length 'ℓ' of an antenna is proportiond to ℓ/λ^2.
2. As the base band frequency is less, the corresponding wave lengths are larger so the power radiated is less.
3. This limits the usage of AF tranmission.
4. By decreasing λ, that is increasing the frequency of transmission the power radiated increases. Hence HF transmission is preferred.

ii) Identification of a particular message

1. If a number of transmitters work simulteneously in AF range in the same line, they cannot be distinguished from one another.
2. If HF is used for transmission different transmitters can be alloted different HF bands for tansmission.

iii) Amplitude Modulation

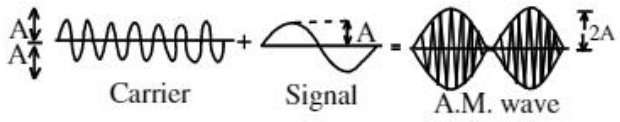
1. The extent to which the modulation is to be taken up is called the modulation factor (m_a)

$$m_a = \frac{\text{Amplitude change in carrier wave}}{\text{Amplitude of normal (un modulated) CW}}$$

2. In the absence of signal.

Modulation factor $m_a = \frac{O}{A} \times 100 = 0\%$

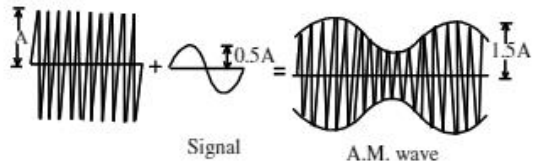
3. When the signal amplitude is equal to CW wave. Amplitude varies from 2A to zero.



$$\frac{\text{Amplitude change in carrier wave}}{\text{Amplitude of CW}} = \frac{2A - A}{A} = 100\%$$

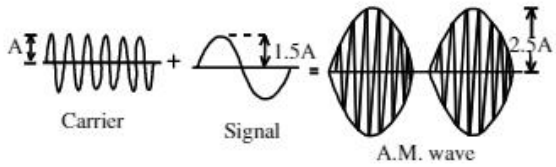
4. When the amplitude of the signal is half of that of CW.

Amplitude of CW changes from A to $\left(A + \frac{A}{2}\right) = 1.5\ A$



Modulation factor $= \frac{0.5A}{A} = 0.5 = 50\%$

5. When the amplitude of signal is 1.5 times that of the CW. Amplitude of the modulated wave changes from 2.5 A to A



Modulation factor $m_a = \frac{2.5A - A}{A} = 1.5 = 150\ \%.$

In this case the quality of signal is lost

6. In general the modulation factor is kept $\leq$ 1.
7. Modulation factor determines the strength and quality of the transmitted signal.
8. If a C.W. is modulated by different audio waves to different strengths then the effective modulation factor is given by $\sqrt{m_1^2 + m_2^2 + ...}$

iv) Power transmitted

1. Total power radiated is distributed among the component frequencies.
2. Power radiated depends on the square of the rms voltage across the circuit and the effective resistance of circuit R.
3. Carrier wave power $P_c = \frac{V_c^{\ 2}}{2R}$
4. Power of each side band $P_l = \frac{m_a^{\ 2} V_c^{\ 2}}{8R}$

5. Total power of side bands $P_s = \frac{m_a^2 V_c^2}{4R}$

6. Total power carried by modulated wave $P_T = \frac{V_C^2}{2R} + \frac{m_a^2 V_C^2}{4R} = \frac{V_C^2}{2R}\left[\frac{2+m_a^2}{2}\right]$

7. Fractional power carried by the side bands $\frac{P_s}{P_T} = \frac{m_a^2}{2+m_a^2}$

8. Fractional power carried by CW, $\frac{P_c}{P_T} = \frac{2}{2+m_a^2}$

9. $\frac{P_c}{P_T} = \left(\frac{I_c}{I_t}\right)^2$ where I_c and I_t are current in the antenna with only CW and modulated wave.

10. As the side band frequencies contain the signal. The power in side bands depends on modulation factor.

11. If the modulation factor is greater then the useful power is carried by the side bands.

12. Normally the power in the side bands are used in the receiver.

13. The side bands play an important in transmitting the information.

14. If the modulation factor is 1 ie 100 % modulation then the useful power is $\frac{1}{3}$ of the total power radiated. The remaining 2/3 power is contained by carrier wave

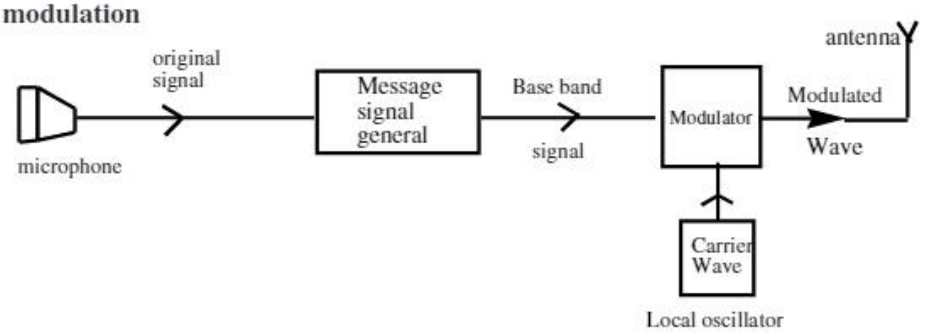
$$\boxed{\frac{P_s}{P_T} = \frac{m_a^2}{2+m_a^2} = \frac{1}{3}} \text{ and } \boxed{\frac{P_c}{P_T} = \frac{2}{2+m_a^2} = \frac{2}{3}}$$

15. The power content of CW does not change but the power radiated changes with m_a.

*v) **Production of AM Wave :*** Two types of production

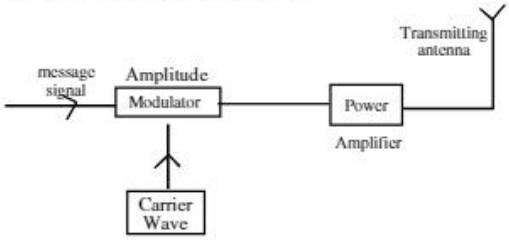
a) Linear modulation method b) Square law modulation

a) Linear modulation



1. The sound waves received by the microphone are converted into continuous electrical variations.
2. These variations are in accordance with the original signal variations.
3. It passes through the message signal generator.
4. The base band signal is emitted out.
5. There is a local oscillator which produces the carrier wave.
6. The base band signal and the carrier wave are fed to the modulator.

7. Then the modulated wave is emitted.
8. This modulated wave cannot be transmitted as it is.



9. The modulated wave is applied to power Amplifier.
10. Power amplifier increases the power of modulated wave, to required level.
11. Now this modulated wave with larger power is radiated from transmitting Antenna.

*vi) **Square law modulation :***

1. To produce AM wave having required band width rejecting un wanted frequencies this type of modulation is used.

   The modulating signal Vm $\sin\omega_m t$ is added to the Carrier signal. $V_C \sin\omega_c t$

   This produces another wave of the form $x(t) = V_m \sin\omega t + V_{Cl}\sin\omega_c t$.

   This combined wave is passed through a square law device.

   A square law device is a non linear device produces an output of form $y(t) = Bx(t) + Cx^2(t)$

   where B and C are constants.

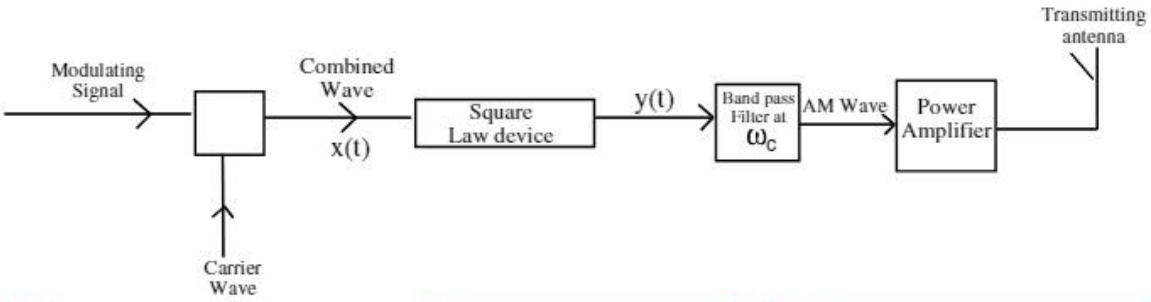
   Then the output wave generated takes the form

   $y(t) = BV_m \text{ Sin}\,\omega_m t + B\,V_c \text{ Sin}\,\omega_c + C\,[Vm^2 \text{ Sin}^2\,\omega_m t + V_c^2 \text{ Sin}^2\omega_c t + 2V_m V_c \text{ Sin }\omega_m t \text{ Sin}\,\omega_c t]t$

   This reduces to

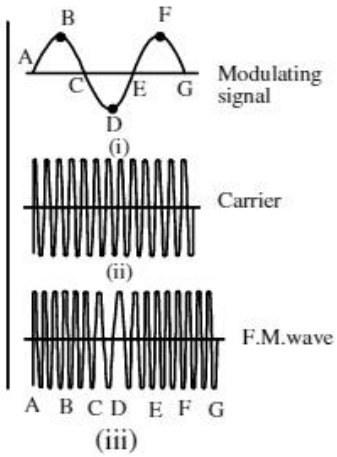
$$y(t) = BV_m \text{ Sin }\omega_m t + BV_c \text{ Sin }\omega_c t + \frac{CV_m^2}{2} + V_c^2 - \frac{CV_m^2}{2}\text{ Cos }2\omega_m t - \frac{CV_c^2}{2}\text{ Cos }2\omega_c t$$
$$+CV_m V_c \text{ Cos }(\omega_c - \omega_m)t - CV_m V_c \text{ Cos }(\omega_c + \omega_m)t$$

2. The above equation contains DC terms $\frac{C}{2}(V_m^2 + V_c^2)$ and terms containing frequencies ω_m, $2\omega_m, 2\omega_c$. These are not useful.
3. The useful frequancies are ω_c, $(\omega_c - \omega_m)$, $(\omega_c + \omega_m)$ and frequencies (f_c, $f_c - f_m$, $f_c + f_m$).
4. So this wave is allowed to pass through a band pass filter.
5. This filters low frequencies and higher frequencies. It retains only frequencies f_c, $f_c - f_m$ and $f_c + f_m$.
6. The Out put is AM wave
7. This AM wave is to be amplified to the required power and than fed to the Transmitting antenna.



vii) Frequency modulation

1. The frequency of carrier wave is changed in accordance with the instanteneous amplitude of the signal.
2. The amplitude of the Carrier wave remains same.



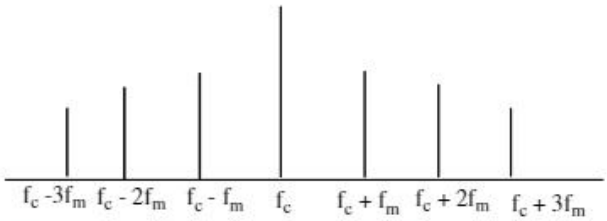
3. Consider the points A, C, E of the signal wave. At these points the signal voltage is zero.
4. So at these points the CW frequency remains same.
5. As the signal voltage increases to maximum value at B, the CW frequency increases. so the waves are crowded.
6. As the signal voltage decreases to a minimum value at D (the negative peak) the CW frequency decreases. So the waves are widely spaced.
7. Since noise is a form of amplitude variation, FM receiver refuses such variation.
8. This type of modulation gives noiseless reception.
9. Frequencymodulation index, $m_f = \dfrac{\text{Maximum frequency deviation}}{\text{mod ulating frequency}}$

   f_c is Carrier wave frequency, f_m is modulating wave frequency , f is frequency of modulated wave.

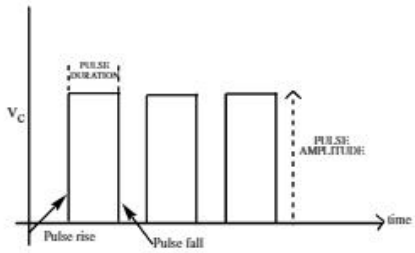
   $m_f = \dfrac{f - f_c}{f_m} = \pm\dfrac{K V_m f_c}{f_m}$

   KV_m - Maximum value of modulating voltage $\pm KV_m f_c$ is the maximum deviation.
10. A series of side bands of frequencies $(f_c \pm f_m);(f_c \pm 2f_m);(f_c \pm 3f_m)$ are obtained.
11. They are symmetrical about f_c.

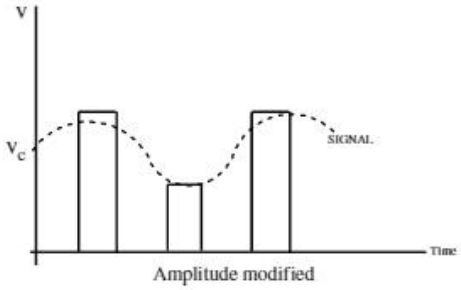
    Note : Bandwidth of the signal is $2f_c$.
12. As more number of side bands are present, the stereo phonic messages can be transmitted with attenuation.



viii) Pulse modulation

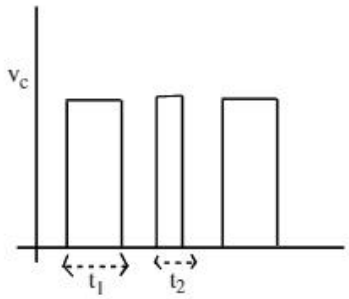


1. The carrier wave is a pulse train as shown.
2. Pulse Amplitude modulation (PAM) : The amplitude of the pulse changes in accordance with the instanteneous values (amplitude) of the modulating signal wave.
3. Pulse time modulation (PTM) : The pulse duration of the carrier pulse train changes in accordance with the instantaneous values of the modulating signal.



Amplitude modified

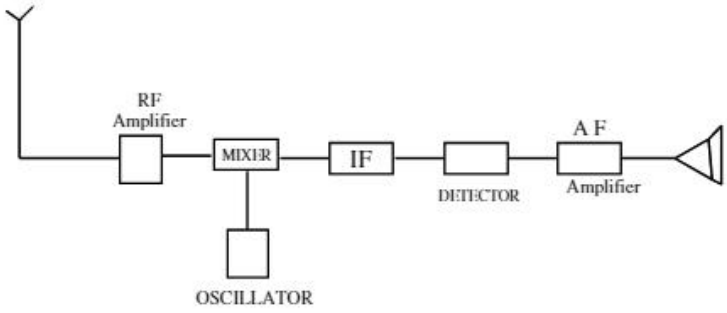
4. Pulse width modulation (PWM) : The pulse duration of the carrier pulse train changes in accordance with the instanteneous values of the modulating signal. As such the width of the pulse changes. Hence it is called as pulse width modulation (PWM) or pulse duration modulation (PDM)
5. In this case the amplitude of the pulse remains same.



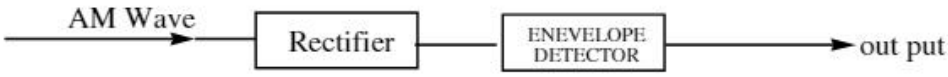
6. These modulations PAM and PDM are not completely, used in digital transmission.
7. In digital transmission pulse code modulation PCM is used.
8. The message is coded interms of zero and one in the binary system.

ix) Amplitude Demodulation

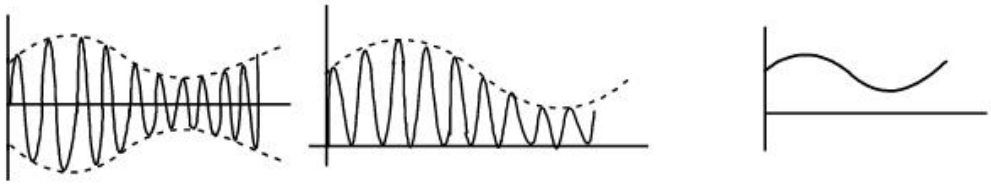
1. The attenuated modulated wave is received by the receiving antenna.
2. This received AM wave must be amplified and then detected.
3. For effective amplification the carrier Frequency is decreased to intermediate frequency called (IF) with the help of local oscillator.



4. The signal intercepted by the receiving antenna is fed to RF amplifier.
5. Another RF wave having nearer frequency is produced in the local oscillator.
6. This RF wave and the amplified AM wave are fed to mixer.
7. The mixer emits an AM wave having the frequency of difference of CW and RF. This frequency is equal to the required IF stage.
8. This IF stage frequency helps to have maximum amplification and to have faithful reproduction of the message contained by the signal.
9. This IF signal is fed to the detector (demodulator). This detects the Audio wave which is the message.
10. The AF signal is amplified and fed to the out put end
11. This out put end may be any transducer or a speaker or any recording system or to a computer.
12. Detection : Detection is the process of recovering the modulating signal from the modulated carrier wave.
13. Detection contains two steps.



x) ***AM Wave :*** ***Rectified Wave :*** **Audio Wave :**



1. The AM wave passes through rectifier.
2. The wave from the rectifier contains CW with audio wave.
3. This wave passes through enevelope detector . This removes the CW wave and emits the audio wave which is the message.
4. This audio wave is amplified and fed to a transducer say speaker or a recorder or a computer.
5. A Geostationary satellite is one that appears to be stationary relative to the earth. It has a circular orbit lying in the equatorial plane of the earth (inclination 0^0) at an approximate height of 36,000 km.

LECTURE SHEET

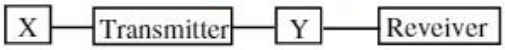
LEVEL-I (MAIN)

EXERCISE-I

(Elements of communication system and propogation of Radiowaves)

Straight Objective Type Questions

1. Identify the parts X and Y in the block diagram of a generalised communication system



1) Information source, transducer
2) Information source, communication channel
3) Communication channel, information source
4) Transducer, information source

2. Sky wave propagation is used in
1) radio communication
2) satellite communication
3) TV communication
4) both TV and satellite communication

3. The sky wave propagation is suitable for radio waves of frequency
1) upto 2MHz
2) from 2 MHz to 20 MHz
3) from 2MHz to 50 MHz
4) from 2MHz to 80 MHz

4. Statement-1 : Sky wave signals are used for long distance radio communication. These signals are in general less stable than ground wave signals
Statement-2 : The state of ionosphere varies from hour to hour, day to day and season to season
1) S-1 is false, S-2 is true
2) S-1 is true, S-1 is false
3) S-1 is true, S-2 is true, S-2 is the correct explanation of S-1
4) S-1 is true, S-2 is true, S-2 is not the correct explanation of S-1

5. Which of the following statements is wrong ?
1) Ground wave propagation can be sustained at frequencies 500 kHz to 1500 kHz
2) Satellite communication is useful for the frequencies above 30 MHz
3) Space wave propagation takes place through tropospheric space
4) Sky wave propagation is useful in the range 30 to 40 MHz

6. Which of the following frequencies will be suitable for beyond-the-horizon communication using sky waves ?
1) 10 kHz
2) 10 MHz
3) 1 GHz
4) 1000 GHz

7. Frequencies in the UHF range normally propagate by means of
1) ground waves
2) sky waves
3) surface waves
4) space waves

8. A basic communication system consists of
A) transmitter
B) information source
C) user of information
D) channel
E) receiver
Choose the correct sequence in which these are arranged in a basic communication system
1) ABCDE
2) BADEC
3) BDACE
4) BEADC

9. Through which mode of propagation, the radio waves can be sent from one place to another ?
1) Ground wave propagation
2) Sky wave propagation
3) Space wave propagation
4) All of the above

10. The frequencies of electromagnetic waves employed in space communication vary over a range of
1) 10^4Hz to 10^7Hz 2) 10^4 Hz to 10^{11}Hz 3) 1Hz to 10^4Hz 4) 1Hz to 10^{11}Hz

11. The wavelength of electromagnetic waves employed for space communication lie in the range of
1) 1mm to 30m 2) 1mm to 300m 3) 1mm to 3km 4) 1mm to 30km

12. The radiowaves of frequency 300MHz to 300MHz belongs to
1) high frequency band 2) very high frequency band
3) ultra high frequency band 4) super high frequency band

13. The maximum range of ground or surface wave propagation depends on
1) the frequency of the radiowaves only 2) power of the transmitter only
3) both (1) and (2) 4) none of the above

14. Because of tilting, which waves finally disappear ?
1) Micro waves 2) Surface waves 3) Sky waves 4) Space waves

15. When microwaves signals follow the curvature of earth, this is known as
1) window 2) the faraday effect
3) ionospehric reflection 4) ducting

16. The absorption of radio waves by the atmosphere depends on
1) their distance from the transmitter 2) the polarisation of the wave
3) their frequency 4) the polarisation of the atmosphere

17. The wave relevant to telecommunications are
1) visible light 2) infrared 3) ultraviolet 4) microwaves

18. Polarization of electromagnetic wave is caused by
1) reflection 2) refraction
3) transverse nature of electromagnetic waves 4) longitudinal nature of electromagnetic waves

19. The polarization of electromagnetic waves is in
1) the directions of electric and magnetic field 2) the directions of electric field
3) the direction of electric field 4) none of the above

20. In a single reflection from the ionosphere, the sky waves cover a distance on ground not more than
1) 400 m 2) 4000 m 3) 400 km 4) 4000 km

21. A sky wave with a frequency 55 MHz is incident on D-region of the earth's atmosphere at 45°. The angle of refraction is (electron density for D-region is 400 electron/c.c)
1) 60° 2) 45° 3) 30° 4) 15°

22. In which frequency range, space waves are normally propagated ?
1) HF 2) VHF 3) UHF 4) SHF

23. For television broadcasting, the frequency employed is normally
1) 30Hz -30 MHz 2) 30Hz -300GHz 3) 30Hz – 300 KHz 4) 30Hz – 300 Hz

24. The sound waves after being converted into electrical waves, are not transmitted as such because
1) they travel with the speed of sound 2) the frequency is not constant
3) they are heavily absorbed by the atmosphere
4) the height of antenna has to be increased several times

25. Calculated the phase velocity of electromagnetic wave having electron density and frequency for D -layer : (N = 400 electrion/cc and v = 300 kHz)
1) 3×10^8 m/s 2) 3.75×10^8 m/s 3) 6.8×10^8m/s 4) 1.1×10^9m/s

26. A digital signal possesses
1) continuously varying values 2) only two discrete values
3) only for discrete values 4) none of the above

27. A digital signal
1) is less reliable than analog signal 2) is more reliable than analog signal
3) is equally reliable as the analog signal 4) none of the above

28. Modern communication systems is based on
1) analog circuits 2) digital circuits
3) combination of analog and digital circuits 4) none of the above

29. The audio signal
1) can be sent directly over the air for large distance
2) cannot be sent directly over than air for large distance
3) possess very high frequency 4) None of the above

30. Which of the following is preferred modulation scheme for digital communication ?
1) Pulse Code Modulation (PCM) 2) Pulse Amplitude Modulation (PAM)
3) Pulse Position Modulation (PPM) 4) Pulse Width Modulation (PWM)

31. For transmitting audio signal properly
1) it is first superimposed on high frequency carrier wave
2) it is first superimposed on low frequency carrier wave
3) it is sent directly without superimposing on any wave
4) none of the above

32. The process of changing some characteristic of a carrier wave in accordance with the intensity of the signal is called
1) amplification 2) rectification 3) modulation 4) none of these

33. The process of superimposing signal frequency (i.e. audiowave) on the carrier wave is known as
1) transmission 2) reception 3) modulation 4) detection

34. Modulation is the process of superposing
1) low frequency audio signal on high frequency waves
2) low frequency radio signal on low frequency audio waves
3) high frequency audio signal on low frequency radio waves
4) low frequency radio signal on high frequency audio waves

35. What is the need for doing modulation ?
1) To increase the intensity of audio signal 2) To decrease the intensity of audio signal
3) To transmit audio signal to large distances 4) None of the above

36. The types of modulation which are possible are
1) one only 2) two only 3) three only 4) none of these

37. In amplitude modulation
1) only the amplitude is changed but frequency remains same
2) both the amplitude and frequency change equally
3) both the amplitude and frequency change unequally
4) none of the above

38. What type of modulation is employed in India for radio transmission ?
1) Pulse modulation
2) Frequency modulation
3) Amplitude modulation
4) None of these

39. What is the band width in amplitude modulation ?
1) Equal to audio signal frequency
2) Two times the audio signal frequency
3) Hald the signal frequency
4) None of the above

40. The process of recovering the audio signal from the modulated wave is known as
1) amplification 2) rectification 3) modulation 4) demodulation

41. Modem is a device which performs
1) modulation
2) demodulation
3) rectification
4) modulation and demodulation

42. The main objective of an optical source is
1) to convert electrical energy into an optical energy
2) to detect the signal
3) to demodulate the electrical signal
4) all of the above

43. Optical fibre communication is generally preferred over general communication system because
1) it is more efficient 2) of signal security 3) both (a) and (b) 4) none of these

44. The diameter of an optical fibre is
1) 10^{-3} cm 2) 10^{-4} cm 3) 10^{-2} cm 4) 10^{-5} cm

45. Modulation factor determines
1) Only the strength of the transmitted signal
2) Only the quality of the transmitted signal
3) both the strength and quality of the signal
4) none of the above

46. Degree of modulation
1) can take any value
2) should be less than 100%
3) should exceed 100%
4) none of these

47. Which of the following is not transducer ?
1) Loudspeaker 2) Amplifier 3) Microphone 4) All of these

48. The principle used in the transmission of signals through an optical fibre is
1) total internal reflection
2) reflection
3) refraction
4) dispersion

49. The optical fibres have in an inner core of refractive index n_1 and a cladding of refractive index n_2, such that
1) $n_1 = n_2$ 2) $n_1 < n_2$ 3) $n_1 < n_2$ 4) $n_1 > n_2$

50. Advantages of optical fibre communications over two wire transmission line or co-axial cable transmission are
1) low band width, low transmission loss
2) high band width, high transmission loss
3) high band width, low transmission loss
4) low band width, high transmission loss

51. In satellite communication
1) the frequency used lies between 5MHz and 10MHz
2) the uplink and downlink frequencies are different
3) the orbit of geostationary satellite lies in the equatorial plane at an inclination of 0°
In the above statements
1) Only 2 and 3 true 2) All are true 3) only 2 true 4) only 1 and 2 true

52. Which of the following four alternatives is not correct ? We need modulation
1) to increase the selectivity
2) to reduce the time lag between transmission and reception of the information signal
3) to reduce the size of antenna
4) to reduce the fractional bandwidth, that is the ratio of the signal bandwidth to the centre frequency

53. Statement-1 : Sky wave signals are used for long distance radio communication. These signals are in general less stable than ground wave signals
Statement-2 : The state of ionosphere varies from hour to hour, day to day and season to season
1) S-1 is false, S-2 is true
2) S-1 is true, S-1 is false
3) S-1 is true, S-2 is true, S-2 is the correct explanation of S-1
4) S-1 is true, S-2 is true, S-2 is not the correct explanation of S-1

54. Match Column-I (layers in the ionosphere for skywave propagation) with Column-II (their height range) :

Column-I	**Column-II**
I) D-layer	a) 250-400 km
II) E-layer	b) 170-190 km
III) F_1-layer	c) 95-120 km
IV) F_2-layer	d) 65-75 km

The correct answer is

	I	II	III	IV		I	II	III	IV		I	II	III	IV		I	II	III	IV
1)	a	b	c	d	2)	d	c	a	b	3)	d	c	b	a	4)	c	d	a	b

55. Match the following Column-I with Column-II

Column-I **Space communications**	**Column-II** **Frequencies**
I) Ground wave propagation	A) 30 MHz to 300 MHz
II) Sky wave propagation	B) 80 MHz to 200 MHz
III) Space wave propagation	C) 2 MHz to 30 MHz
IV) Television signal propagation	D) 500 kHz to 1500 kHz

Code
1) I-D, II-C, III-A, IV-B
2) I-A, II-B, III-C, IV-D
3) I-B, II-A, III-D, IV-C
4) I-C, II-D, III-B, IV-A

EXERCISE-II

(Antenna)

Straight Objective & More than one Correct Answer Type Questions

1. Antenna is
   1) inductive
   2) capactive
   3) resistive above its resonant frequency
   4) resistive at resonant frequency

2. The fundamental radio antenna is a metal rod which has a length equal to
   1) λ in free space at the frequency of operation
   2) $\lambda/2$ in free space at the frequency of operation
   3) $\lambda/4$ in free space at the frequency of operation
   4) $3\lambda/4$ in free space at the frequency of operation

3. A signal emitted by an antenna from a certain point can be received at another point of the surface in the form of
   1) sky wave 2) ground wave 3) sea wave 4) Both (1) and (2)

4. A radio station has two channels. One is AM at 1020kHz and the other is FM at 89.5MHz. For good results, you will use
   1) longer antenna for the AM channel and shorter for the FM
   2) shorter antenna for the AM channel and longer for the FM
   3) same antenna length will work for both
   4) information given is not enough to say which one to use for which

5. Broadcasting antennas are generally
   1) omnidirectional type 2) vertical type 3) horizontal type 4) none of these

6. If the audio signal is transmitted directly into space, the length of transmitting antenna required will be
   1) extremely small 2) extremely large 3) infinitely large 4) none of these

7. A radar has a power of 1kW and is operating at a frequency of 10 GHz. It is located on a mountain top of height 500m. The maximum distance upto which it can detect object located on the surface of the Earth is (Radius of Earth = 6.4×10^6m)
   1) 80 km 2) 16 km 3) 40 km 4) 64 km

8. The maximum distance upto which TV transmission from a TV tower of height h can be received is proportional to
   1) $h^{3/2}$ 2) h 3) $h^{1/2}$ 4) h^2

9. A TV transmission tower has a height of 240m. Signals broadcast from this tower will be received by LOS communication at a distance of (assume the radius of earth to be 6.4×10^6m)
   1) 100 km 2) 24 km 3) 55 km 4) 50 km

10. The maximum distance between the transmitting and receiving TV towers is 72 km. If the ratio of the heights of the TV transmitting tower to receiving tower is 16 : 25, the heights of the transmitting and receiving towers are
    1) 51.2 m ; 80 m 2) 40 m ; 80 m 3) 80 m ; 125 m 4) 25 m ; 75 m

11. A T.V. transmitting antenna is 128 m tall. If the receiving antenna is at the ground level, the maximum distance between them for satisfactory communication in L.O.S. mode is (Radius of the earth = 6.4×10^6 m)

1) $64\times\sqrt{10}$km 2) $\frac{128}{\sqrt{10}}$ km 3) $128\times\sqrt{10}$ km 4) $\frac{64}{\sqrt{10}}$ km

12. If height of a transmitting tower increases by 21% then the area to be covered increases by

1) 10% 2) 21% 3) 42% 4) 84%

EXERCISE-III

(Modulation and Applications)

Straight Objective & More than one Correct Answer Type Questions

1. Which of the following four alternatives is not correct ? We need modulation

1) to reduce the size of the antenna

2) to reduce the fractional bandwidth, that is the ratio of the signal bandwidth to the centre frequency

3) to increases the selectivity

4) to reduce the time lag between transmission and reception of the information signal

2. In frequency modulation

1) the amplitude of the modulated wave varies as frequency of the carrier wave

2) the frequency of the modulated wave varies as the amplitude of the modulating wave

3) the amplitude of the modulated wave varies as the amplitude of the carrier wave

4) the frequency of the modulated wave varies as the frequency of the modulating wave

3. The frequency of a FM transmitter without signal input is called

1) lower side band frequency 2) upper side band frequency

3) resting frequency 4) none of the above

4. The AM wave of equivalent to the summation of

1) two sinusoidal waves 2) three sinusoidal waves

3) four sinusoidal waves 4) none of these

5. The AM wave contains three frequencies, viz ;

1) $\frac{f_c}{2},\frac{f_c+f_s}{2},\frac{f_c-f_s}{2}$ 2) $2f_c$, $2(f_c+f_s)$, $2(f_c-f_s)$

3) f_c, (f_c+f_s), (f_c-f_s) 4) f_c, f_c, f_c

6. In AM wave, the amplitude of each side band frequency is

1) E_c 2) mE_c 3) $\frac{mE_c}{2}$ 4) $2mE_c$

7. In AM wave, carrier power is given by

1) $P_c=\frac{2E_c^2}{R}$ 2) $P_c=\frac{E_c^2}{R}$ 3) $P_c=\frac{E_c^2}{2R}$ 4) $P_c=\frac{E_c^2}{\sqrt{2}R}$

8. In AM wave, total power of side bands is given by

1) $P_s=\frac{E_c^2}{4R}$ 2) $P_s=\frac{4E_c^2}{R}$ 3) $P_s=\frac{m^2E_c^2}{4R}$ 4) $P_s=\frac{E_c^2}{4m^2R}$

9. Fractional of total power carried by side bands is given by

1) $\frac{P_s}{P_T} = m^2$ 2) $\frac{P_s}{P_T} = \frac{1}{m^2}$ 3) $\frac{P_s}{P_T} = \frac{2+m^2}{m^2}$ 4) $\frac{P_s}{P_T} = \frac{m^2}{2+m^2}$

10. Modulation factor determines

1) only the strength of the transmitted signal 2) only the quality of the transmitted signal
3) both the strength and quality of the signal 4) none of the above

11. If the maximum and minimum voltage of an AM wave are $V_{max.}$ and $V_{min.}$ respectively then modulation factor

1) $m = \frac{V_{max.}}{V_{max.} + V_{min}}$ 2) $m = \frac{V_{min.}}{V_{max.} + V_{min.}}$ 3) $m = \frac{V_{max.} + V_{min.}}{V_{max.} - V_{min.}}$ 4) $m = \frac{V_{max.} - V_{min.}}{V_{max.} + V_{min.}}$

12. When m = 1, power carried by side bands is

1) 11.1% of the total power of AM wave 2) 22.2% of the total power of AM wave
3) 33.3% of the total power of AM wave 4) 44.4% of the total power of AM wave

13. Which of the following is/are the limitations of amplitude modulation ?

1) Clear reception 2) High efficiency
3) Small operating range 4) Good audio quality

14. Degree of modulation

1) can take any value 2) should be less than 100%
3) should exceed 100% 4) none of the these

15. A signal wave of frequency 12kHz is modulated with a carrier wave of frequency 2.51MKz. The upper and lower side band frequency are respectively

1) 2512 kHz and 2508 kHz 2) 2522 kHz and 2488 kHz
3) 2502 kHz and 2498 kHz 4) 2522 kHz and 2498 kHz

16. The antenna current of an AM transmitter is 8A when only the carrier is sent, but it increases to 8.93A when the carrier is modulated by a single sine wave. Find the percentage modulation

1) 60.1% 2) 70.1 % 3) 80.1 % 4) 50.1 %

17. A kW signal is transmitted using a communication channel which provides attenuation at the rate of –2dB per km. If the communication channel has a total length of 5km, the power of the signal received is [gain in dB = 10log $(P_0/P_i0]$

1) 900 W 2) 100 W 3) 990 W 4) 1010 W

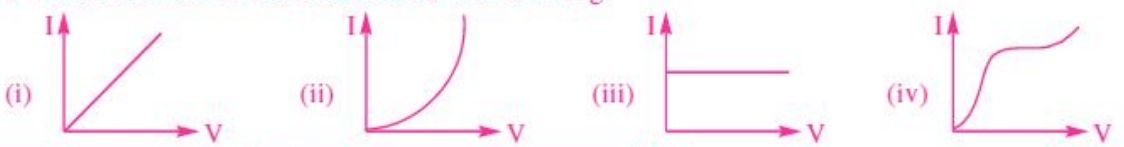
18. A speech signal of 3kHz is used to modulate .a carrier signal of frequency 1MHz using amplitude modulation. The frequencies of the side bands will be

1) 1.003 MHz and 0.997 MHz 2) 3001 kHz and 2997 kHz
3) 1003 kHz and 1000 kHz 4) 1MHz and 0.997 MHz

19. A message signal of frequency ω_m is superposed on a carrier wave of frequency ω_c to get an amplitude modulated wave (AM). The frequency of the AM wave will be

1) ω_m 2) ω_c 3) $\frac{\omega_c + \omega_m}{2}$ 4) $\frac{\omega_c - \omega_m}{2}$

20. I-V characteristic of four devices are shown in Fig



Identify devices that can be used for modulation

1) (i) and (iii) 2) only (iii)

3) (ii) and some region of (iv) 4) all the devices can be used

21. A male voice after modulation-transmission sounds like that of a female to the receiver. The problem is due to

1) poor selection of modulation index (selected $0 < m < 1$)

2) poor bandwidth selection of amplifiers

3) poor selection of carrier frequency 4) loss of energy in transmission

22. Identify the mathematical expression for amplitude modulated wave

1) $A_c \sin[\{\omega_c + k_1 \upsilon_m(t)\}t + \phi]$ 2) $A_c \sin\{\omega_c t + \phi + k_2 \upsilon_m(t)\}$

3) $\{A_c + k_2 \upsilon_m(t)\}\sin(\omega_c t + \phi)$ 4) $A_c \upsilon_m(t)\sin(\omega_c t + \phi)$

23. Audio sine wave of 3kHz frequency are used to amplitude modulate a carrier signal of 1.5MHz. Which of the following statements are true ?

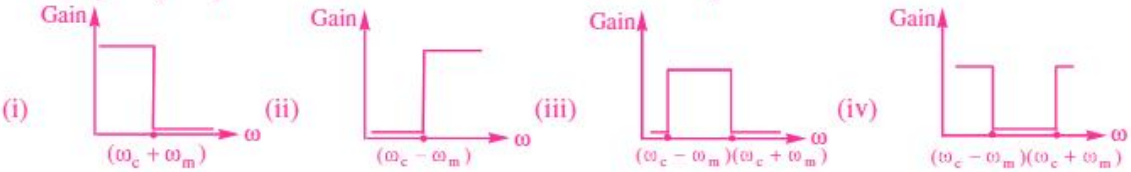
1) The side band frequencies are 1506 kHz and 1494 kHz

2) The bandwidth required for amplitude modulation is 6kHz

3) The bandwidth required for amplitude modulation is 3 MHz

4) The side band frequencies are 1503 kHz and 1497 kHz

24. The frequency response curve for the filter circuit used for production of AM wave should be



1) (i) followed by (ii) 2) (ii) followed by (i) 3) (iii) 4) (iv)

25. In amplitude modulation, the modulation index m, is kept less than or equal to 1 because

1) $m > 1$, will result in interference between carrier frequency and message frequency, resulting into distortion

2) $m > 1$, will result in overlapping of both side bands resulting into loss of information

3) $m > 1$, will result in change in phase between carrier signal and message signal

4) $m > 1$, indicates amplitude of message signal greater than amplitude of carrier signal resulting into distortion

26. An amplitude modulated wave is as shown in Fig.

Which of the following is/are correct?

1) The percentage of modulation is 66.67% 2) The percentage of modulation is 33.33%

3) The peak carrier voltage is 30 V 4) The peak value of information voltage is 20V

EXERCISE-IV

(Miscellaneous)

Straight Objective & More than one Correct Answer Type Questions

1. The highest frequency of radiowaves which when sent at some angle towards the ionosphere, gets reflected from that and returns to the earth is called
   1) critical frequency
   2) maximum unusable frequency
   3) polarisation of waves
   4) None of the above

2. When electromagnetic waves enter the ionised layer of ionosphere, then the relative permittivity i.e., dielectric constant of the ionised layer
   1) does not change
   2) appears to increase
   3) appears to decrease
   4) sometimes appears to increase and sometimes to decrease

3. In space communication, the information can be passed from one place to another at a distance of 100km in
   1) 1 s
   2) 0.5 s
   3) 0.003 s
   4) 3.3×10^{-4} sec

4. Which one of the following is correct ?
   1) A single geostationary satellite can cover the whole part of the earth for microwave communication
   2) Atleast three gerostationary satellite in the same orbit around earth's can cover the whole part of the earth for microwave communication
   3) The first Indian communication satellite is Apple
   4) The satellite communication is not like the line of sight microwave communication

5. The space wave propagation is utilised in
   1) only television communication
   2) can be reflected by ionosphere
   3) can be reflected by mesosphere
   4) cannot be reflected by any layer of earth's atmosphere

6. Three waves A, B and C of frequencies 1600 kHz, 5 MHz, and 60 MHz respectively are to be transmitted from one place to another. Which of the following is the most appropriate mode of communication ?
   1) A is transmitted via space wave while B and C are transmitted via sky wave
   2) A is transmitted via ground wave, B via sky wave and C via space wave
   3) B and C are transmitted via ground wave while A is transmitted via sky wave
   4) B is transmitted via ground wave while A and C are transmitted via space wave

7. A transmitter transmits the message in original
   1) True
   2) False
   3) Sometimes true and sometimes false
   4) Never true

8. A receiver reconstructs the original message after propagation through the channel
   1) may be true
   2) may be false
   3) may be true or false
   4) is certainly true

9. A 100m long antenna is mounted on a 500m tall building. The complex can become a transmission tower for waves with 'λ'
   1) – 400 m
   2) – 25 m
   3) – 150 m
   4) – 2400 m

10. A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 20 picofarad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency which could be detected by
    1) 10.62 kHz
    2) 5.31 MHz
    3) 5.31 kHz
    4) 10.62 MHz

11. Which of the following devices is full duplex ?
    1) Mobile phone
    2) Walky-talky
    3) Loud speaker
    4) Radio

12. Which of the following devices is half duplex ?
    1) Mobile phone
    2) Walky-talky
    3) Loud speaker
    4) Radio

13. Which of the following statement is wrong?
    1) Ground wave propagation can be sustained at frequencies 500kHz to 1500 kHz
    2) Satellite communication is useful for the frequencies above 30 MHz
    3) Sky wave propagation is useful in the range of 30 to 40 MHz
    4) Sky wave propagation takes place through tropospheric space
    5) The phenomenon involved in sky wave propagation is total internal reflection

14. Through which modes of propagation the radio waves can be sent from one place to another ?
    1) Ground wave propagation
    2) Sky wave propagation
    3) Space wave propagation
    4) None of these

15. The maximum peak to peak voltage of an AM wave is 24mV and the minimum peak to peak voltage is 8mV. The modulation factor is not equal to
    1) 10% 2) 20 % 3) 25% 4) 50%

16. In a communication system noise does not affect the signal
    1) at the transmitter
    2) in the channel or transmission line
    3) in the information source
    4) at the receiver

17. The radio waves of frequency 300 MHz to 3000MHz does not belong to
    1) high frequency band
    2) very high frequency band
    3) ultra high frequency band
    4) super high frequency band

18. Communication system is some set up used to convey some type of information in the form of voice, data or picture from one point to other in its true or original form. During transmission of information some phenomenon change the originality of information. Can you match these processes affecting the originality of information mentioned in Column-I with their meaning to be understood by you in Column-II ?

Column-I	Column-II
A) Noise	1) Decrease in energy losses causing loss in strength of signal
B) Interference	2) Changes in shape of wave form during conversion of one form of energy to other
C) Distortion	3) Mixing of external signals with original ones
D) Attenuation	4) Random changes in electrical signal

1) A-1, B-2, C-3, D-4 2) A-2, B-4, C-1, D-3
3) A-3, B-1, C-4, D-2 4) A-4, B-3, C-2, D-1

19. Short wave propagation of radio waves consists of freqeuncies which are reflected by ionosphere. Some important technical terms are defined related to the free electron density N of layers and the frequencies v to be reflected are mentioned in Column-I. They are related to frequency v and free electron density N as shown in Column-II

Column-I	Column-II
A) Critical frequency v_C	1) $\sqrt{\left(1-\frac{81.45N}{v^2}\right)}$
B) Skip distance D_{skip}	2) $9\sqrt{N}$
C) Refractive index of layer (μ)	3) $2h\sqrt{\left(\frac{v_{max}}{v_C}\right)^2-1}$
D) Dielectric constant (K) of atmosphere layer	4) $\left(1-\frac{81.45N}{v^2}\right)^{\frac{1}{2}}$

1) A-1, B-2, C-3, D-4 2) A-2, B-3, C-4, D-1 3) A-3, B-4, C-1, D-2 4) A-4, B-1, C-2, D-3

Numerical Value Type Questions

20. A TV tower has a height of 75m. What is the maximum distance (in Km) upto which this TV transmission can be received ? (Radius of the earth = 64×10^6m)

21. If a carrier wave of 100kHz is used to carry the signal, the length of transmitting antenna will be equal to (in meters)

22. A TV tower has a height of 100m. What is the maximum distance (in Km) upto which TV transmission can be received ? ($R = 6.4 \times 10^6$ m)

23. Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for the of sight communication ? A TV transmitting antenna is 81m tall. How much service area (in Km^2) can it cover, if the receiving antenna is at the ground level ?

24. A TV tower has a height of 75m. What is the maximum area (in Km^2) upto which this TV communication can be possible ?

25. The power of a transmitter 19 kW. The power of the Carrier wave is (in kW) , if the amplitude of modulated wave is 10 V and that of Carrier is 30 V,

26. The power of a AM transmitter is 100 W. If the modulation index is 0.5 and the transmission is having single side band, the percentage of useful power is (in W)

KEY SHEET (LECTURE SHEET)

LEVEL-I (MAIN)

EXERCISE-I

1) **2**	2) **1**	3) **3**	4) **3**	5) **4**	6) **2**	7) **4**	8) **2**	9) **4**	10) **2**
11) **4**	12) **3**	13) **3**	14) **2**	15) **4**	16) **3**	17) **4**	18) **3**	19) **2**	20) **4**
21) **2**	22) **1**	23) **1**	24) **3**	25) **2**	26) **2**	27) **2**	28) **2**	29) **2**	30) **1**
31) **1**	32) **3**	33) **3**	34) **1**	35) **3**	36) **3**	37) **1**	38) **3**	39) **2**	40) **4**
41) **4**	42) **1**	43) **1**	44) **2**	45) **3**	46) **2**	47) **2**	48) **1**	49) **4**	50) **3**
51) **1**	52) **2**	53) **2**	54) **3**	55) **1**					

EXERCISE-II

1) **1**	2) **2,3**	3) **4**	4) **1**	5) **2**	6) **2**	7) **1**	8) **2**	9) **2,3,4**	10) **3**
11) **2**	12) **2**								

EXERCISE-III

1) **1**	2) **2**	3) **3**	4) **2**	5) **3**	6) **3**	7) **3**	8) **3**	9) **4**	10) **3**
11) **2**	12) **3**	13) **3**	14) **2**	15) **4**	16) **2**	17) **2**	18) **1**	19) **2**	20) **3**
21) **2**	22) **3**	23) **2,4**	24) **1,2,3**		25) **1,2,3,4**		26) **1,3,4**		

EXERCISE-IV

1) **2**	2) **3**	3) **4**	4) **2**	5) **4**	6) **2**	7) **3**	8) **4**	9) **1**	10) **1**
11) **1**	12) **2**	13) **3**	14) **1,2,3**	15) **1,2,3**	16) **1,2,3**	17) **1,2,3**		18) **4**	19) **2**
20) **30.98**	21) **300**	22) **35.77**	23) **3260**	24) **3018**	25) **1**	26) **2.20**			