MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

SUMMER – 13 EXAMINATION

Subject Code**: 12118** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

1. a) Attempt any SIX of the following: (12 M)

i) Define modulation and Bandwidth.

Ans i)

- **Modulation - 1M**

It is defined as the process in electronics circuits by which some characteristics usually amplitude, frequency or phase of a high frequency sine wave (carrier) is varied in accordance with the instantaneous value of some other low frequency signal (modulating).

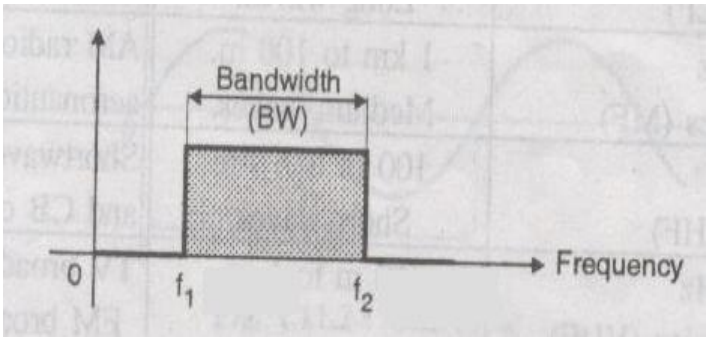
- **Bandwidth: 1M**

Bandwidth is the difference between the upper and lower frequency limits of the signal or the equipment operation range.

$BW = F_2 - F_1$

OR

The range of frequencies that contain the information is called Bandwidth.



ii) What is Deviation Ratio? Write the expression for maximum deviation ratio.

Ans ii)

Deviation Ratio in FM range: **(1M)**

The modulation index corresponding to maximum deviation and maximum modulation frequency is called deviation ratio.

Deviation ratio = $\frac{\delta_{max}}{f_{m\ max}}$ **(1M)**

iii) Why limiter stage is not used before Ratio Detector?

Ans iii) **--2M**

The limiter circuit removes the unwanted amplitude that is added in original FM signal while travelling in free space.

Ratio detector circuit to the amplitude changes in the FM signal which is applied at its input .If the FM input tries to increase , the secondary voltage also increases. Due to this the extra diode current will start flowing hence the load current increases. But the voltage across the large capacitor will not change instantaneously. It will increase gradually.

Therefore, the load current increases but load voltage is constant so the load impedance decreases.

Due to decreased load impedance the secondary of the input transformer is heavily damped.

Due to damping , the Q decreases and therefore the gain of the amplifier driving the ratio detector will also decrease. This will counteract the increase in FM input voltage to the ratio detector. The ratio detector provides the amplitude by means of the process called diode variable damping .

So, limiter stage is not used before ratio detector.

iv) Give examples of Simplex and Duplex communication system.

Ans iv)

Examples of simplex communication : **1M**

- TV broadcasting, radio broadcasting

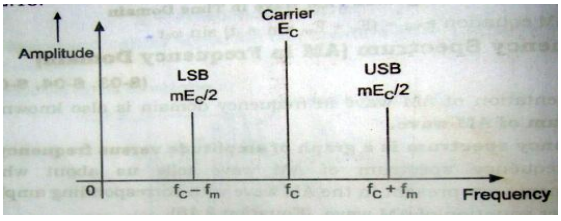
Examples of duplex communication: 1M

- Walky-talky, citizen radio, armature radio, telephone system, mobile communication.

v) Write expression for an AM wave and draw its diagram in frequency domain

Ans v)

Representation of AM in frequency domain -: 1M



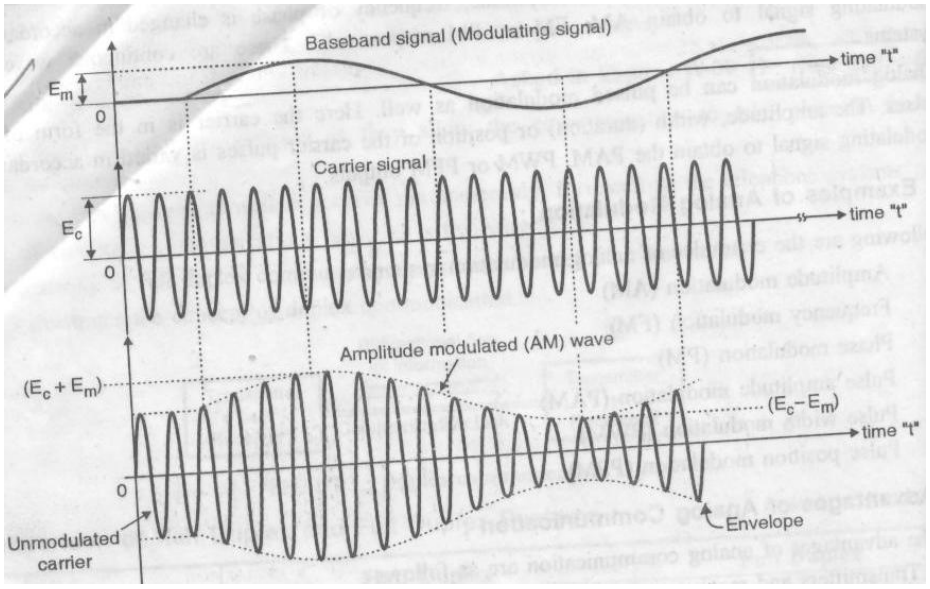
- **Expression for an AM wave** : **1M**

$$v = V_c \sin\omega_c t + \frac{mV_c}{2}\cos(\omega_c t - \omega_m t) - \frac{mV_c}{2}\cos(\omega_c t + \omega_m t)$$

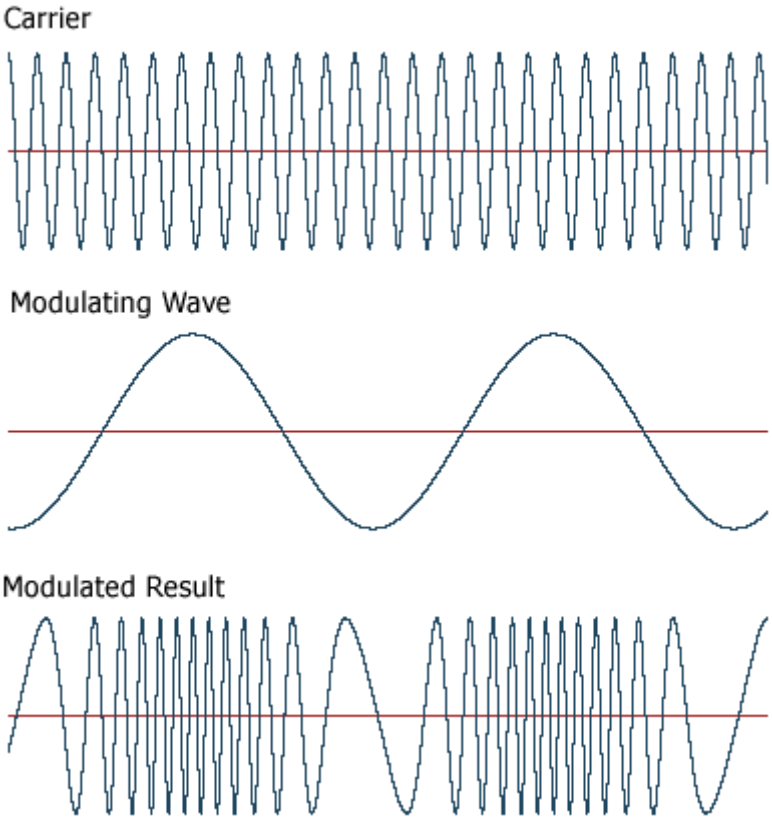
vi) Draw the waveforms of AM wave and FM wave with message signal and carrier signal showing separately.

Ans vi)

Amplitude Frequency : 1M



Frequency Modulation (FM): -- 1M



vii) What is an Antenna? List different types of antennas.

Ans vii) **Antenna Definition : 1M**

- An antenna is a structure that is generally a metallic object, often a wire or group of wires, used to convert high frequency current into electromagnetic waves, and vice versa.
- Thus, an antenna is an essential interface between the transmitter and free space while transmitting the signals, and between the free space and the receiver while receiving the signals.

  Different types of Antennas: 1M

  - Dipole Antenna
  - Half wave Dipole
  - Folded dipole
  - Loop Antenna
  - Ferrite loop antenna
  - Telescopic antenna
  - Yagi- Uda Antenna
  - Microwave Antenna - Dish antenna ,Horn Antenna

viii) Define :

1) Beamwidth
2) Polarization for an Antenna.

Ans viii)

- **Beam width - (1M)**

It is defined as the angular separation between the two half power points on the power density radiation patterns.

- **Polarization -(1M)**

Polarization is defined as the direction of the electric vector in the electromagnetic wave radiated by the transmitting antenna.

b) Attempt any <u>TWO</u> of the following: (8M)

i) State the need for Modulation.

Ans i) Any **four points –4M**

Radio, Television, radar and many other systems of communication would be impossible without modulation. Modulation is therefore, necessary in a communication system due to the following reasons.

- **Multiplexing :**
  Simultaneous transmission of multiple messages (more than one message) over a channel is known as multiplexing. The channels used for transmission may be a pair of wire (called transmission lines) or free space. If transmitted without modulation the different message signal over a single channel will interfere with one another. However, different message signals can be transmitted over a single channel without interference using multiplexing techniques (FDM and TDM). Thus no of channels needed will be less. This reduces the cost of installation and maintenance of more channels.
- **Practicability of antenna:**
  When free space is used as a communication media, message are transmitted and received with the help of an antenna. The message signal is radiation by an antenna at the transmitter. The antenna radiates effectively when its height is of quarter wavelength of the signal being transmitted. Mathematically, the height of a transmitting antenna would be,

$$H = \frac{\lambda}{4} = \frac{c}{4f} = \frac{\text{velocity of light}}{4 \text{ X frequency of wave}}$$

This shows that greater the frequency, the smaller is the height of transmitting antenna and smaller the frequency, long transmitting antenna is required, which would be lightly impracticable and uneconomical to construct.

- **Narrow banding:**

  Let the base band signal in a radio broadcast system is radiated directly with the frequency range extending from 50Hz to 10kHz, the ratio of highest to lowest wavelength is 200. If the antenna is designed for 50Hz, it will belong for 10kHz and vice versa and we may require a wide band antenna. However, suppose the audio signal is translated to radio range frequency say 1MHz, then ratio of lowest to highest frequency will be

$$\frac{10^6 + 50}{10^6 + 10^4} = \frac{1}{101}$$

Thus frequency translation converts a wide band signal to a narrow band. Here bandwidth is referred to as the ratio of the edge frequencies of the band. This is called narrow banding.

- **Operating Range:**

The energy or power of a wave depends upon its frequency. The greater the frequency of the wave the greater the energy possessed by it. As the audio frequencies are small, therefore they possess low energy &hence these frequencies cannot be transmitted over large distances if radiated directly into space. The only practical solution is to modulate a high frequency (150KHz to several MHz) carrier waves with audio signal and permit the transmission to occur at the high frequency. Thus, it increases the operating range.

- **Wireless Communication:**

The basic requirement of radio transmission is that it should be carried out without any wire. This is not practicable because of its poor radiation efficiency. However, the efficient radiation of electrical energy is possible at high frequencies (>100 kHz).

Greater the frequency better is the radiation efficiency. Therefore it permits the transmission without wire.

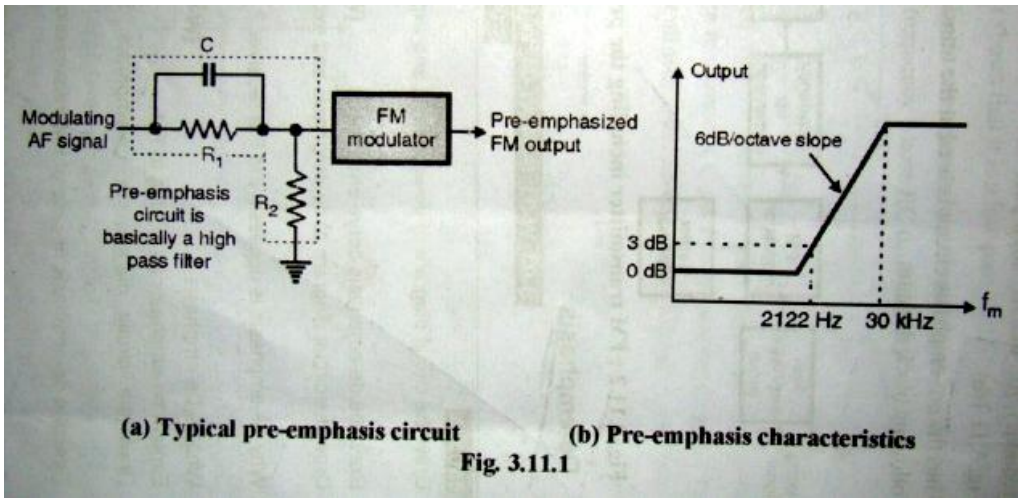
ii) Draw the circuit diagram of pre- emphasis and De- emphasis and explain its working.

Ans ii)

<u>Pre- emphasis</u> :- **(2-Marks)**

It has been observed that in FM ,the noise has a greater effect on the higher modulating frequencies. This effect can be reduced by increasing the value of modulation index (m_f) for higher modulating frequencies (m_f). This can be done by increasing the deviation "δ" and δ can be increased by increasing the amplitude of modulating signal at higher modulating frequencies. Thus

if we “boost” the amplitude of higher frequency modulating signal artificially then it will be possible to improve the noise immunity at higher modulating frequencies. The artificial boosting of higher modulating frequencies is called as Pre-emphasis. Boosting of higher frequency modulating signal is achieved by using the pre-emphasis circuit of Fig (a). The modulating AF signal is passed through a high pass RC filter, before applying it to the FM modulator. As f_m increases , reactance of C decreases and modulating voltage applied to FM modulator goes on increasing. The frequency response characteristic of the RC high pass network is shown in Fig (b). The boosting is done according to this prearranged curve. The amount of pre-emphasis in US FM transmission and sound transmission in TV has been standardized at 75μsec . The pre-emphasis circuit is basically a high pass filter.



(a) Typical pre-emphasis circuit (b) Pre-emphasis characteristics

Fig. 3.11.1

De-emphasis :- **(2-Marks)**

The artificial boosting given to the higher modulating frequencies in the process of pre-emphasis is nullified or compensated at the receiver by a process called “De-emphasis”. The artificially boosted high frequency signal are brought to their original amplitude using the de-emphasis circuit. The 75 μsec de-emphasis circuits is standard and it is as shown in fig (a) .It is shown that it is a low pass filter. 75 μsec de-emphasis corresponds to a frequency response curve that is 3dB down at a frequency whose RC time constant is μsec. The demodulated FM is applied to the De-emphasis circuit with increase in f_m the reactance of C goes on decreasing and the output of de-emphasis circuit will also reduce as shown in Fig (b)

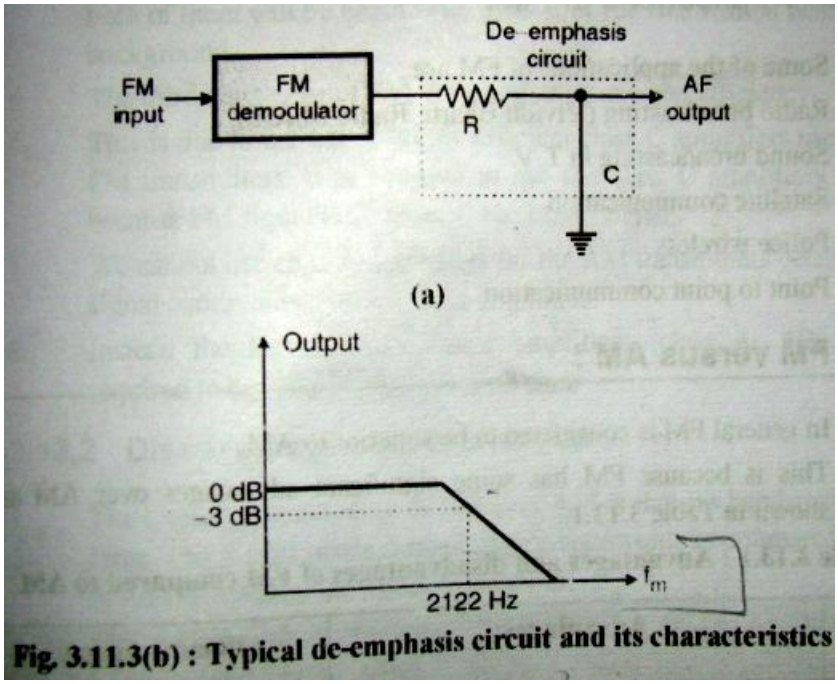


Fig. 3.11.3(b) : Typical de-emphasis circuit and its characteristics

iii) Draw the block diagram of superheterodyne AM Radio Receiver and explain the working of each block

Ans iii)

The problems in TRF radio receiver are solved superheterodyne receiver by converting RF signal frequency into lower fixed frequency signal called Intermediate frequency (IF).

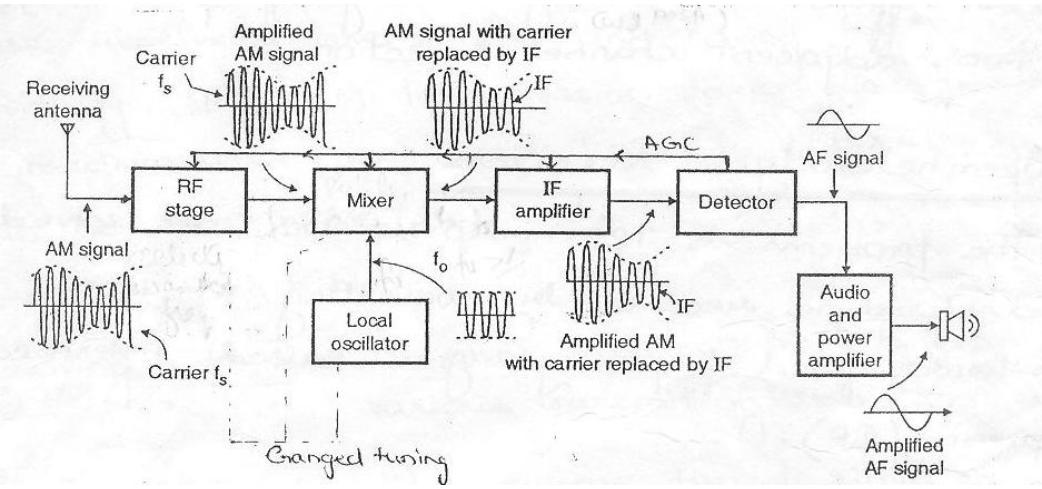
- **Principle of heterodyne:-**

The primary requirement for any communication receiver is that it have the ability to select desired signal from among thousands of other present and to provide sufficient amplification to receiver the modulating signal.

The key concept in super heterodyne receiver is frequency conversion. Frequency conversion is the process of translating a modulating signal to a higher or lower frequency while retaining all the originally transmitted information.

Frequency conversion is carried out by a mixer circuit. The function performed by the mixer is called heterodyning, mixing two frequencies.

- **Block Diagram: 2M**



- **Operation: 2M**

  The 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 into the receiving antenna.

  RF stage is an amplifier which is used to select the wanted signal and reject unwanted ones. It also reduces the effect of noise. At the output of the RF amplifier, we get the desired signal at frequency "fs".

- **Mixer** receiver signal from the RF amplifier at frequency (f_s) and from the local oscillator at frequency f_o such that $f_s > f_o$. 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 the 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).
- **Ganged tuning**

  Ganged tuning is used to maintain a constant difference between the local oscillator frequencies and the incoming frequency. This is simultaneous tuning of RF amplifier, mixer and local oscillator and it is achieved by using ganged tuning capacitor.

  This IF signal is then amplified by one or more IF Amplifier stages. IF amplifier provide most of the gain and the bandwidth requirements of the receiver.

  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 (Automatic Gain Control)**

  Circuit controls the gain of the RF and IF amplifiers 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.

2. Attempt any <u>FOUR</u> of the following: (16)

a. What is transmission line, draw it general equivalent circuit?

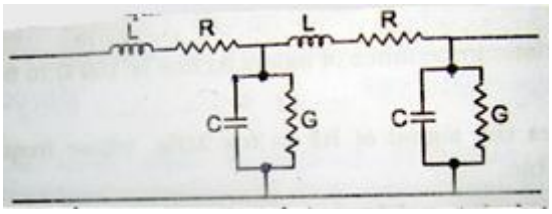
Ans a. **Transmission line-- 2M**

Transmission lines are conducting wires used for connecting points that are some distances apart from each other. They are impedance matching circuits designed to deliver power (RF) from the transmitter to the antenna, and maximum signal from the antenna to the receiver.

Each Conductor has a certain length & diameter, so it will have a resistance & inductance. Since there are two wires close to each other, therefore there will be capacitance

The wires are separated by a medium called the dielectric, which cannot perfect in its insulation, the current leakage. Through it, can be represented by a shunt conductance.

Equivalent circuit 2M



b) State the different losses in transmission line and describe them.

Ans b) **1M each**

There are three ways in which energy, applied to a transmission line, may become dissipated before reaching the load.

1. Radiation.
2. Conductor Heating (I^2R loss).
3. Dielectric Heating.
4. Coupling Loss

1) **Radiation** losses arise because; a transmission line may act as an antenna if the separation of the conductors is an appreciable fraction of a wavelength. It occurs more in parallel wire lines than in coaxial lines. Radiation losses are normally measures than calculated. They increase with frequency. They are reduced by proper shielding of the cable.

2) **Conductor heating** or I^2 R loss is proportional to current and therefore inversely proportional to characteristic impedance. It also increases with frequency because of the skin effect. At higher frequencies, the current flowing through a conductor tends to concentrate more at the surface rather than at the core. This is called as skin effect. Skin effect reduces the equivalent cross sectional area of the conductor and hence increases the

resistance R. In order to reduce the conductor loss, the length of the transmission lines should be shortened or use the wires of larger diameter.

3) **Dielectric Heating** is proportional to the voltage across the dielectric and hence inversely proportional to the characterisitcs impedance for nay power transmitted. It increases with frequency (for solid dielectric lines) because of gradually worsening properties with increasing frequency for any given dielectric medium negligible. For line at 1GHz, these losses vary from as much as 200db/100 m for a solid dielectric, flexible 6mm line.

4) **Coupling loss** : This loss is related with the coupling of two transmission lines whenever a connection is made to or from a transmission line the loss of power called coupling loss will take place .The mechanical connections give rise to coupling loss. The discontinuities heat up and radiate energy and lose power.

c) A 500 watt carrier is modulated to depth of 80%. Calculate

i) Total power in AM wave

ii) Power in sidebands.

Ans c)

P_c = 500W

M = 80% = 0.8

i) $\frac{P_t}{P_c} = 1 + \frac{m^2}{2}$

$P_t = \left[1 + \frac{(0.8)^2}{2}\right] \text{ X } P_c$

P_t = 660 W ------ **2M**

ii) Power in sidebands

$P_{USB} = P_{LSB} = \frac{m^2}{4} \text{ X } P_c$

$= \frac{(0.8)^2}{4} \text{ X } 500$

$P_{USB} = P_{LSB}$ = 80W **2M**

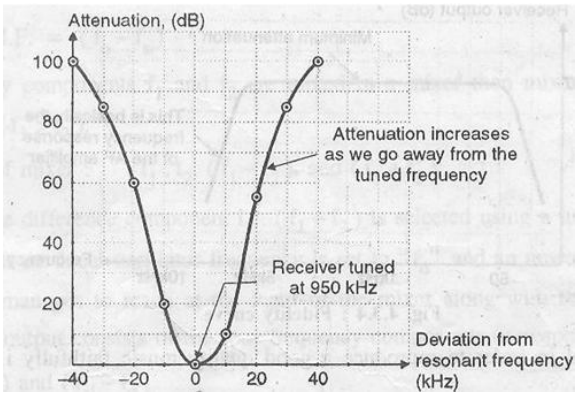
d) Explain the term sensitivity and selectivity for AM receiver.

Ans d)

- **Selectivity** :- **(2-M)**

Selectivity refers to the ability of a receiver to select a signal of a desired frequency while rejecting those an closely adjacent frequencies.

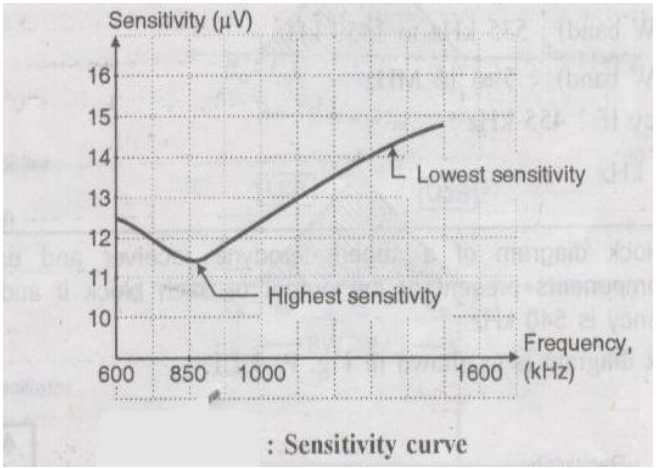
A receiver with good selectivity will isolate the desired signal in the RF spectrum and eliminate all other signals. Selectivity in a receiver is obtained by using tuned circuits.



- **Sensitivity** :- **(2-Marks)**

The sensitivity of a communication receiver refers to the receiver's ability to pick up weak signals. Sensitivity is primarily a function of the overall receiver gain; gain of course is the factor by which an input signal is multiplied to produce the output. The sensitivity of a communication receiver is usually expressed as the minimum amount of signal voltage SIP that will produce an output signal that is 10dB higher than the receiver back ground noise. Sensitivity improves with the help of tuned circuit.

Diagram



: Sensitivity curve

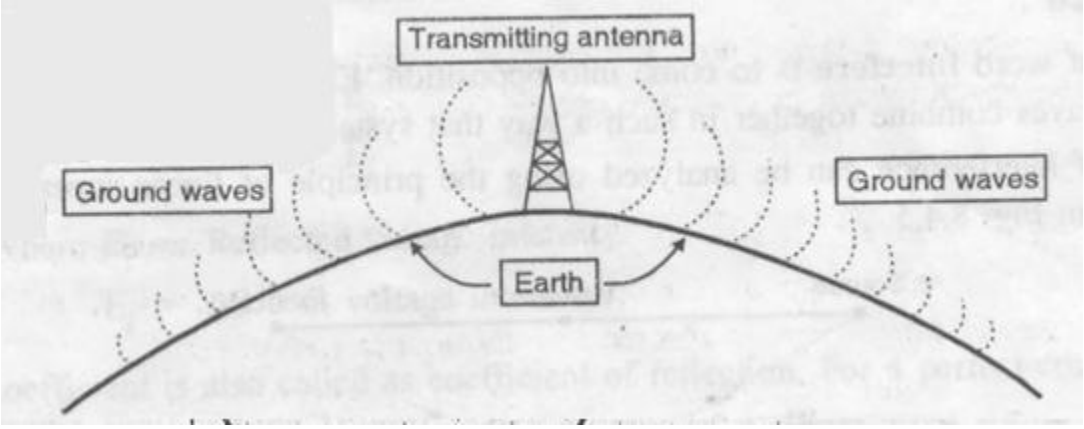
e) Describe ground wave propogation.

Ans e)

Ground wave propagation: 2M

1. The ground or surface wave leaves the antenna and remain closed to the earth. The ground wave will actually follow the curvature of the earth and therefore can travel a distance beyond the horizon.
2. The ground wave propagation is the strongest at the low and medium frequency ranges.
3. To prevent short circuiting of the electric field component. The EM waves are said to be vertically polarized if all its electric intensity vectors are vertical. The EM wave is vertically polarized.

Diagram : 2M



f) Explain the term "Maximum usable frequency" and "Critical Frequency" with respect to sky wave propogation?

Ans f)

- **Critical frequency** – **(2M)**

The critical frequency of a layer is defined as the maximum frequency that is returned back to the earth by that layer ,when the wave is incident at an angle 90^0 to it. It is denoted by (f_C).
The critical frequency for F2 layer is between 5MHz to 12MHz.

- **MUF** – Maximum Usable Frequency **(2M)**

The maximum Usable Frequency is defined for a certain value of the angle of incidence θ rather than defining it at normal .

MUF is given as

$$MUF = \frac{\text{Critical frequency}}{\cos\theta}$$

This is known as **Secant law**.
MUF can be used for sky-wave propagation normal value of MUF vary from 8 MHz to 35 MHz.

3. Attempt any four of the following : 16

a) Explain the effect of modulation index on AM with waveforms.

Ans:- The modulation index for AM ranges from 0 to 1and is given as-

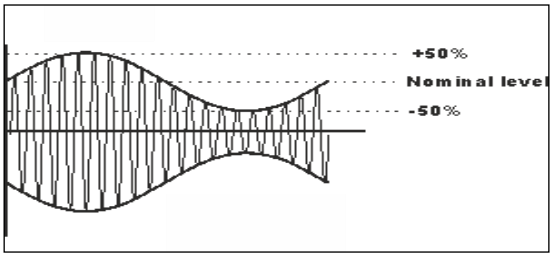
$$m=Vm/Vc$$

where, Vm=Modulating signal amplitude

Vc =Carrier signal amplitude (1 mks)

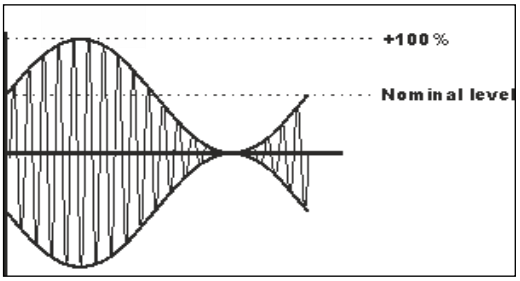
The effect of m on AM is as shown in the figures below-

a) m<1 (m < 100%)- no distortion in the Recovered signal at the receiver.



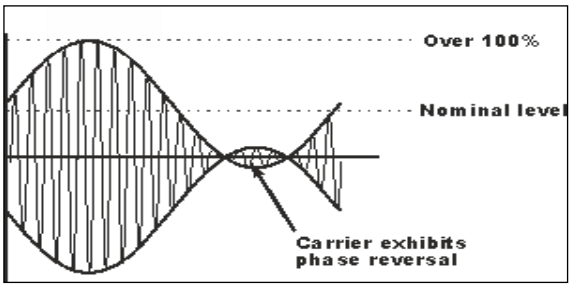
(1 mks)

b) m=1(m=100%)-Distortion occurs at the receiver after demodulation.



(1 mks)

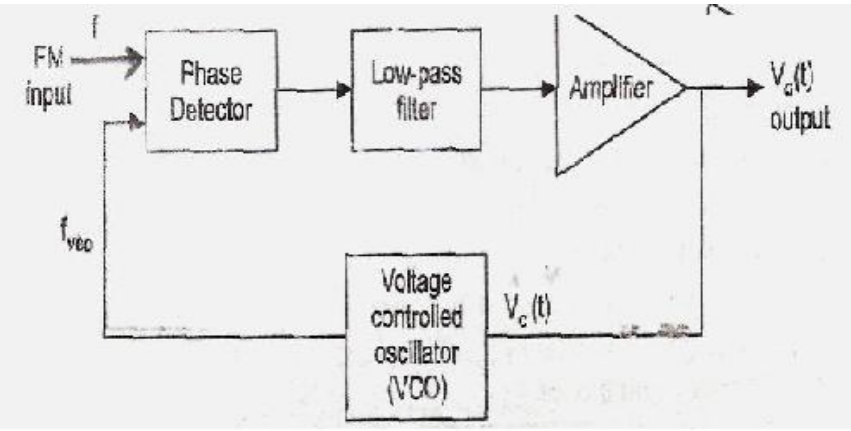
c) m>1 (m> 100%)-Over modulation ,resulting in distortion at the receiver after demodulation.



(1 mks)

b) Explain the working of PLL with block diagram.

Ans:- PLL block diagram - (2 mks)



Explanation (2 mks)

Phase Detector:- It is basically a balanced modulator, produces an average (or low frequency) output voltage that is linear function of the phase difference between the two input signals.

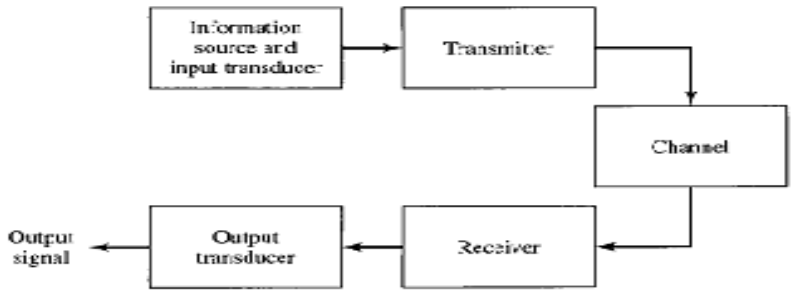
Low-pass Filter:- The frequency component is selected by the low-pass filter which also removes much of the noise.

Amplifier:-The filtered signal is amplified by amplifier.

VCO:-Amplified signal passed as a voltage to the VCO where it results in frequency modulation of the VCO frequency.

c) Explain the basic block diagram of communication system.

Ans:- Communication System block **diagram 2M**



Explanation 2M

Transducer: -A transducer is usually 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.

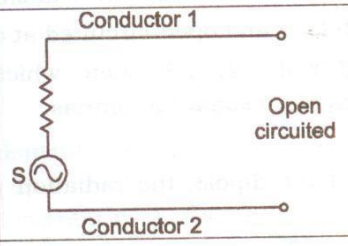
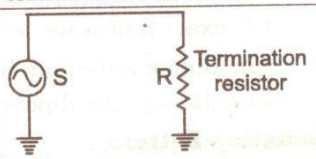
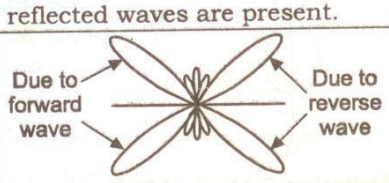
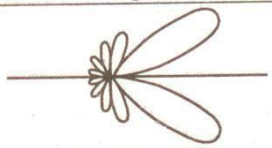
The transmitter:- The transmitter converts the electrical signal into a form that is suitable for transmission through the physical channel or transmission medium. For example, in radio and TV

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.

The channel:- The communications channel is the physical medium that is used to send the signal from the transmitter to the receiver. In wireless transmission, the channel is usually the atmosphere (free space).
The 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.
Output Transducer:- The output transducer converts electrical signal into original form, eg. Loudspeaker etc.

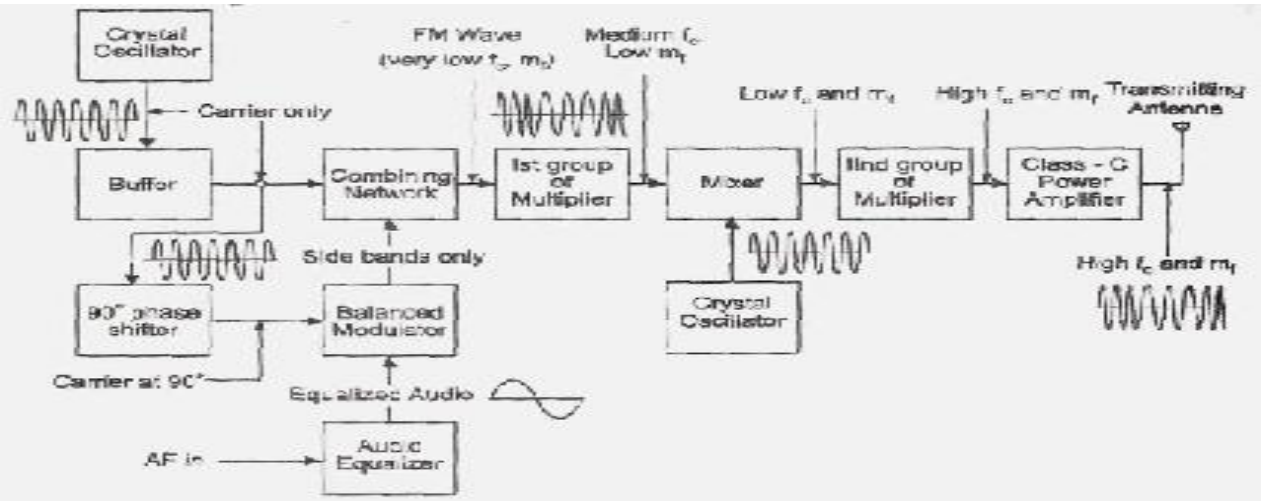
d) What are stubs and baluns.?
Ans:-Stubs:-
In order to connect sections of open or short circuit line stub or tuning stub in shunt with the main line at a certain point to effect the impedance matching, called as stub matching.
Types -Single stub matching
-Double stub matching (2 mks)
A Balun or a balance to unbalance transformer, is a circuit element used to connect a balanced line to unbalanced line. i.e. it is used to connect an unbalanced (coaxial) line to a balance antenna such as a dipole that provides impedance matching between antenna and transmission line.
(2 mks)

e) Compare resonant and non-resonant antenna for four points.
Ans:- (4 points- 4 mks)

Sr. No.	Parameter	Resonant Antenna	Non-Resonant Antenna
1.	Definition	Resonant antennas are open-circuited transmission line at one end.	Non-resonant antennas are like a properly terminated transmission line by correct termination resistor.
2.	Circuit		
3.	Standing Waves	Present	Not present.
4.	Reflection	Takes place so forward and reflected waves are present.	No reflection so only forward waves are present.
5.	Radiation Pattern	 Bidirectional	 Unidirectional

f) Draw the block diagram of Armstrong method to generate FM wave and explain its working.

Ans:- In direct methods of FM generation LC oscillators are used. The LC oscillators are not stable enough for broad-cast purpose. Thus, the direct methods are not used for broadcast applications. The alternative method is to use the indirect method called Armstrong method of FM generation .



(2 mks)

Functions of each block are as follows**:** **(2 mks)**
Crystal Oscillator:- It generates the carrier at low frequency upto 1 MHz.
Buffer:-It is unity gain amplifier to amplify the carrier.
Audio Equalizer:-AF signal i.e. modulating signal passed through audio equalizer to boost the low modulating frequencies.
Balanced Modulator:-90° phase shifted carried and equalized audio signal applied to balanced modulator. It produces two sidebands such that their resultant is 90° phase shifted with respect to unmodulated carrier.
Combining Network:-The unmodulated carrier and 90° phase shifted sidebands added here. The output of combining network is FM wave with low carrier frequency fc' and low value of modulation index 'mf'.
Ist Group of Multipliers:-It increases the carrier frequency and modulation index.
Mixer:-The carrier frequency again raised by mixer.
IInd Group of Multipliers:-The fc and mf both are raised to required high values.
Class-C Power Amplifier:-It increases the power level of FM signal.
Transmitting Antenna:-The high powered FM signal collected at antenna and transmitted .

4**. Attempt any four of the following :** **16**

a) Write the expression for characteristics impedance of transmission line for low frequency and radio frequency.

Ans:- Characteristic Impedance (Zo) :Characteristic impedance of a transmission line Zo is the impedance measured at the input of this line when its length is infinite.

Method of Calculation : If a line has infinite length, all the power fed into it will be absorbed, because the voltage drops across the inductance and leakage current through capacitance.

For low frequency it is given as -

$$Z_O = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

(2 mks)

While for high frequency Zo is given as-

$$Z_O = \sqrt{\frac{Z}{Y}}$$

(2 mks)

where, Z_0 = Characteristic impedance

Z = Series impedance per section

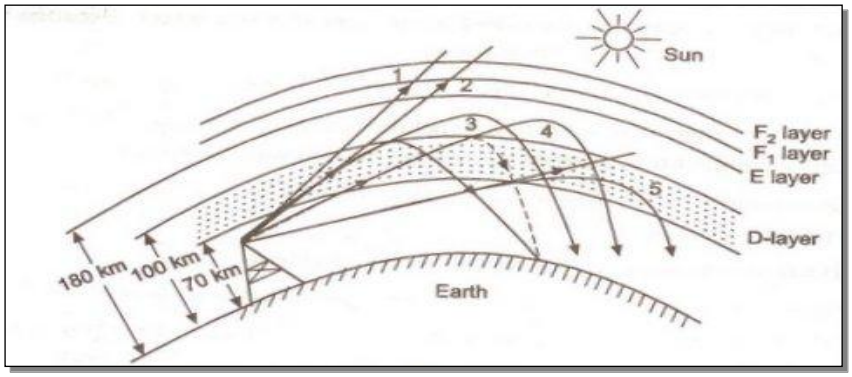
$= R + j\omega L\ (\Omega/m)$

Y = Shunt admittance per section

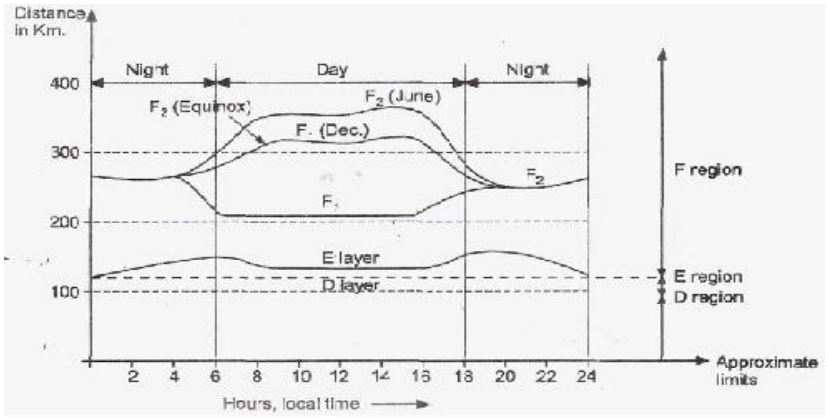
$= G + j\omega C\ (s/m)$

b) Describe the various layers of ionosphere.

Ans:- The different layers of ionosphere are as shown below-



OR



(2 mks)

The ionosphere is divided into different layers according to the electron density present, which is always equal to the ion density.

D Layer:-It is the lowest layer of ionosphere existing at average height of 70Km with average thickness of 10km.This layer disappears completely at night .This layer reflects some of VLF & LF waves while absorbs MF & HF waves.

E Layer :-This is the next layer above D layer existing at height of about 100Km with thickness of around 25Km, like D layer this layer disappears almost completely at night due to recombination of ions into molecules This layer is useful for surface wave propagation.

F1 layer:-This layer is present at height of 180 Km in daytime and its daytime thickness is of about 20km although some HF waves are reflected from it .This layer recombines with F2 layer during night.

F2 layer:- This is far most layer of ionosphere & is spared between height of 250 to 400 km during daytime and having thickness of 200 km .This layer is most important layer for reflection of high frequency radio wave .This layer recombines with F2 layer during night and is highly ionized layer. (2 marks)

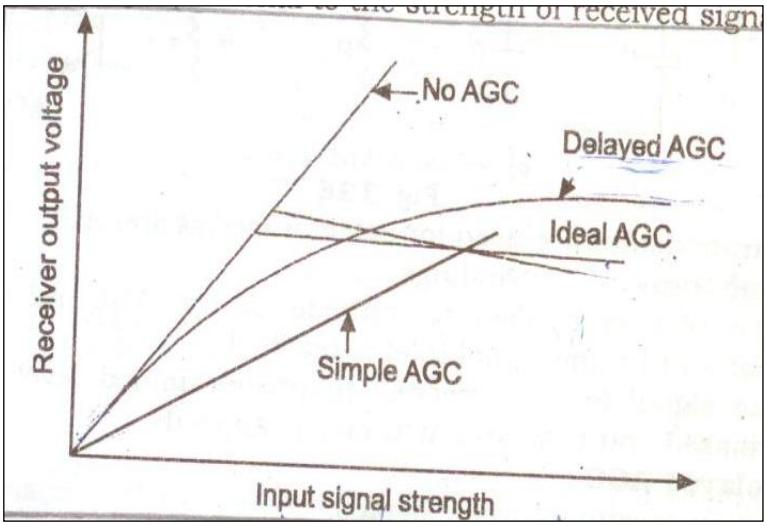
c) Compare between AM and FM for four points.

Ans:- (any 4 points -4 mks)

Sr.no	**AM**	**FM**
1.	Amplitude of carrier signal is changed in proportion to the instantaneous amplitude of modulating signal.	Frequency of carrier signal is changed in proportion to the instantaneous amplitude of modulation index.
2.	M.I=E_M/E_C	M.I= δ/f_m
3.	Bandwidth= 2fm	Bandwidth= 2[$\delta+f_m$]
4.	Less bandwidth	Wider bandwidth
5.	Less immune to noise	More immune to noise
6.	Transmitting and receiving equipment's tends to less complex.	Transmitting and receiving equipment's tends to more complex.
7.	Area of reception is larger	Area of reception is smaller
8.	AM broadcast operate in the MF and HF frequency range.	FM broadcast operates in the upper VHF and UHF frequency range.
9	In AM noise cannot be reduced by increasing the deviation.	In FM further noise can be reduced by increasing the deviation.

d) Explain AGC and delayed AGC with graph.

Ans:-The graph is as shown below-



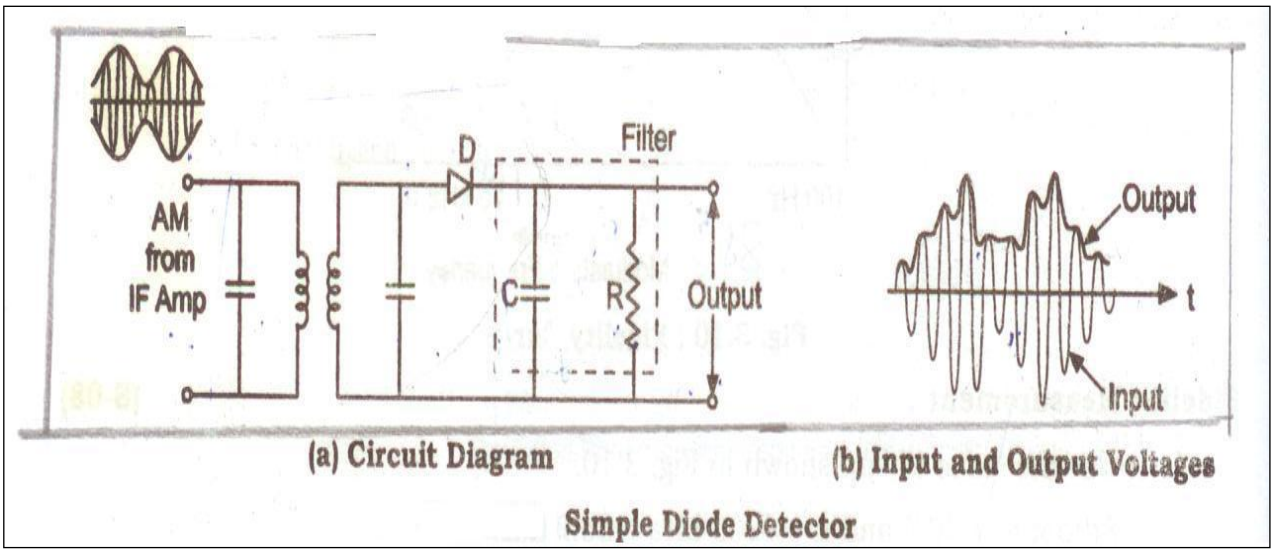
(2 mks)

Automatic gain control, controls the gain of RF and IF amplifiers to maintain a constant output level at the speaker even though the signal strength at the antenna varies. Thus even though the signal strength at the antenna keeps fluctuating, the AGC keeps the receiver output constant . (1 mks)

Delayed AGC:-In this technique bias is applied only after signal strength has reached a particular level.As seen in the graph,the AGC is not applied until the input signal strength reaches a predetermined level,so called ad delayed AGC, which is more stronger than simple AGC. Thus problem of reducing the receiver gain for weak signals is thus avoided. (1 mks)

e) Explain the working of simple diode AM Detector with circuit diagram and waveforms.

Ans:- S**imple diode AM Detector with circuit diagram and waveforms**



(Diagram 2 mks,waveforms 1 mks)

The diode is the most common device used for AM demodulation.

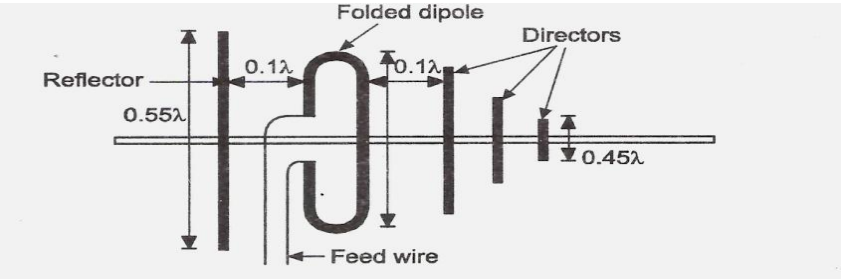
AM signal is applied to the input of the simple detector. In every positive half cycle ,diode is forward biased so that capacitor charges to peak value of input voltage. As soon as input voltage goes below peak point voltage, diode will be reverse biased and capacitor discharges through R. Charging and discharging of capacitor repeats for each cycle that results in positive envelope of AM signal that appears at the output. This envelope is nothing but original modulating signal .

(1 mks)

f) Explain the working of Yagi Uda antenna and draw its radiation pattern.

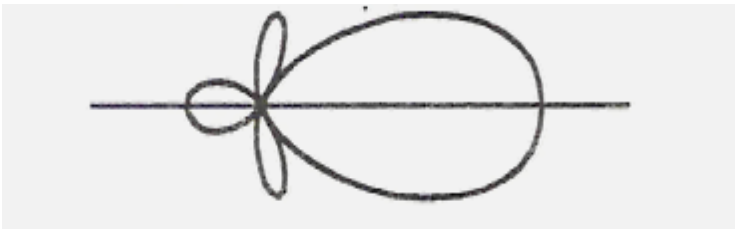
Ans:- Yagi-Uda Antennas are the most high gain antennas and are known after the names of Prof. S. Uda and H. Yagi.

It is an array consisting of the main driven element called folded dipole, the parasitic elements called reflector and director. As shown in Figure above the reflector is placed at the back of folded dipole which reflects the unwanted signals. The directors are placed in front of folded dipole which collects the wanted signals. The directors are always more than one, and always face the transmitting antenna. The length of fold dipole is l /2. (2 mks)



(1 mks)

Radiation Pattern: The antenna is unidirectional



(1 mks)

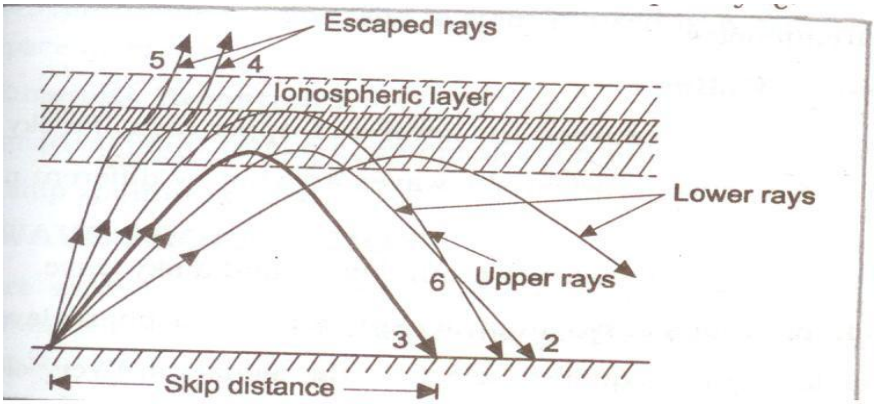
5. Attempt any four of the following : **16**

a) With the help of figure , explain skip distance and fading.

Ans:-

Skip distance:- The skip distance is defined as the shortest distance from a transmitter measured along the surface of the earth at which sky wave of fixed frequency returns back to the earth.

(1 mks)



Fading:-Fading means the fluctuations in the signal strength at the receiver.(1mks)

Causes:- 1) Due to interference between the lower and upper rays of sky wave,

2) interference between the sky waves arriving by different paths

3) interference between the ground wave and sky wave.

4) Fluctuations of height or density in the ionosphere layers. (any 2 points-1 mks each)

b) List applications of ferrite rod antenna and telescopic antenna.

Ans:- **(2 applications each)**

Ferrite rod antenna-In AM radio receiver to receive MW and SW band signals**.**

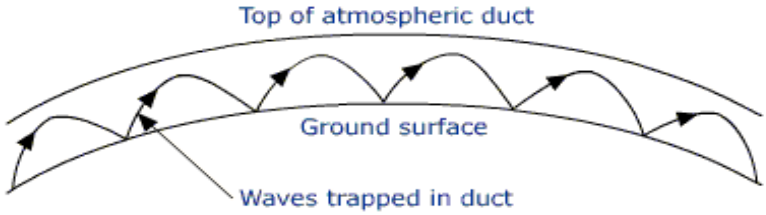
- In FM radio receiver (2 mks)

Telescopic antenna-Telescopic antennas used at VHF for mobile communication service due to simple structure.

-For telescopic radar tracking system for fighter planes. (2 mks)

c) Explain duct propagation with the help of diagram.

Ans:- Duct propagation is a special type of phenomenon which is also called as “super reflection”. It is observed at very high microwave frequencies.



(2 mks)

The duct propagation can be explained as follows:

As the height above the earth increases, the air density decreases and the refractive index increases. The change in the refractive index is normally linear or gradual.

However under special atmospheric conditions, a layer of warm air may get trapped above the cool air. This happens usually over the surface of water.

Due to this refractive index will decrease more rapidly with height than usual. This happens near the ground normally within a distance of 30 meters above the surface.

Due to this rapid reduction of refractive index, the microwave completely turns back towards the earth surface. This is similar to what happens in sky wave propagation.

microwaves are thus continuously refracted inside the duct and reflected back by the conducting ground.Thus for duct propagation to take place “temperature inversion” must take place. (2 mks)

d) Draw the nature AM wave for following conditions.

i) Fc=100Khz,2Vp-p

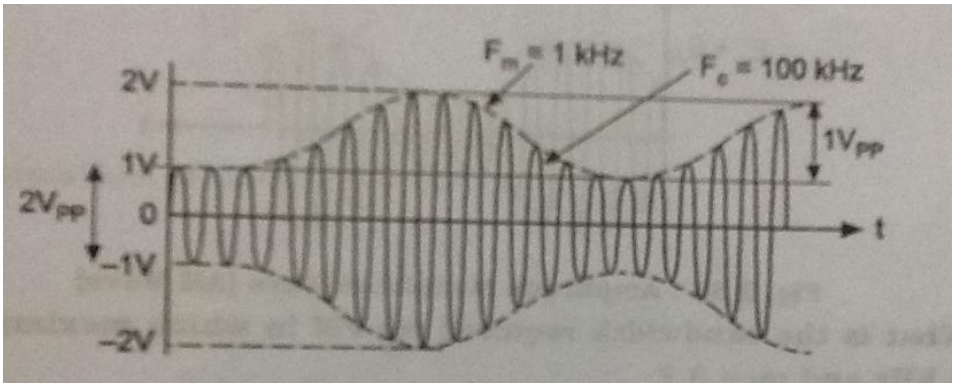
Fm=1 Khz,1Vp-p

ii) Fc=100Khz,2Vp-p

Fm=2 Khz,1Vp-p

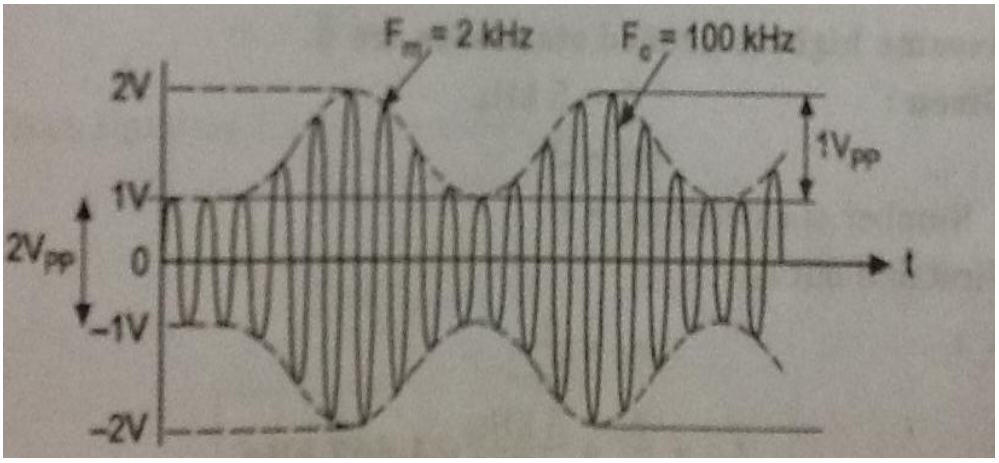
Ans:- Fc=100Khz,2Vp-p (2 mks)

Fm=1 Khz,1Vp-p



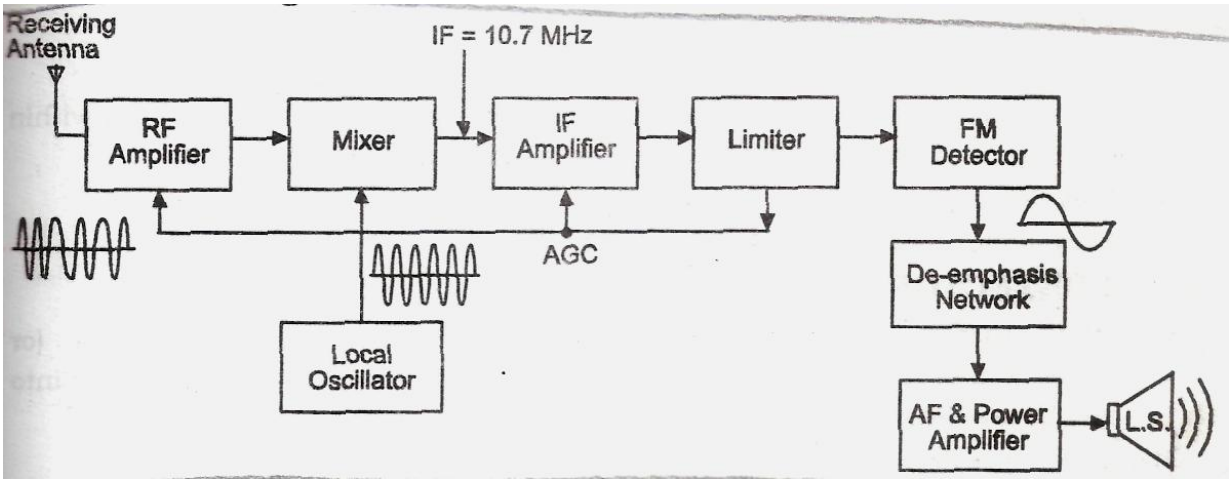
Fc=100Khz,2Vp-p (2 mks)

Fm=2 Khz,1Vp-p



e) Draw the block diagram of FM Radio receiver and explain its working.

Ans:- Block diagram of FM receiver



(2 mks)

Block Diagram of FM Receiver- (FM Radio Frequency Range **88 MHz-108** MHz).

As shown in block diagram of FM receiver functions of each block are:

RF Amplifier :In domestic AM receivers, RF amplifier is not used but in FM receivers, FM amplifiers are used. Its function is -

1. To improve signal to noise ratio.

2. To match the receiver input impedance to antenna impedance.

3. To reduce noise figure.

Mixer: It is also known as frequency changer.

Input signal frequency f_s and local oscillator frequency f_0 are mixed down to convert received signal to intermediate frequency (IF).

$IF = f_0 - f_s$

IF = 10.7 MHz for FM ranges from 88 MHz to 108 MHz.

IF Amplifiers: It amplifies the IF of mixer output. Due to large bandwidth gain per stage is low. Therefore, two or more stages of IF amplifier are used.

Amplitude Limiter: It removes the unwanted amplitude that is added in original FM signal while travelling in free space. It is removed before demodulation, otherwise distortion appears at output.

FM Detector: Converts the FM signal into original modulating signal.

De-emphasis: The artificially boosted high frequencies at transmitter are removed by de-emphasis.

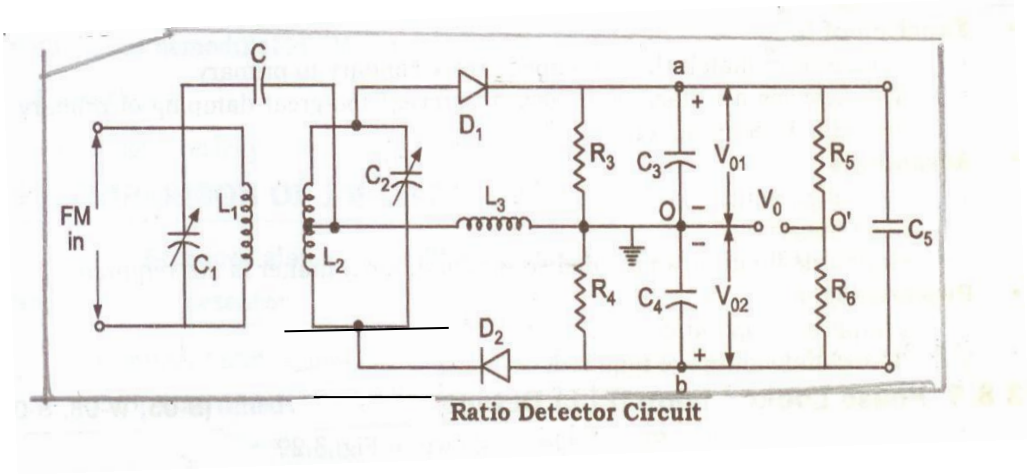
AF and Power Amplifier: First the modulating signal is voltage amplified and its power is increased to drive the loudspeaker.

AGC: Automatic gain control is used to ensure that the signal fed to the limiter is within its limiting range and also prevents overloading of last IF amplifier.

Loudspeaker: Converts modulating signal into sound information. (2 mks)

f) Explain the working principle of ratio detector with neat diagram.

Ans:-Ratio detector is the modification in phase discriminator by adding amplitude limiting .



Ratio Detector Circuit

(2 mks)

With diode D2 reversed biased ,point O is now positive with respect to b, so that Vab is now sum voltage. Large capacitor C5 is connected to keep the o/p sum voltage constant, even though the load current increases. Thus provides the amplitude limiting.

Output voltage Vo is equal to half of the difference between the output voltages from the individual diodes.

Vo= (Vo1-Vo2) /2

Thus output voltage is proportional to the difference between the individual output voltages.

L3 matches the low impedance secondary to primary and provides voltage step down to prevent too great damping of primary by the ratio detector action. (2 mks)

6. Attempt any four of the following : 16

a) Define modulation index for AM wave and calculate percentage modulation, if Emax= 77 V and Emin=37 V.

Ans:- Modulation index for AM wave –A carrier by itself is unmodulated or is at zero modulation, its amplitude is constant. When the amplitude of the signal is changed, the degree or amount of

change from unmodulated carrier is a measure of the % of modulation, called as modulation index. (2 mks)

It is given as-

$$m = \frac{Emax-Emin}{Emax+Emin}$$

So in the given problem,

$$m = \frac{77-37}{77+37} = 0.35 \text{ i.e. } 35\%$$ (2 mks)

b) Redraw the circuit diagram in correct form and name it.Refer fig no 1.

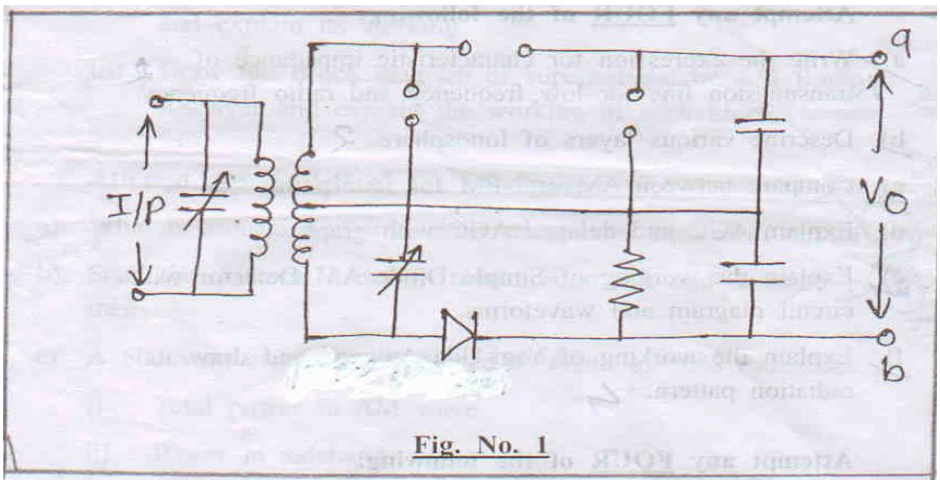
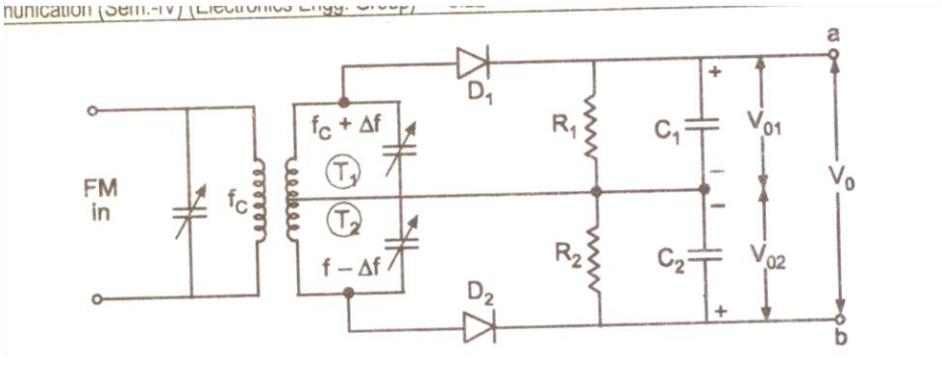


Fig. No. 1

Ans:-The given circuit is the Balance Slope Detector (2 mks)

The redrawn circuit is as shown below-

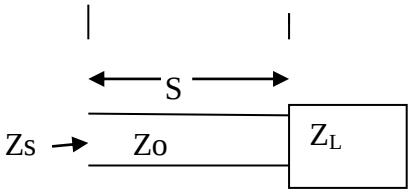


(2 mks)

c) How quarter wave transformer is used for impedance matching?

Ans:-In all applications of transmission line, it is required that the load be matched to line, which requires tuning out the unwanted load reactance and the transformation of resulting impedance to the required value especially at high frequencies.

The impedance of the quarter line depends on load impedance and characteristics impedance as shown-



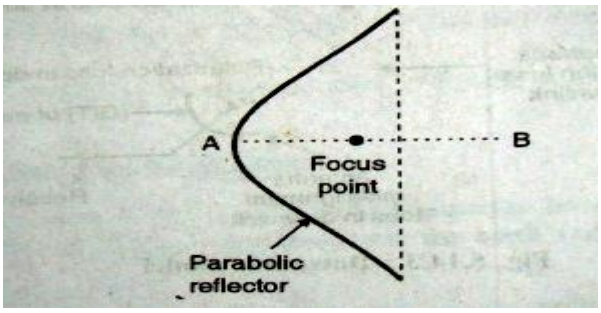
$$Zs = \frac{Zo^2}{Z_L}$$

When the length S is exactly quarter wavelength line then the line is lossless .If the Zo is varied, the impedance seen at the input to the λ/4 transformer will also vary accordingly, so that load may be matched to characteristics impedance of the main line. This is similar to varying turns ratio of a transformer to obtain the required value of input impedance to match the load impedance.

Quarter wave transformer works as filter to prevent unwanted frequencies from reaching the load such as antenna. (4 mks)

d) State the working of parabolic dish antenna.

Ans:-Parabolic Dish antennas:



(2 mks)

Dish antennas are the microwave antennas which use parabolic reflectors. The antenna is actually placed at the focal point of the parabolic reflector. The special geometric properties of parabolic reflectors make it very useful as a microwave or light reflector.

The dish antenna can be a transmitting antenna or a receiving antenna. If it is a transmitting antenna, then all the waves coming out of the source (which is at the focal point) are reflected equally by the reflector from every point. It should be noted that all the reflected waves are in phase with each other. So they will assist each other, get added to give out a strong radiation along the axis AB.We can use the dish antenna as a receiving antenna as well. The construction remains same but at the focal point, we need to use a receiver instead of a source. The parabolic reflector will bring only those rays together which are coming in direction BA. These rays are brought together at the focal point. The rays arriving from any other direction are canceled out. The parabolic reflector actually increases the gain as well as the directivity of the microwave antenna.

(2 mks)

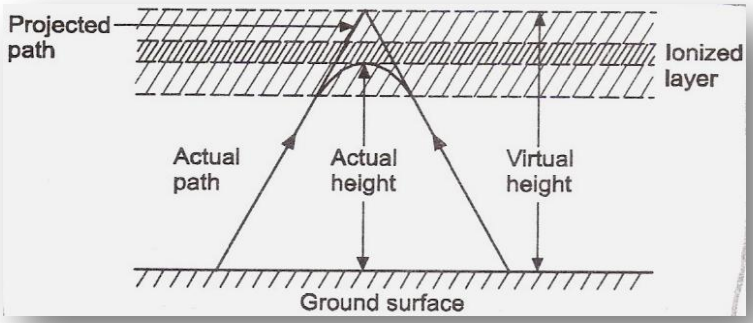
e) State the effect of actual height in the sky wave propagation.

Explain vertical height with respect to sky wave propagation.

Ans:- Actual height:- The actual path of the wave in the ionized layer and is due to refraction of wave. The height from this curve to earth surface is called actual height.

Effect:-As the actual height increases, the rays returns at a farther distance on the earth, then the distance of signal coverage increases. (2mks)

The concept of actual and virtual height is as shown below-



1 mks

As seen the wave is refracted, it bends down gradually rather than sharply.

Vertical/Virtual height:-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. (1 mks)