Principles of Electronics Communication

Time: 3 Hrs.] Prelim Question Paper Solution [Marks : 70

Q.1 Attempt any FIVE of the following : [10]

Q.1 (a) Define modulation index of FM. [2]

Ans.: Modulation Index : The modulation index of an frequency modulation wave is defined as

$$m_f = \frac{\text{Frequency deviation}}{\text{Modulating Frequency}} \qquad m_f = \frac{\delta}{f_m}$$

(a) Modulation index decides the bandwidth of the frequency modulation wave.
(b) Modulation index also decides the number of sidebands having significant amplitudes.

Q.1(b) Define (i) MUF (ii) Critical frequency. [2]

Ans.: (i) MUF: The limiting frequency when the angle of incidence is other than the normal is known as maximum unstable frequency.

$$MUF = fc \sec\theta$$

(ii) Critical frequency : The critical frequency of a layer is defined as the maximum frequency that is returned back to the earth by thaa layer, when the wave is incident at an angle 900 (normal) to it. The critical frequency for F2 layer is between 5 to 12 MHz.

Q.1 (c) List application of ground wave. [2]

Ans.: Applications of ground wave

(i) In the A.M. radio broadcasting operating in MW band.
(ii) Ship to ship and ship to shore communication, for radio navigation, and
(iii) Maritime [near the sea or of the sea] mobile communication.
(iv) Ground waves are used as low as 15 KHz.

Q.1 (d) Draw Radiation pattern of yagi uda antenna. [2]

Ans.: The Yagi Antenna / Yagi-Uda Antenna

- The Yagi antenna or Yagi-Uda antenna as it is sometimes called is a group of dipole antenna (driven element) and one or more parasitic element.
- All these elements are arranged collinearly and close together as shown in figure 1.
- The Yagi antenna can be used as a transmitting or receiving antenna.
- When used as a transmitting antenna, the source is connected to the dipole called driven element. The parasitic elements (reflectors and directors) are not connected electrically anywhere.

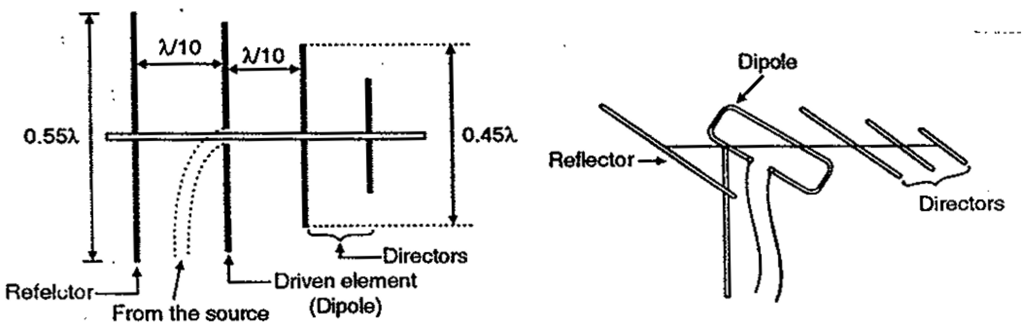


Fig. 1 : Construction of Yagi antenna.

Radiation Pattern :

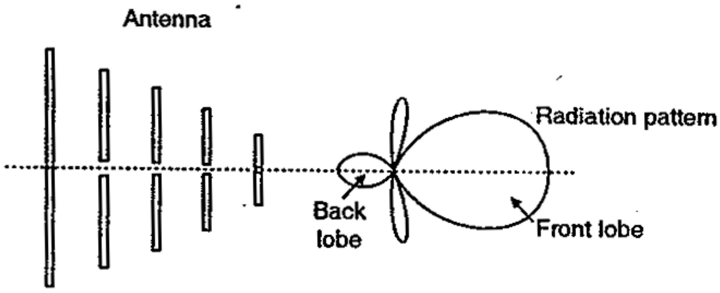
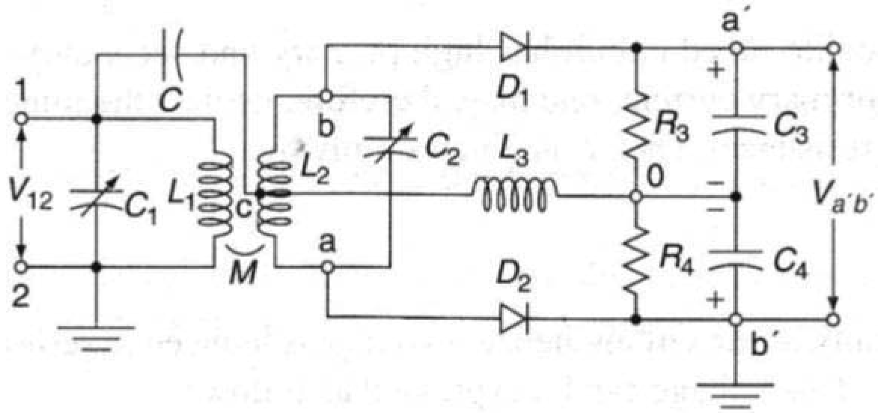


Fig. 2 : Radiation pattern of Yagi-antenna.

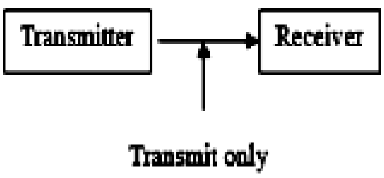
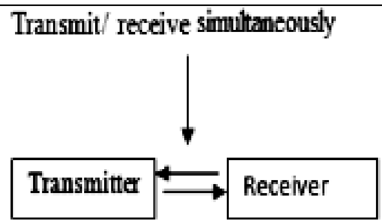
Q.1(e) Draw circuit diagram of phase discriminator. **[2]**

Ans.:



Q.1 (f) Compare between simplex and full duplex communication on the basis of : **[2]**
(i) Definition **(ii) Sketch**

Ans.:

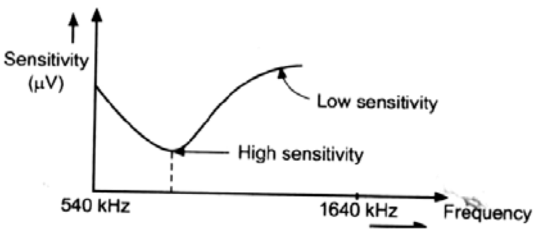
	Simple Communication	Full Duplex Communication
(i)	It's a one way communication (unidirectional)	It's a two way Communication (bidirectional) with simultaneous data transfer.
(ii)		

Q.1 (g) Define sensitivity with graph. **[2]**

Ans.: **Sensitivity:** The ability to amplify weak signals is called sensitivity. The sensitivity is expressed in millivolt. It is often defined in terms of the input voltage that must be applied at the input of the receiver to obtain a standard output power.

The sensitivity curve indicates that the receiver input required to obtain the same standard output changes with carrier frequency.

Graph



Q.2 Attempt any THREE of the following : [12]

Q.2 (a) Draw block diagram of basic communication system. State function of transmitter and receiver. [4]

Ans.: The Elements of a Communications System

All electronic communications systems have the basic form shown in figure. The basic components are a transmitter, a communications channel or medium and a receiver. In most systems, a human generates a message that we call the information or intelligence, signal. This signal is inputted to the transmitter which then transmits the message over the communications channel. The message is picked up by the receiver and is relayed to another human. Along the way, noise is added to the message in the communications channel. Noise is the general term applied to any interference that degrades the transmitted information. Let's take a closer look at each of these basic elements.

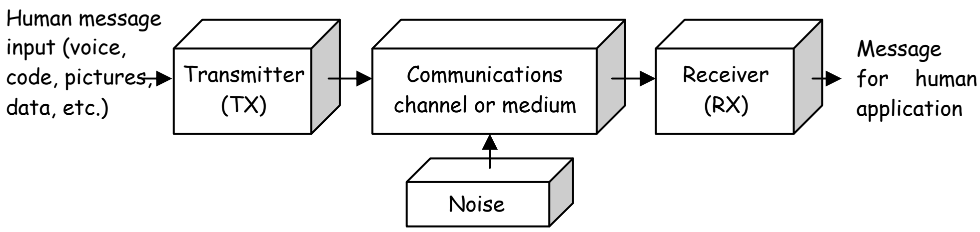


Fig.1: The basic elements of any communications system.

Transmitter

The transmitter is a collection of electronic components and circuits designed to convert the information into a signal suitable for transmission over a given communications medium. It may be as simple as a microphone or as complex as a microwave radio transmitter.

Communications Channel

(i) The communications channel is the medium by which the electronic signal is sent from one place to another. In its simples form, the medium may simply be a pair of wires that carry a voice signal from a microphone to a headset. The communications medium may also be a fiber–optic cable or "light pipe" that carries the message on a light wave.

(ii) On the other hand, the medium may be wireless or radio. Radio is the broad general term applied to any form of wireless communication from one point to another. Radio makes use of electromagnetic spectrum where signals are communicated from one point to another by converting them into electric and magnetic fields that propagate readily over long distances.

(iii) Although the medium supports the transmission of information, it also attenuates it. Any type of media degrades the signal and causes it to appear much lower in amplitude at the receiver. Considerable amplification of the signal, both at the transmitter and the receiver, is required for successful communication.

Receiver

(i) The receiver (RX) is another collection of electronic components and circuits that accept the transmitted message from the channel and convert it back into a form understandable by humans.

(ii) Again it may be a simple earphone or a complex electronic receiver.

Noise

(i) Noise is random, undesirable electric energy then enters the communication system via the communication medium and interferes with the transmitted message. However, some noise is also produced in the receiver.

(ii) Noise comes from the atmosphere (e.g., from lightning which produces static), from outer space where the sun and other stars emit various kinds of radiation that can interfere with communication, and from electrical interference created by manufactured equipment. The electric ignition systems of cars, electric motors. Fluorescent lights, and other types of equipment generate signals that can also interfere with the transmission of the message.

(iii) Finally, many electronic components generate noise internally due to thermal agitation of the atoms. Although such noise signals are low level, they can often seriously interfere with the extremely low-level signals that appear greatly attenuated at the receiver after being transmitted over a long distance. In some cases, noise completely obliterates the message. At other times, it simply causes interference, which in turn. Means some of the message is completely missed or misinterpreted.

(iv) Noise is one of the more, serious problems of electronic communications. For the most part, it cannot be completely eliminated. However, there are ways to deal with it, as you will discover.

Q.2(b) Compare sky wave propagation and space wave propagation w.r. to following points : **[4]**

(i) Application **(ii) Polarization**

(iii) Frequency range **(iv) Effect of fading**

Ans.:

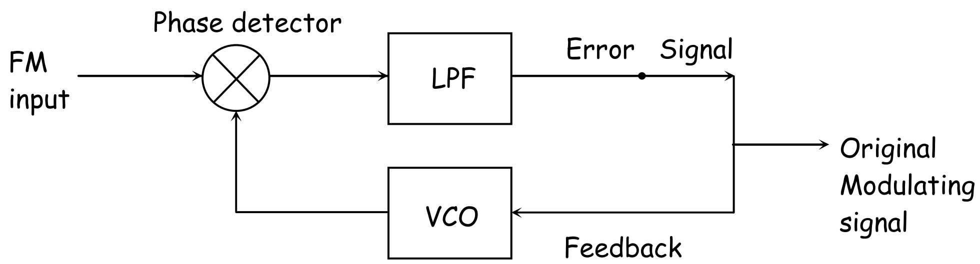
	Parameters	Sky wave propagation	Space wave propagation
(i)	Applications	Radio Broadcasting (SW Range)	Satellite communication, TV, frequency modulation broadcast, RADAR system etc
(ii)	Polarization	Vertical	Horizontal
(iii)	Frequency range	3 MHz to 30 MHz	Frequencies above 30 MHz
(iv)	Effect of fading	Severe	Less

Q.2(c) Write short note an phase lock loop of FM. **[4]**

Ans.: Phase Locked Loop (PLL)

Three basic elements of PLL :

(1) Phase detector (Mixer)
(2) Low pass filter (LPF)
(3) Voltage controlled oscillator (VCO)



(1) Phase detector : The phase detector compares two input signals. If there is a phase or frequency difference between the input (FM signal) and Voltage controlled oscillator signal, the phase detector output will vary in proportion. This error voltage is then applied to a Low pass filter.

(2) Low Pass filter : The low pass filter produces a ripple free dc signal by removing the high frequency noise present in the phase detector. This dc voltage is called the error signal and is also the feedback in this circuit.

(3) Voltage controlled oscillator : The output frequency of voltage controlled oscillator is proportional to the dc control voltage.

Free-running frequency : If input to voltage controlled oscillator i.e. error signal is zero, the voltage controlled oscillator then operates at what is called as its free-running frequency.

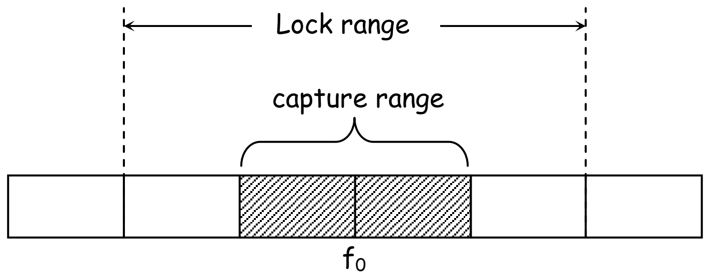
- Initially when there is no input signal, the phase detector and low pass filter output are zero, then the voltage controlled oscillator operates at free-running frequency.

- When input signal frequency is close to the frequency of voltage controlled oscillator output, the phase detector produces an output voltage proportional to the frequency difference. The dc error voltage forces the voltage controlled oscillator frequency to move in a direction that reduces the dc error voltage.

At same point, voltage controlled oscillator frequency = input signal frequency, then Phase Locked Loop (PLL) is said to be in a locked condition.

Lock range : The range of frequencies over which the PLL will track the input signal and remain locked is called lock range.

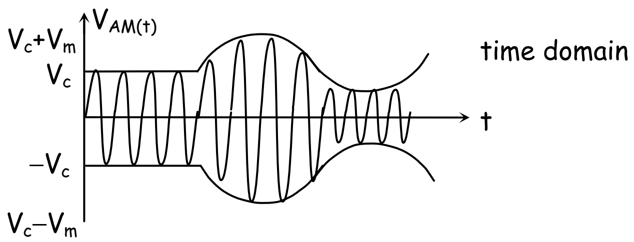
Capture range : The range of frequencies over which the PLL will capture the input signal is known as capture range.



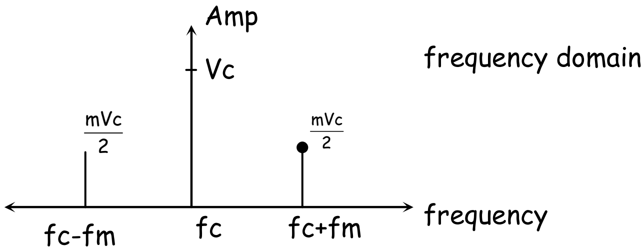
In locked phase, the voltage controlled oscillator output will be equal to the input signal and error signal will be identified to the original modulating signal of the frequency modulator input.

Q.2(d) Sketch AM signal (i) Time domain (ii) Frequency domain **[4]**

Ans.: (i) Time domain



(ii) Frequency domain



Q.3 Attempt any THREE of the following : **[12]**

Q.3(a) A 10 kw carrier is amplitude modulated by two sine to a depth of 0.5 and 0.6 respectively. Determine total power of modulated carrier. **[4]**

Ans.: Given : Pc = 10 Kw = 10,000 w $M_1 = 0.5$ $M_2 = 0.6$

To find : Total Power (P_t)

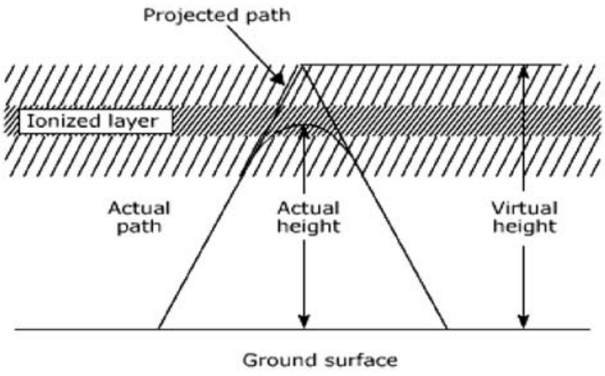
Total modulation Index (M_a) is given as,

$$M_a = \sqrt{M_1^2 + M_2^2} = \sqrt{0.5^2 + 0.6^2} = \sqrt{0.61} = 0.78$$

$$P_t = P_c\left(1 + \frac{M_a^2}{2}\right) = 10\left(1 + \frac{0.78^2}{2}\right) = 13.05 \text{ kW}$$

Q.3 (b) Explain virtual height with respect to wave propogation with neat sketch. **[4]**

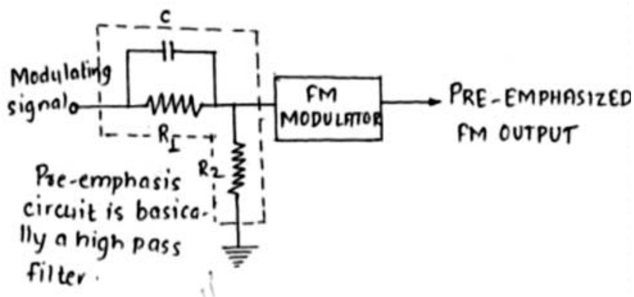
Ans.: In ionization layer the incident wave refracts and bends down gradually than sharply.



The incident and refracted rays follow paths that are exactly the same as they would have been if reflection had taken place from a surface located at a greater height called virtual height of this layer.

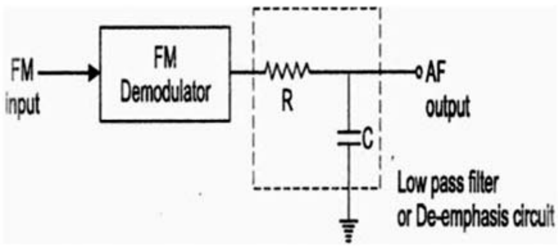
Q.3(c) Explain pre emphasis and emphasis Network in FM. **[4]**

Ans.: **Pre-emphasis**



- The artifical boosting of higher audio modulating frequencies in accordance with prearranged response curve is called pre-emphasis.
- In FM, the noise has a greater effect on the higher modulating freuencies. This effect can be reduced by increasing the value of modulation index (mf).
- This can be done by increasing the deviation and can be increased by increasing the amplitude of modulating signal at higher frquencies.

De-emphasis:



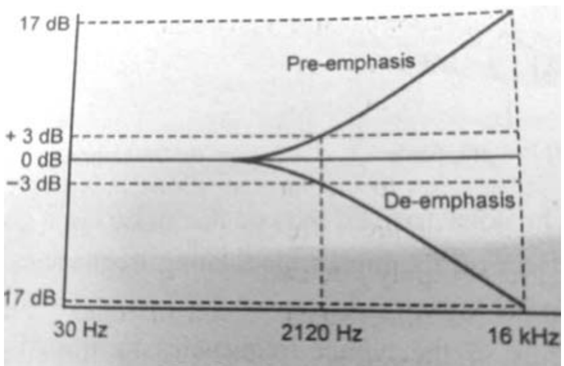


Fig. Emphasis curves

In FM, noise has greater effect on higher modulating frequencies than the lower one. Therefore the higher modulating frequencies have to be boosted artificially at the transmitter before modulation and corresponding cut off at the receiver after demodulation.

This boosting of higher modulation frequencies at the transmitter in order to improve noise immunity is called as pre-emphasis. The compensation at the receiver ie. Attenuation of this higher modulation frequency after detector at receiver is called as De-emphasis, which is basically a low pass filter.

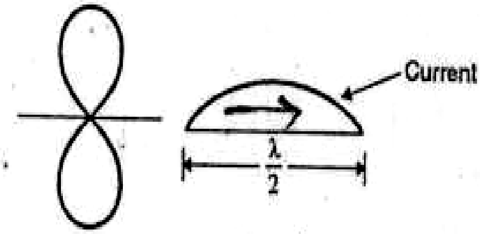
Pre-emphasis is used at transmitter and de-emphasis at receiver to improve the noise immunity.

Q.3 (d) Draw radiation pattern of resonant dipole antenna **[4]**

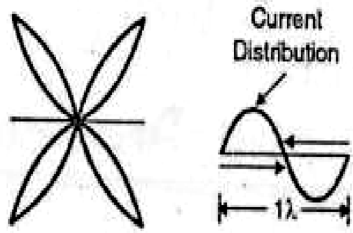
(i) l = $\lambda/2$ (ii) l = λ (iii) l = $3\lambda/2$ (iv) l = 3λ

Ans.:

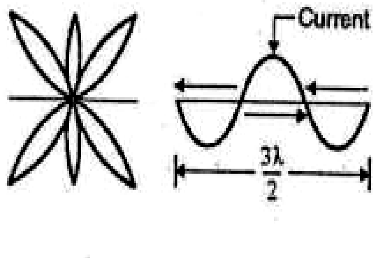
where l = length of dipole



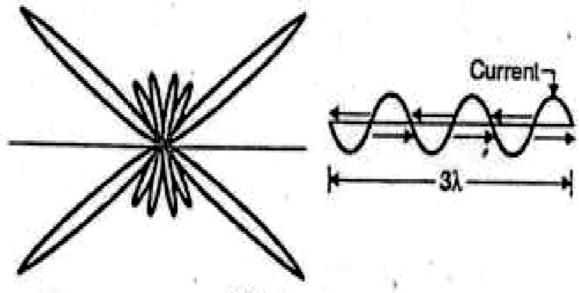
(a) $l = \frac{\lambda}{2}$



(b) $l = \lambda$



(c) $l = \frac{3\lambda}{2}$



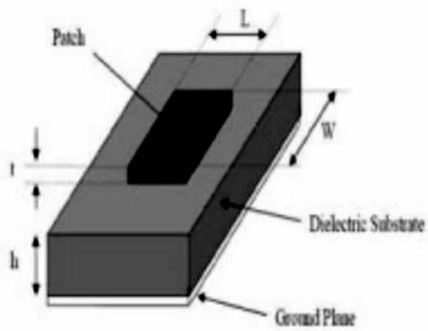
(d) $l = 3\lambda$

Q.4 Attempt any THREE of the following : **[12]**

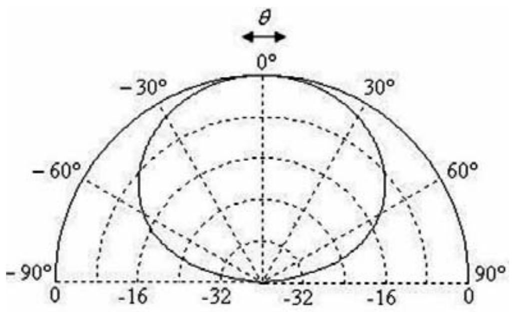
Q.4(a) Explain structure of rectangular micro strip antenna with its radiation pattern. **[4]**

Ans.: **(i) Structure of rectangular microstrip patch antenna**

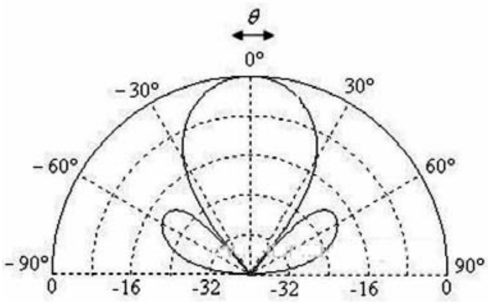
- In its most basic form, a Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side.
- For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation.
- In general Micro strip antennas are also known as "Printed Antennas".
- These are mostly used at microwave frequencies.
- Because the size of the antenna is directly tied the wavelength at the resonant frequency.
- Micro strip patch antenna or patch antenna is a narrowband wide-beam antenna.



Structure of a Microstrip Patch Antenna



(a) $\phi = 0°$



(b) $\phi = 90°$

Q.4 (b) Explain electromagnetic spectrum in brief. [4]

Ans.: The Electromagnetic Spectrum

Before it can be transmitted, information must be converted into electronic signals compatible with the medium. For example, a microphone changes voice into a voltage of varying frequency and amplitude. This baseband signal is then passed over wires baseband signal is then passed over wires to a receiver or head phone. This is the way the telephone system works. A tremendous amount of information is transmitted in this way.

Instead of using wires, free space can be used. The information is converted into electronic signals which radiate into space. Such signals consist of both electric and magnetic fields. These so called electromagnetic signals travel through space for long distances. Electromagnetic signals are also referred to as radio-frequency (RF) waves.

Electromagnetic waves are signals that oscillate; that is, the amplitudes of the electric and magnetic fields vary at a specific rate. The field intensities fluctuate up and down a given number of times per second. The electromagnetic waves vary sinusoidally. Their frequency is measured in cycles per second (cps) or hertz (Hz). These oscillations may occur at a very low frequency or at an extremely high frequency. This entire range of frequencies is referred to as the electromagnetic spectrum. It includes signals such as the 60-Hz power line frequency and audio (voice) signals at the low end. In the midrange are the most commonly used radio frequencies for two-way communications, television, and other applications. At the upper end of the spectrum are infrared and visible light. Figure below shows the entire electromagnetic spectrum. Both frequency and wavelength are given.

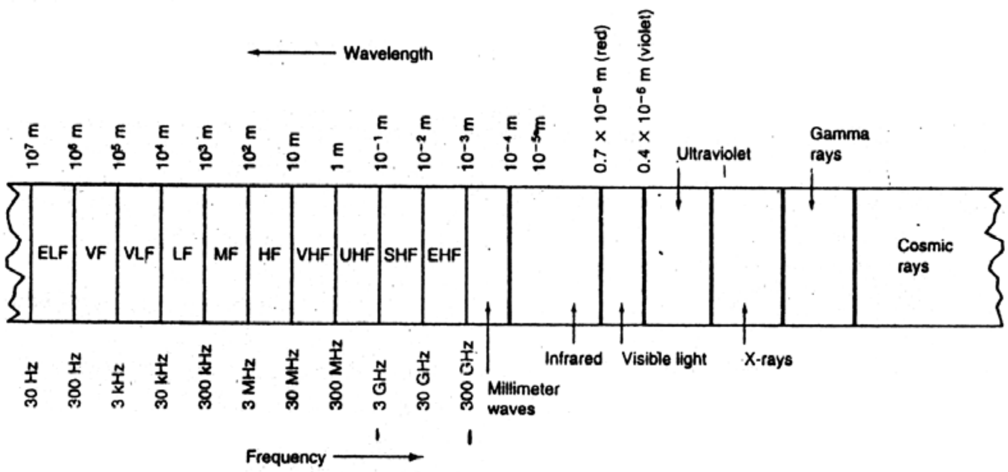


Fig. : The electromagnetic spectrum used in electronic

Remember the relationship between frequency f and wavelength λ.

$$\lambda = \frac{300}{f}$$

where λ is in meters and f is in megahertz (MHz). For instance, if f = 21 MHz, then

$$\lambda = \frac{300}{f} = 14.29 \text{ m}$$

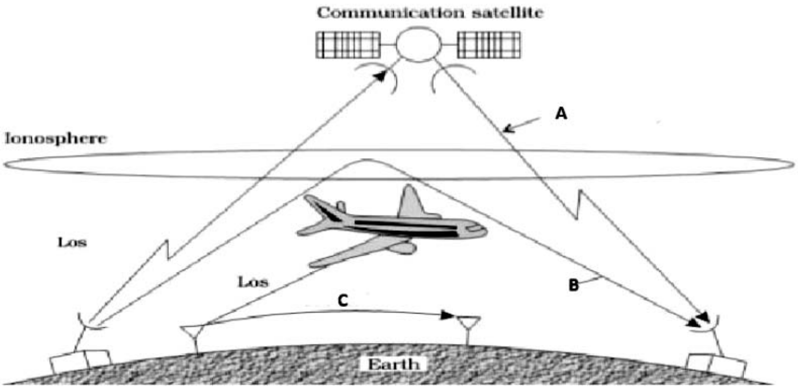
If you know the wavelength in meters, you can compute the corresponding frequency with the expression

$$f = \frac{300}{\lambda}$$

A wavelength of 2.4 m expressed as a frequency is :

$$f = \frac{300}{2.4} = 125 \text{ MHz}$$

Q.4(c) Identify wave propagation mode for A, B, C shown in the figure and write the one application of each mode. **[4]**



Ans.: **A :** Wave is sky wave propagation as it reflected back from ionospheric region.
Application : tv broadcasts

B : this is ground wave propagation as they reflects back from trophospheric region
Application : short distance communication, Point to point communication

C : this is space wave propagation as there direct path is used for communication.
Application: for line of sight communication

Q.4 (d) Write frequency band used for (i) Mobile communication (ii) TV communication **[4]**

Ans.: **Frequency band used for TV broadcasting and mobile communication**
Carrier frequency ranges for broadcast television transmission vary from country to country. In most of North America there are multiple bands that range from 42 Mhz - 88 Mhz (VHF band 1) and 174-216 Mhz (VHF band 3). UHF has several bands that range from 470 Mhz up to about 900 Mhz.

Q.4 (e) The equation of FM wave is given by AFM = 20 sin(10^8t + 4 sin 10^3t) **[4]**
(i) carrier frequency
(ii) Modulation frequency
(iii) Modulation Index
(iv) Power dissipated in 10Ω resistor.

Ans.: FM signal is represented as $l_{FM} = V_C \sin(\omega_t + m_f \cos \omega_{mt})$
Given : FM = 20 sin (10^8t + 4 sin 10^3t)

$V_C = 20$
$\omega_C = 10^8$
$2\pi f_C = 10^8$
$f_C = \frac{10^8}{2\pi} = 15.9$ MHz

Carrier frequency = 15.9 MHz

$\omega_m = 10^3 = 1000$
$2\pi f_m = 1000$
$f_m = \frac{1000}{2\pi} = 159$ Hz

Modulation index $m_f = 4$
Power dissipated in 10Ω resistor

$$P = \frac{V_{rms}^2}{R} = \frac{\left(V_c/\sqrt{2}\right)^2}{R} = \frac{\left(20/\sqrt{2}\right)^2}{10} = 20 \text{ watt}$$

∴ Power dissipated = 20 watts

Q.5 Attempt any TWO of the following : [12]

Q.5(a) Draw block diagram of super heterodyne receiver. Write disadvantage of TRF over super heterodyne. [6]

Ans.:

- The problem in the TRF receiver are solved in this receiver by converting every selected RF–signal (station) to a fixed lower frequency called as the "intermediate frequency(IF)".
- This frequency contains the same modulation as the original carrier. The IF signal is then amplified and detected to get back the modulating signal. The intermediate frequency is lower than the lowest frequency that is to be received 530 kHz.
- As the "IF" is lower than the lowest RF signal frequency, the possibility of oscillations and instability is minimized.
- Also the required value of Q for constant BW does not depend on the frequency of desired input signal, because the "IF" is constant and same to all the incoming RF signals.
- Thus the superheterodyne receiver solves all the problems associated with the TRF receiver.
- The radio and TV receivers operate on the principle of superheterodyning. The block diagram of a superheterodyne radio receiver is shown in Figure.

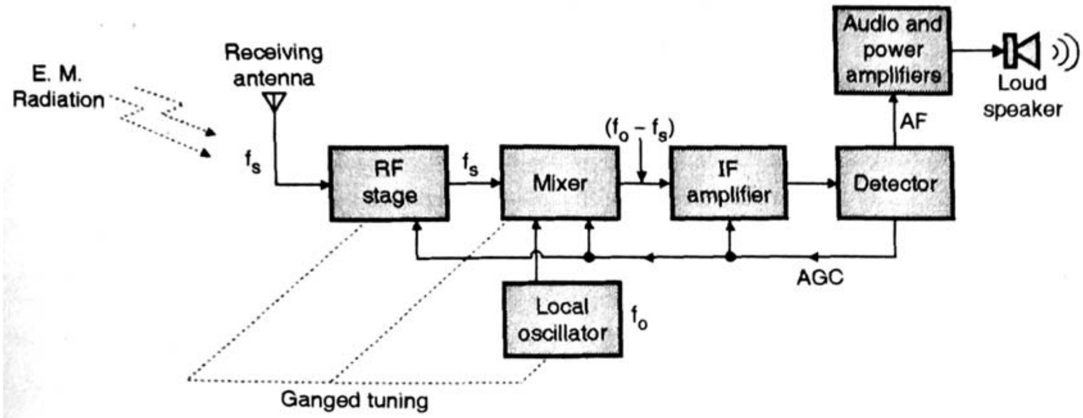


Fig.: The superheterodyne receiver

Operation:

- The DSBFC or AM signal transmitted by the transmitter travels through the air and reaches the receiving antenna. This signal is in the form of electromagnetic waves. It induces a very small voltage (few μV) into the receiving antenna.
- **RF stage :** The RF stage is an amplifier which is used to select the desired signal and reject other out of many, present at the antenna. It also reduces the effect of noise. At the output of the RF amplifier we get the desired signal at frequency "f_s".
- **Mixer :** The mixer receives signals from the RF amplifier at frequency (f_s) and from the local oscillator at frequency (f_o) such that $f_0 > f_s$.
- **Intermediate frequency (IF):** The mixer will mix these signals to produce signals having frequencies f_s, f_o, $(f_o + f_s)$ and $(f_o - f_s)$. Out of these die difference of frequency component i.e. $(f_o - f_s)$ is selected and all others are rejected. This frequency is called as the intermediate frequency (IF).

  $\therefore$ I.F. = $(f_o - f_s)$
- This frequency contains the same modulation as the original signal f_s.
- In order to maintain a constant difference between the local oscillator frequency and the incoming frequency, ganged tuning is used. This is simultaneous tuning of RF amplifier, mixer and local oscillator and it is achieved by using ganged tuning capacitors (Tuning control knob in radio set).
- This intermediate frequency signal is then amplified by one or more IF amplifier stages. IF amplifiers satisfy most of the gain (and hence sensitivity) and the bandwidth requirements of the receiver. Therefore the sensitivity and selectivity of this receiver do not change much with changes in the incoming frequency.

- The amplified IF signal is detected by the detector to recover the original modulating signal. This is then amplified and applied to the loudspeaker.
- AGC means automatic gain control. This circuit controls the gains of the RF and IF amplifiers automatically to maintain a constant output voltage level even when the signal level at the receiver input is fluctuating. This is done by feeding a controlling dc voltage to the RF and IF amplifiers. The amplitude of this dc voltage is proportional to the detector output.

Disadvntages of TRF Receiver
(i) Instability due to oscillatory nature of RF amplifier.
(ii) Variation in bandwidth over tuning range.
(iii) Insufficient selectivity at high frequencies.
(iv) Poor adjacent channel rejection capability.

Q.5(b) Explain the concept of virtual height with sketch. [6]
Ans.: Virtual height

- The concept of virtual height can be understood by looking at figure. The incident wave returns back to earth due to refraction.
- In this process it bends down gradually and not sharply. But it is interesting to see that the incident and reflected rays follow exactly the same paths as though the signal would have been reflected from a surface located at greater height.
- This height is called as the virtual height of a layer is known then it is possible to find the angle of incidence required to return the wave to the ground at a selected point.

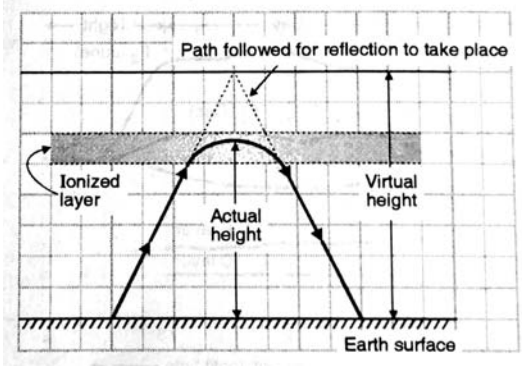
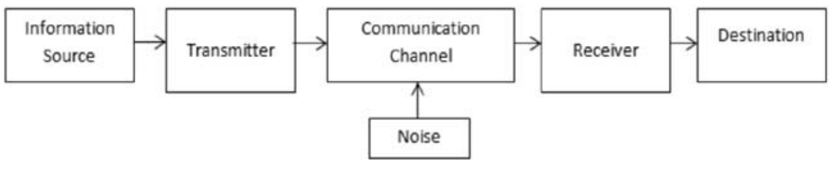


Fig.: Virtual height of an ionized layer

Q.5(c) Draw and explain block diagram of electronic communication system. [6]
Ans.: Block diagram of electronic communication system



Explanation

Transducer: A tranducer is ususally required to convert the output of a source into an electrical signal that is suitable for transmission. For example, a microphone serves as the transducer that converts an acoustic speech signal into an electrical signal.

Transmitter: The transmitter converts the electrical signal into a form that is suitable for transmission through the physcial channel or transmission medium. For example, in radio and TV broadcast, the transmitter must translate the information signal to be transmitted into the appropriate frequency range that matches the frequency allocation assigned to the transmitter. There is some internal noise available inside the transmitter section due to the electronic circuits used which is called thermal noise due to heat dissipation and other noises etc.

Channel: The communcation channel is the physcial medium that is used to send the signal from the transmiiter to the receiver. In wireless transmission, the channel is usually the atmosphere (free space).

Receiver: The function of the receiver is to recover the message signal contained in the received signal. If the message signal is transmitted by carrier modulation, the receiver performs carrier demodulation in order to extract the message from the sinusoidal carrier. There is some internal noise available inside the receiver section due to the electronic circuits used which is called thermal noise due to hea dissipation and other noises etc.

Output Transducer: The output transducer converts electrical signal in to sound signal.

Q.6 Attempt any TWO of the following : [12]

Q.6(a) (i) Define : (1) Bandwidth (2) Fidelity [6]

(ii) Explain skip distance.

Ans.: **(i) (1) Bandwidth:** Bandwidth is that portion of the electromagnetic spectrum occupied by a signal. It is also the frequency range over which an information signal is transmitted or over which a receiver or other electronic circuit-operates. More specifically, bandwidth (BW) is the difference between the upper and lower frequency limits of the signal or the equipment operation range. The bandwidth of the voice frequency range from 300 to 3000 Hz. The upper frequency is f_2 and the lower frequency is f_1. The bandwidth then is

$$BW = f_2 - f_1$$
$$= 3000 - 300$$
$$= 2700 \text{ Hz}$$

(2) Fidelity

- The fidelity is the ability of a receiver to response all the modulating frequencies equally.
- The fidelity basically depends on the frequency response of the AF amplifier. The typical fidelity curve is an shown in figure.

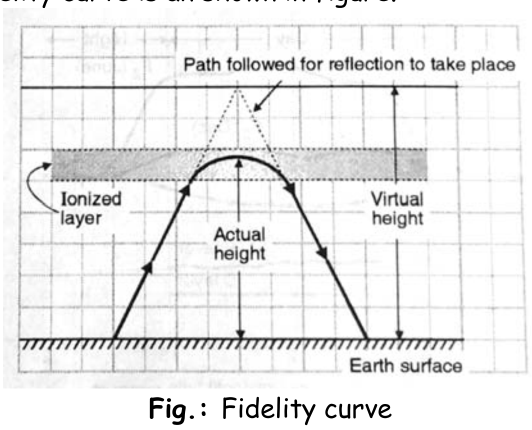


Fig.: Fidelity curve

- High fidelity is essential in order to reproduce a good quality music faithfully i.e. without introducing any distortion.
- For this it is essential to have a flat frequency response over a wide range of audio frequencies.
- The fidelity curve for a receiver shown in figure is basically the frequency response of the AF amplifier stage in the receiver.

(ii) Skip distance: Radio wave radiated horizontally from a transmitter near the earth's surface is quickly absorbed due to large ground losses and hence only short distance communication is carried out by this horizontal radiations of ground or surface wave.

Radio wave radiated at high angle may not be bent sufficiently at the ionospheric layers to return to earth at all and hence escapes rather penetrates the layer. Thus radio wave radiated at shallow angle (i.e. angle between horizontal and high angle) just great enough to escape absorption by the earth, will enter the lower layer, suffer attenuation, be bent at the upper layer and return to earth. In other words between, the distance at which surface wave becomes negligible and the distance at which the first wave returns to earth from the ionospheric layer, there is a zone which is not covered by any wave (i.e. neither ground nor sky). This is called skip zone or area and the distance across it is the 'skip distance.' Although, it is more usual to consider skip distance from the transmitter to the point where first sky wave is received, as range of surface wave is always small.

Hence skip distance may be defined as

(a) The minimum distance from the transmitter at which a sky wave of given frequency is returned to earth by the ionosphere. It is represented by D as in the Fig. 1, or
(b) The minimum distance from the transmitter to a point where sky wave of a given frequency is first received, or
(c) The minimum distance within which a sky wave of given frequency fails to be reflected back, or
(d) The minimum distance for which sky wave propagation just takes place and no sky wave propagation is possible for points nearer than this distance.

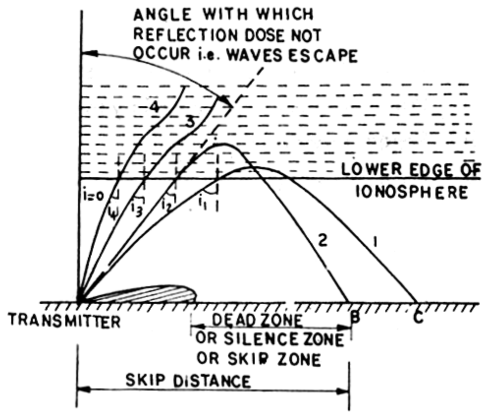


Fig. 1 : Skip distance explanation

The higher the frequency, the higher the skip distance and for a frequency less than critical frequency of a layer skip distance is zero. As the frequency of a wave exceeds the critical frequency, the effect of the ionosphere depends upon the angle of incidence at the ionosphere as shown in Fig. 1 in which waves of different angle of incidence is shown.

As the angle of incidence at the ionosphere decreases, the distance from the transmitter, at which the ray returns to ground first decreases. This behaviour continues until eventually an angle of incidence is reached at which the distance becomes minimum. The minimum distance is called skip distance D (as with wave no. 2). With further decrease in angle of incidence, the wave penetrates the layer (as wave nos. 3 and 4) and does not return to earth. Infact, skip distance is the distance skipped over by the sky wave.

This happens because

(i) As the angle of incidence i is large (say for wave no. 1), the eqn.

$$\mu = \sin I = \sqrt{1 - \frac{81N}{f^2}}$$

is satisfied with small electron density. This means μ is slightly less than unity and hence wave returns after slight penetration into the layer.

As the angle of incidence is further decreased (As in wave no. 2) sin i decrease still more and so also the u as N becomes comparatively more. Hence the wave penetrates still more before it reaches to earth.

Lastly when angle of incidence is small enough so that μ = sin I can be satisfied even by maximum electron density of the layer, then the wave penetrates (as the wave nos. 3 and 4). The frequency which makes a given distance corresponds to the skip distance is the maximum usable frequency for those two points. If a receiver is placed with the skip distance no signals would be heard unless of course ground wave is strong enough as at A.

For a given frequency of propagation $f = f_{muf}$ the skip distance can be calculated in which D is the skip distance. Thus,

or $$\frac{f_{muf}}{f_c} = \sqrt{1+\left(\frac{D}{2h}\right)^2} \quad \text{or} \quad \left(\frac{f^2_{muf}}{f_c}\right) - 1 = \left(\frac{D_{skip}}{2h}\right)^2$$

$$D_{skip} = 2h\sqrt{\left(\frac{f_{muf}}{f_c}\right)^2 - 1}$$

Q.6(b) State and explain types of AGC. **[6]**

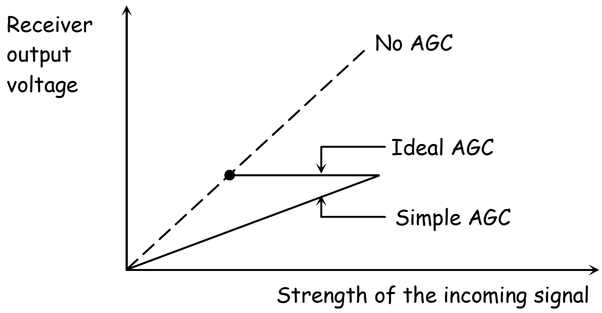
Ans.: Automatic Gain Control (AGC)

- If the gain of the radio receiver is kept constant then the output of the receiver depends on the strength of the input signal.
- Strength of all the input signal is not same all the time for all radio stations reaching the receiver.
- The gain of the radio receiver should change proportional to the strength of the received signals.
- Automatic Gain Control is used to adjust the receiver gain automatically.

Types of AGC :

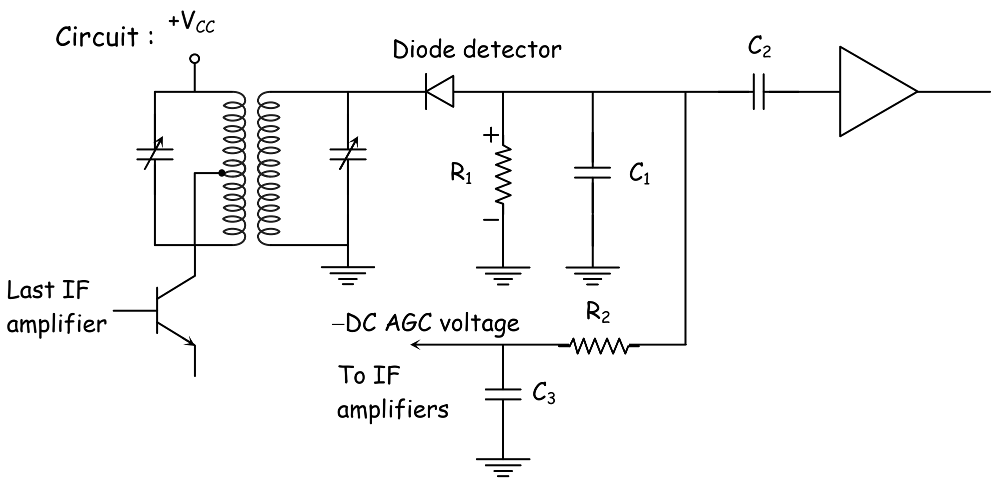
(1) Simple AGC

- In simple AGC the receiver gain is reduced as the input signal is more and more strong.
- This is required to keep the receiver output constant even when the signal strength at the input of the receiver is changing.
- Disadvantage of simple AGC is the reduction in the gain of the receiver will take place even for the weak signals.



(2) Delayed AGC

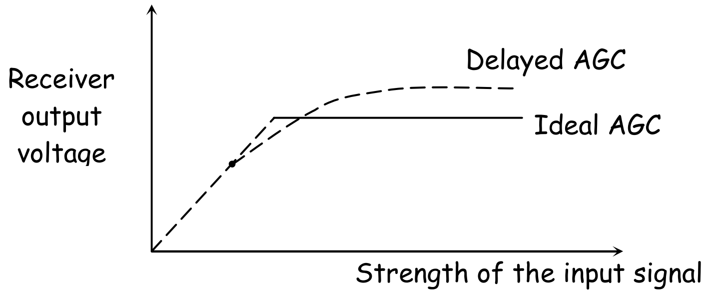
Circuit :



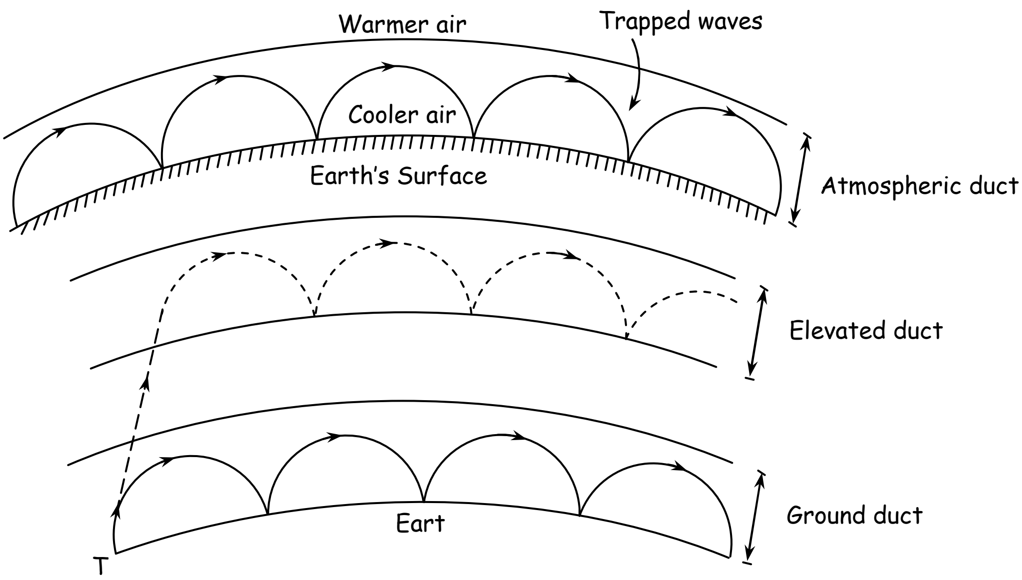
The gain can be adjusted in two ways :
Reverse AGC : It decreases the current flowing in the amplifier in order to decrease the gain.
Forward AGC : It increases the collector current in order to decrease the gain.

Operation :
(i) The diode detector recovers the original AM information.
(ii) The voltage developed across R_1 is a negative dc voltage. Capacitor C_1 filters out the IF signal leaving the original modulating signal. The recovered signal is passed through C_2 to remove the dc and resulting ac signal is further amplified and applied to a loudspeaker.
(iii) The dc voltage across R_1 and C_1 must be further filtered to provide a pure dc voltage. This is done with R_2 and C_3.
(iv) The dc level will vary with the amplitude of the received signal.
(v) The resulting negative voltage is then applied to one or more amplifier stages.

Advantages :
(i) Gain is reduced only for the strong signals and not for weak.
(ii) The characteristics is close to the ideal AGC characteristics.



Q.6 (c) Describe duct propagation with neat diagram. [6]
Ans.: Duct Propagation
Duct propagation is special type of phenomenon which is also called as "Super refraction". It is observed at very high microwave frequencies.



As the height above the Earth increases, the air density decreases and refractive index increases. The change in refractive index increases. The change in refractive index is normally linear and gradual but under certain atmospheric condition a layer of warm air may be get trapped above the cooler air, often over the surface of water, due to this refractive index will decreases rapidly with height than usual. (This happens near the ground, often within 30 m) Due to this rapid reduction of refractive index, the microwaves will completely bend back towards Earth's surface as shown in figure then they will get reflected and this process will continue inside the duct and these waves then propagates around the curvature of Earth over a distance of 1000 km for duct propagation, the main requirement is temperature inversion. The temp inversion is an increase in air temp with height instead of usual decrease of temperate (of 65° C/km in standard atmosphere)

The region in which super refraction takes place is called as duct. The duct can be formed near the Earth's surface or at some height from Earth's surface. If it is second one then it is called as elevated duct.

Duct propagation will takes place only for very high frequencies in the range of GHz.

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