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.

Q1)Attempt any six of the following: **12M**

i) Define with suitable example:
Simplex and Duplex communication system

Ans:-

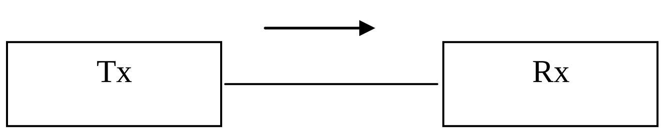
(Definition ½ M each, example ½ M each)

NOTE: - (Marks can be given for defining definitions by words or by diagram and duplex can be defined as half duplex or full duplex or simple duplex)

1) Simplex:-

- In simplex communication the information travels in one direction only.
- A common example of simplex communication is radio and TV broadcasting
- Another example is the information transmitted by the telemetry system of a satellite to earth.

OR



Simplex

Duplex:-

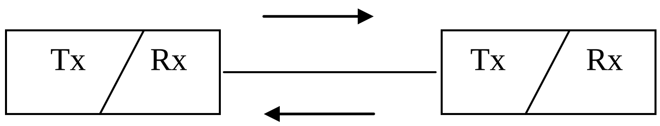
A two way (Bidirectional) communication is called Duplex

OR

Full Duplex :-

- The bulk of electronic communication is two way.
- When individuals communicate with one another over the telephone, each can transmit and hear simultaneously such two way communications is referred to as full duplex

OR



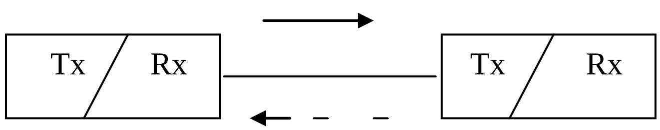
Full duplex

OR

Half Duplex:-

- Form of communications where only one party transmits at a time is known as half duplex.
- The communication is two way but the direction alters.
- Examples of half duplex communication are most radio communications such as those used in the military, fire, police and other services

OR



Half duplex

ii) State the need for modulation

Ans:- **Any 2 point 01M each**

Need of modulation:-

1. The message signal which is to be transmitted to the receiver, cannot travel for long distance by itself. Hence it should take the help of carrier which has the capacity to take the message to the receiver. This is the basic reason why we need to do modulation, so that message can sit on the carrier and reach the receiver.
2. One more reason for modulation is the length of the antenna. The distance that can be travelled by a signal in an open atmosphere is directly proportional to its frequency and inversely proportional to its wavelength. Most of message signals like speech and music are in the audio frequency range (20Hz- 20 KHz) and hence they can hardly travel for few meters on their own. For efficient reception, the transmitting and receiving antenna would have to have lengths comparable to a quarter wavelength of the frequency used. The length of an antenna 5000m is impracticable. Hence we modulate signal to increase its frequency and reduce size of antenna.
3. All the message is concentrated within the same range (20Hz – 20KHz) for speech and music (few MHz for videos) so that all signals from the different sources would be hopelessly and inseparably mixed up. In order to separate the various signals it is necessary to convert them all to different portions of the electromagnetic spectrum. Each must be given its own carrier frequency location. This also overcomes the difficulties of poor radiation at low frequencies and reduces interference. Once signals have been translated, a variable tuned circuit is employed in the front end of receiver to make sure that desired section of spectrum is received and all unwanted ones are rejected.
4. The use of modulation process help in shifting the given message signal frequencies to a very high frequency range where it can occupy only negligible percentage of the spectrum. For example at 1000 KHz the 10 KHz wide message signal represented 1% of spectrum. But at 1GHz same 10KHz

represe3nted 0.001% of spectrum. This means that more number of message signal can be accommodated at higher frequency.

iii) What is deviation ratio for frequency modulation.
Ans:-

NOTE:- **Marks should be considered if deviation ratio is defined by words or by formula.**

Deviation Ratio:- **02M**
Deviation ratio is defined as the ratio of maximum frequency deviation to the maximum modulating frequency.

Deviation ratio is = δ(max)/ fm(max)

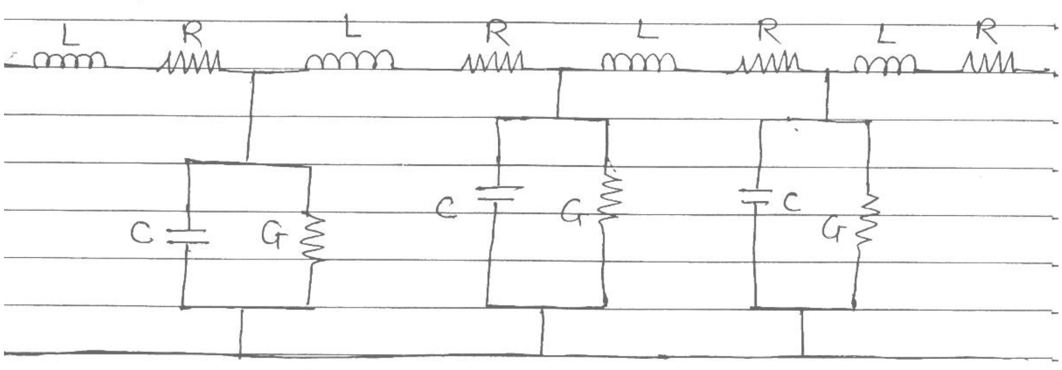
iv) Write the intermediate frequency value for:
1) **AM**
2) **FM**

Ans:- **01M each**
The intermediate frequency for
AM - 455KHz
FM - 10.7MHz

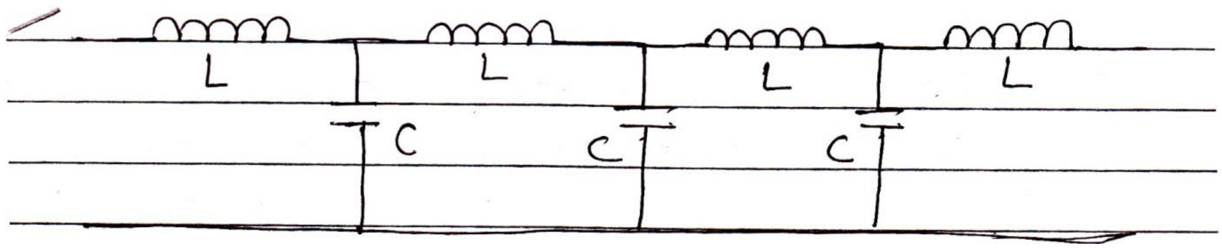
v) Why limiter stage is not used before ratio detector.
Ans:- **02M**
The ratio detector itself consist of limiter stage due to large capacitor (C5). Hence limiter stage is not used in ratio detector.

vi) Explain why electromagnetic waves are called as transverse waves.
Ans:- **02M**
The electromagnetic waves are oscillations which propagate through free space. In electromagnetic waves the direction of electric field, magnetic field & propagation are mutually perpendicular. Hence electromagnetic waves are called as transverse wave.

vii) Draw general and RF equivalent circuit of transmission line.
Ans:-
General Equivalent Circuit of transmission line:- **01M**



RF Equivalent Circuit of transmission line:- **01M**



viii) Define an antenna.

Ans:-

Antenna:- **02M**

Antenna is a metallic object, often a wire or collection of wire which is used to perform following function

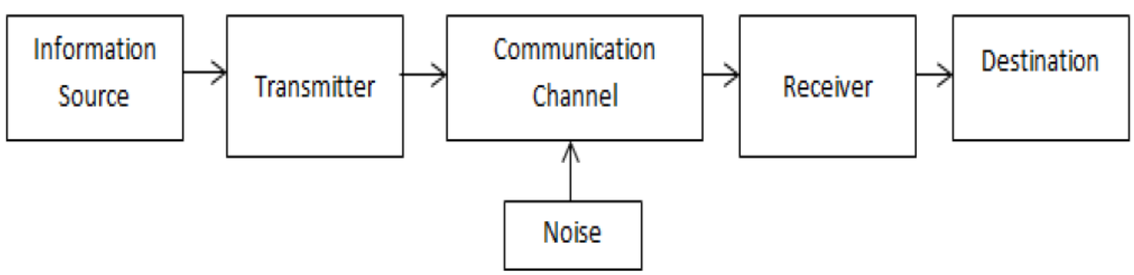
1) It couples the transmitter output to the free space or the received input to the receiver.
2) It must be capable of radiating or receiving the electromagnetic waves
3) It converts high frequency current in to electromagnetic waves and vise-versa.

a) Attempt any two of the following :- **08M**

i) Draw the block diagram of communication system and state the function of each block.

Ans:-

Block Diagram:- **02M**



Function of each block:- **02M**

- The information source generates the information which may be analog or digital which is sent to transmitter section where the information is amplified, filtered to remove noise, processed to become compatible with the channel. For e.g. If channel is optical fiber then information is converted into light energy.
- The information from transmitter is sent to receiver through the communication medium/channel.
- The channel may be wired (co-axial cable/optical fiber cable) or wireless (microwave link).
- The receiver again filters the information to remove noise, amplify, demodulates and convert the information in the type which is compatible with the destination (for e.g. if destination is computer the information is converted into digital binary form).

ii) The parameters of transmission line are i = 65Ω/km, L = 1.6mH/Km, C = 0.1µF/ kM, G = 2.25µΩ/km. calculate the characteristic impedance.

Ans:-

Note:-* *Mark should be given even if only formula is written

(1m) Assume $f = 800Hz$

$\omega = 2\pi f$

$= 2\pi \times 800 = 5024$ rad/sec

Series Impedance

$Z = R + j\omega L$

(1M) $= 65 + j5024 \times 1.6 \times 10^{-3}$

$= 65 + j8$

$Z = 65.48 \angle 7^\circ$

Shunt Admittance

$Y = G + j\omega C$

(1M) $= 2.25 \times 10^{-6} + j5024 \times 0.1 \times 10^{-6}$

$= (2.25 + j502.4) \times 10^{-6}$

$Y = 5 \times 10^{-4} \angle 89.7^\circ$

Characteristic Impedance

$Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{65.48 \angle 7^\circ}{5 \times 10^{-4} \angle 89.7^\circ}}$

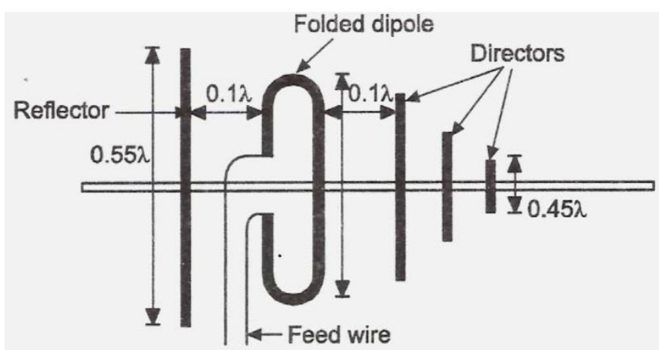
(1M)

$Z_0 = 374 \angle -41.35^\circ$

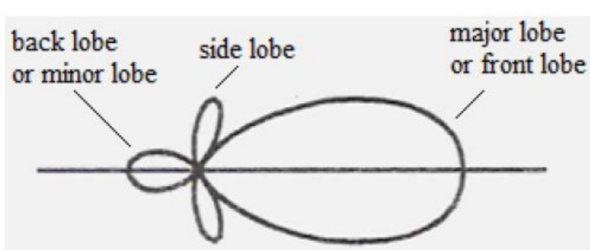
iii) Draw a neat sketch of Yagi –Uda anteena and its radiation pattern. State its two application.

Ans:-

Sketch :- **02M**



Radiation pattern:- **01M**



Application:- (any two) :- **½ M each**

- It is used as HF transmitting antenna.
- It is used as VHF and UHF as TV receiver antenna because of its physical size.
- A stack of Yagi - Uda antenna can be used as a super gain antenna.

Q2) Attempt any four of the following : **16M**

a) Differentiate between AM and FM on the basic of :
i) Definition
ii) Bandwidth
iii) Modulation Index
iv) Application

Ans:- **Each parameter 01M each**

SR. NO	PARAMETER	AM	FM
1	Definition	Amplitude of the carrier signal is varied in accordance to the instantaneous value of the modulating signal keeping frequency and phase of carrier constant.	Frequency of the carrier signal is varied in accordance to the instantaneous value of the modulating signal keeping amplitude and phase of carrier constant.
2	Modulation Index	m = $\frac{V_m}{V_c}$	Mf = $\frac{\delta_m}{f_{m(\max)}}$
3	Bandwidth	BW = 2 fm	BW = 2 (δ+ fm (max))
4	Application **(any relevant point to be considered)**	Video transmission in TV receivers etc.	Sound transmission in TV receivers etc.

b) Explain the different types of losses in transmission line.

Ans:- **04M**

<u>Note:</u>- If only list of losses in transmission line is written then give one mark

Losses in Transmission Line:-

There are three ways in which energy, applied to a transmission may desperate before reaching the load. They are

1) Radiation Losses:-

- Its occurs when a transmission line may act as an antenna when the separation of the conductor is an appreciable fraction of a wave length .
- This loss increase with frequency for any given transmission line eventually ending that lines usefulness at some high frequency.
- This loss is more in parallel wire lines than to coaxial lines.

2) Conductor Or I^2 R loss:-

- This loss is proportional to the current and their fore inversely proportional to characteristics impedance
- It also increases with frequency, this time because of the skin effect.

3) Dielectric loss:

- This loss is proportional to the voltage across the dielectric and hence inversely proportional to the characteristic impedance for any power transmitted.
- It again increases with frequency because a gradually worsening properties with increasing frequency for any given dielectric medium.

4) Corona Effect:-

- Corona is a luminance discharge that occurs between the two conductors of a transmission line when the difference of proportional between them exceeds the break down voltage of the dielectric insulator.
- Generally when corona occurs, the transmission line is destroyed.

c) Compare ground wave and space wave propagation on the basis of
i) Frequency range
ii) Methods of wave propagation

Ans:- **02M each**

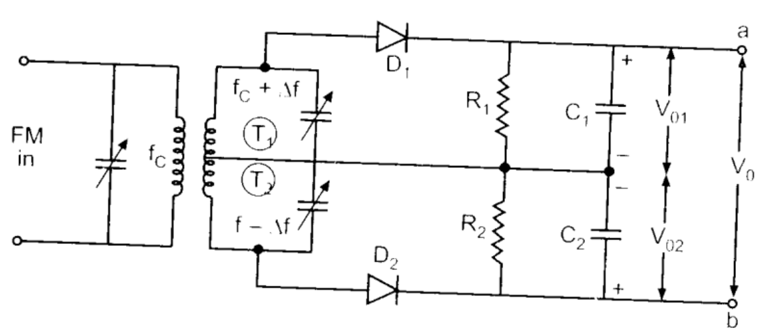
***Note:* polarize point not written also should be considered**

Sr. No	Parameters	Ground Wave Propagation	Space Wave Propagation
1	Frequency Range	30 kHz to 3 MHz	Above 30 MHz
2	method of wave propagation	Surface Wave Propagation which waves vertically polarized	Line of Sight Propagation with waves horizontally polarized

d) Draw the circuit of balance slope detector and describe its working.

Ans:-

Circuit diagram:- **02M**



Working Principle: **02M**

- The difficulties arising in simple slope detector circuit are overcome balanced slope detector.
- The circuit uses two slope detectors, connected back to back to the opposite ends of center tapped transformer and hence fed 180o out of phase.
- The circuit is divided in to three tuned circuits.

- Primary side tuned circuit is tuned to center frequency fc.
- Secondary side top of tuned circuit in tuned above If i.e. (fc +Δf) and bottom of tuned circuit is below IF i.e. (fc-Δf).
- Each tuned circuit is connected to diode detector and RC load.
- R_1C_1 and R_2C_2 are filtered to remove RF ripple.
- Final output voltage V_0 is

$$V_0 = V_{01} - V_{02}$$

e) A 800 watts carrier is amplitude modulated to a depth of 80%. Calculate.

i) TOTAL power in modulated wave

ii) Power in sidebands

Ans:-

***NOTE: -** Mark should be given even if only formula is written*

Sol^n:- $P_c = 800$ watts.

$m = 0.8$

(2M) Power in side bands.

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

$$= \frac{(0.8)^2}{4} \times 800 = 128 \text{ watts.}$$

Total sideband power

$$P_{USB} + P_{LSB} = 128 + 128 = 256 \text{ watts}$$

Total power in AM wave

$$P_t = P_c + P_{LSB} + P_{USB}$$

$$= 800 + 256$$

(2M) $= 1056$ watts.

f) Explain the following terms related to antenna:

i) Beam width

ii) Directivity

Ans:-

Beam width:- **02M**

- The beam width of an antenna is described as the angles created by comparing the half power point (3dB) on the main radiation lobe to its maximum power point.
- As an example the beam width angle is 30^0 which is the sum of the two angles created at the point where the field strength drops to 0.707 of max voltage at center of lobe (these point are known as half power points.)

Directivity:- **02M**

- The directive gain can be defined in any direction. However directivity means the maximum directive gain which is obtained in only one direction in which the radiation is maximum.

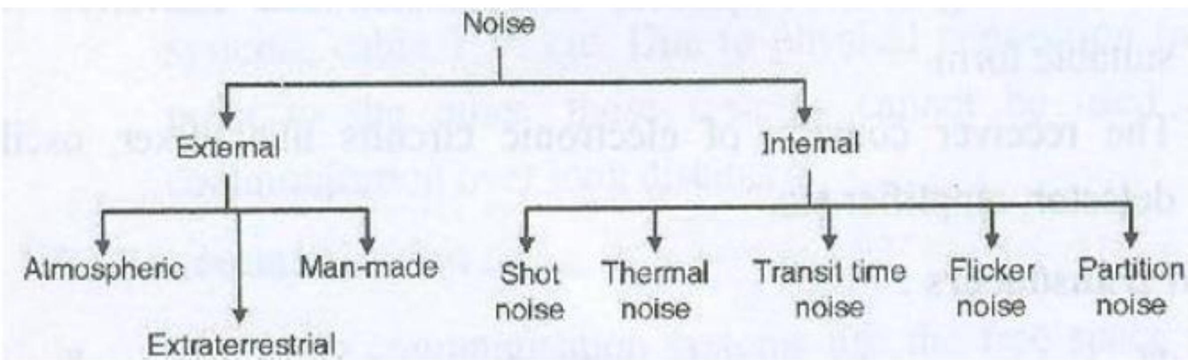
Therefore **Directivity = Maximum Directive gain**

Q.3 Attempt any FOUR of the following: 16M

a) State and explain the types of noise in communication system.

Ans:

(Any 4 types list 2 M, any 1 type explanation 2 M)



Explanation of External Noise:-

Atmospheric Noise

Atmospheric noise or static is caused by lighting discharges in thunderstorms and other natural electrical disturbances occurring in the atmosphere. These electrical impulses are random in nature. Hence the energy is spread over the complete frequency spectrum used for radio communication.

Extraterrestrial Noise

There are numerous types of extraterrestrial noise or space noises depending on their sources. However, these may be put into following two subgroups.

1. Solar noise
2. Cosmic noise

Solar Noise

This is the electrical noise emanating from the sun. Under quite conditions, there is a steady radiation of noise from the sun. This results because sun is a large body at a very high temperature (exceeding 6000°C on the surface), and radiates electrical energy in the form of noise over a very wide frequency spectrum including the spectrum used for radio communication. The intensity produced by the sun varies with time. In fact, the sun has a repeating 11-Year noise cycle. During the peak of the cycle, the sun produces some amount of noise that causes tremendous radio signal interference, making many frequencies unusable for communications. During other years, the noise is at a minimum level.

Cosmic noise

Distant stars are also suns and have high temperatures. These stars, therefore, radiate noise in the same way as our sun. The noise received from these distant stars is thermal noise (or black body noise) and is distributing almost uniformly over the entire sky. We also receive noise from the center of our own galaxy (The Milky Way) from other distant galaxies and from other virtual point sources such as quasars and pulsars.

Man-Made Noise (Industrial Noise)

By man-made noise or industrial- noise is meant the electrical noise produced by such sources as automobiles and aircraft ignition, electrical motors and switch gears, leakage from high voltage lines, fluorescent lights, and numerous other heavy electrical machines. Such noises are produced by the arc discharge taking place during operation of these machines. Such man-made noise is most intensive in industrial and densely populated areas. Man-made noise in such areas far exceeds all other sources of noise in the frequency range extending from about 1 MHz to 600 MHz

Explanation of Internal Noise

Thermal Noise

Conductors contain a large number of 'free" electrons and "ions" strongly bound by molecular forces. The ions vibrate randomly about their normal (average) positions, however, this vibration being a function of the temperature. Continuous collisions between the electrons and the vibrating ions take place. Thus there is a continuous transfer of energy between the ions and electrons. This is the source of resistance in a conductor. The movement of free electrons constitutes a current which is purely random in nature and over a long time averages zero. There is a random motion of the electrons which give rise to noise voltage called thermal noise.

Thus noise generated in any resistance due to random motion of electrons i5 called thermal noise or white or Johnson noise.

Shot Noise

The most common type of noise is referred to as shot noise which is produced by the random arrival of 'electrons or holes at the output element, at the plate in a tube, or at the collector or drain in a transistor. Shot noise is also produced by the random movement of electrons or holes across a PN junction. Even through current flow is established by external bias voltages, there will still be some random movement of electrons or holes due to discontinuities in the device. An example of such a discontinuity is the contact between the copper lead and the semiconductor materials. The interface between the two creates a discontinuity that causes random movement of the current carriers.

Transit Time Noise

Another kind of noise that occurs in transistors is called transit time noise.

Transit time is the duration of time that it takes for a current carrier such as a hole or current to move from the input to the output.

The devices themselves are very tiny, so the distances involved are minimal. Yet the time it takes for the current carriers to move even a short distance is finite. At low frequencies this time is negligible. But when the frequency of operation is high and the signal being processed is the magnitude as the transit time, then problem can occur. The transit time shows up as a kind of random noise within the device, and this is directly proportional to the frequency of operation.

Flicker Noise

Flicker noise or modulation noise is the one appearing in transistors operating at low audio frequencies. Flicker noise is proportional to the emitter current and junction temperature. However, this noise is inversely proportional to the frequency. Hence it may be neglected at frequencies above about 500 Hz and it, Therefore, possess no serious problem.

Transistor Thermal Noise

Within the transistor, thermal noise is caused by the emitter, base and collector internal resistances. Out of these three regions, the base region contributes maximum thermal noise.

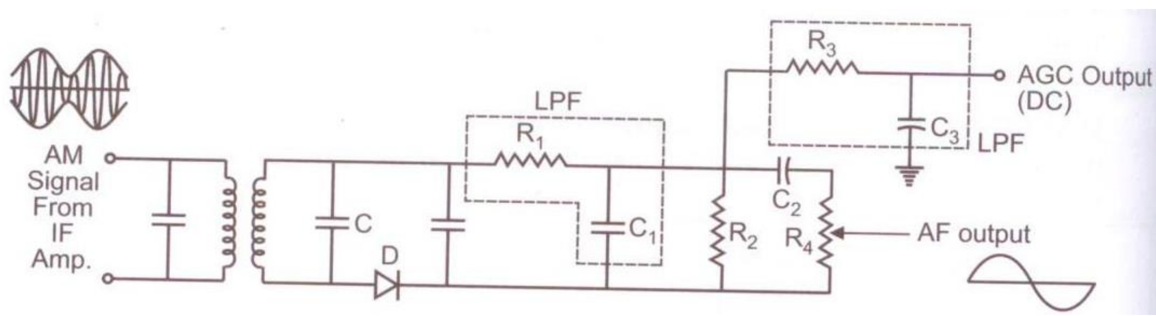
Partition Noise

Partition noise occurs whenever current has to divide between two or more paths, and results from the random fluctuations in the division. It would be expected, therefore, that a diode would be less noisy than a transistor (all other factors being equal) If the third electrode draws current (i.e.., the base current). It is for this reason that the inputs of microwave receivers are often taken directly to diode mixers.

b) Draw the circuit diagram of practical diode detector and explain its working.

Ans: **(Diagram 2 M, Explanation 2M)**

Diagram:-



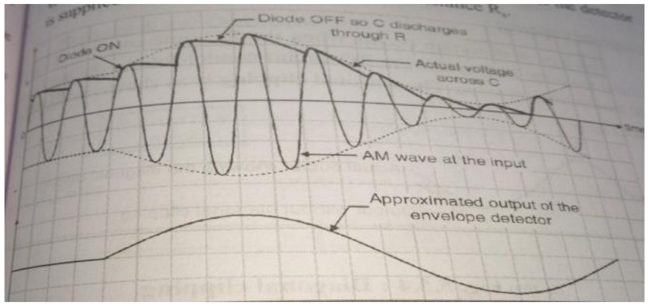
Explanation-

The circuit operates in the following manner-

- The diode has been reversed so that now the negative envelope is demodulated. Due to this negative envelope AGC voltage will be developed.R1 and R2 ensures that there is a series DC path to ground for diode.

- R1 and C1 is the low pass used to remove RF ripple that is present in the detector o/p.C2 is coupling capacitor that prevents the diode DC o/p from reaching the volume control R4.
- R3 and C3 is a low pass filter which removes AF components and helps to produce AGC voltage.
- The DC AGC voltage is proportional to the amplitude of AM signal.

Waveform:- **(optional)**



c) Draw the diagram of radiation pattern of the following resonant dipoles:

(i) l = λ/2

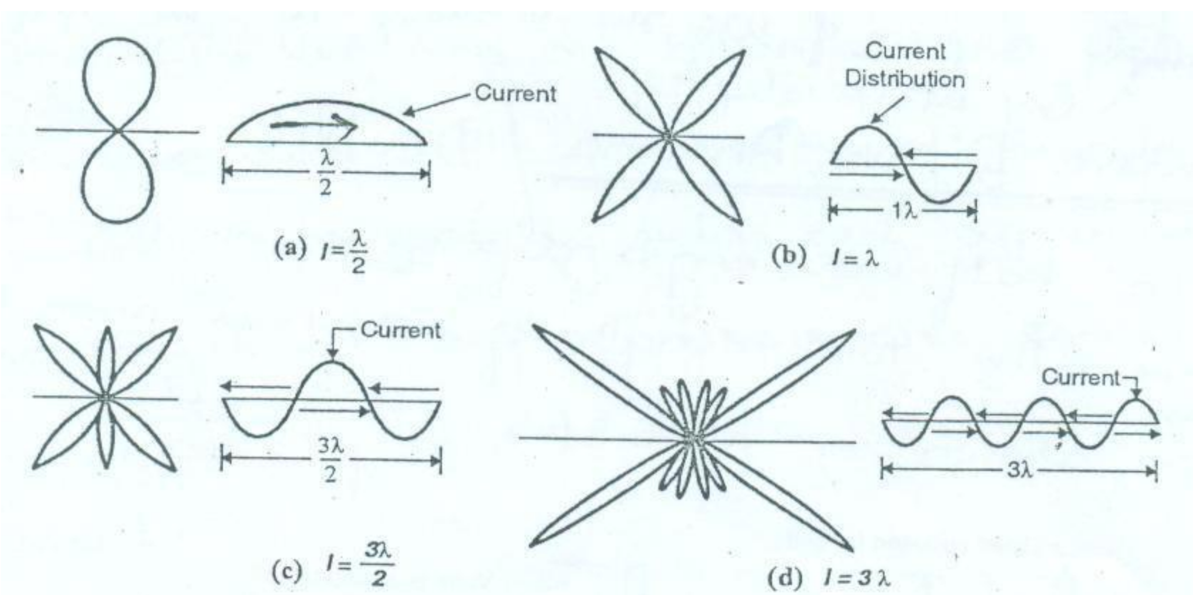
(ii) l = λ

(iii) l =3 λ/2

(iv) l = 3λ

Ans: **(Each correct pattern – 1 M)**

where *l* = length of dipole



d) Describe with neat diagram and waveform the generation of PPM using IC555.

Ans:-

(Diagram 02M, waveform 01M, Explanation 01 M)

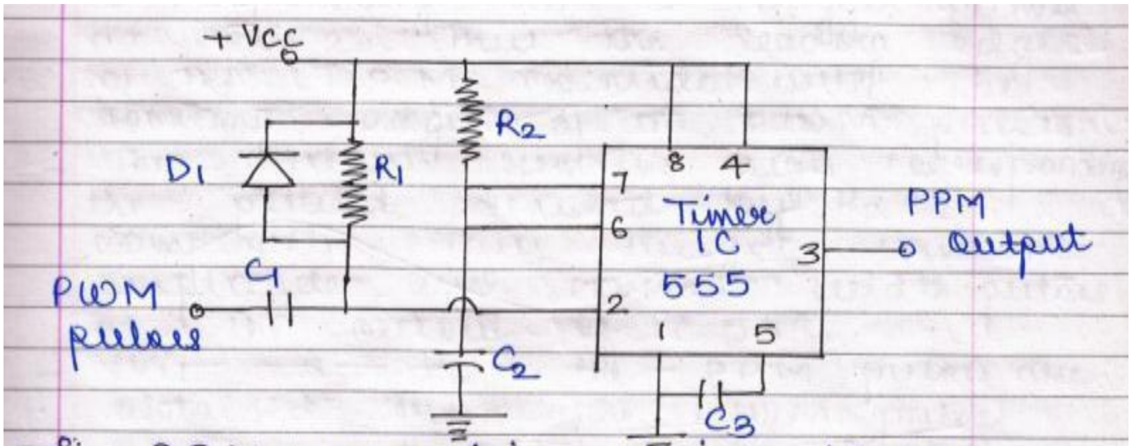


Fig: PPM generation using IC 555

Explanation-

- The PWM pulses are applied to the trigger input pin 2 of the Monostable IC through a differentiating network consisting of D1, R1 and C1
- The output of IC 555 goes high corresponding to the trigger pulses at pin 2 thus leading edges of the PPM coincide with the trailing edges of the PWM pulses.
- The output remains high corresponding the period decided by R2, C2 components.
- Thus we get constant amplitude and constant width pulses at the output of IC 555. This is how the PPM pulses are obtained from the PWM pulses.

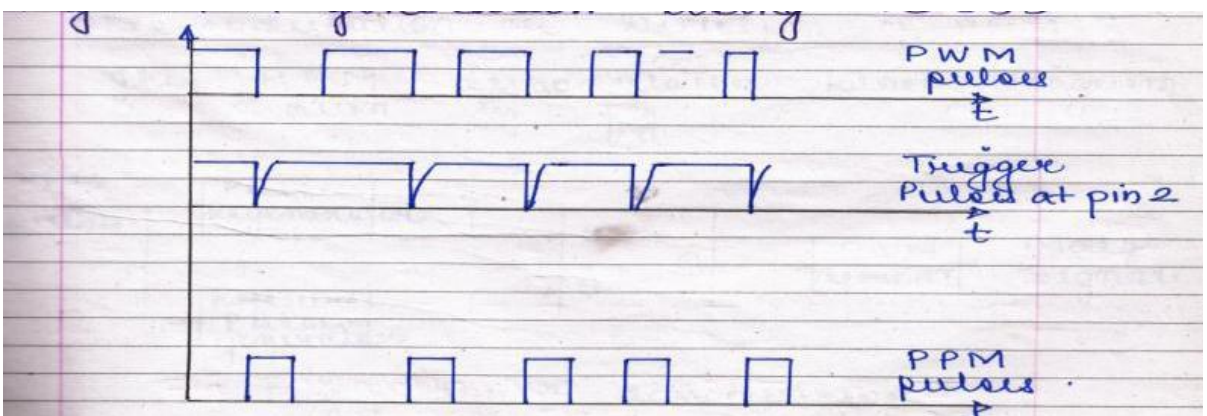


Fig Waveforms for generation of PPM

e) Explain ionosphere layer and the ionospheric propagation.

Ans: (Diagram 1 ½ M, Explanation ionosphere layer 1 ½ M, ionosphere propogation explanation 01M)

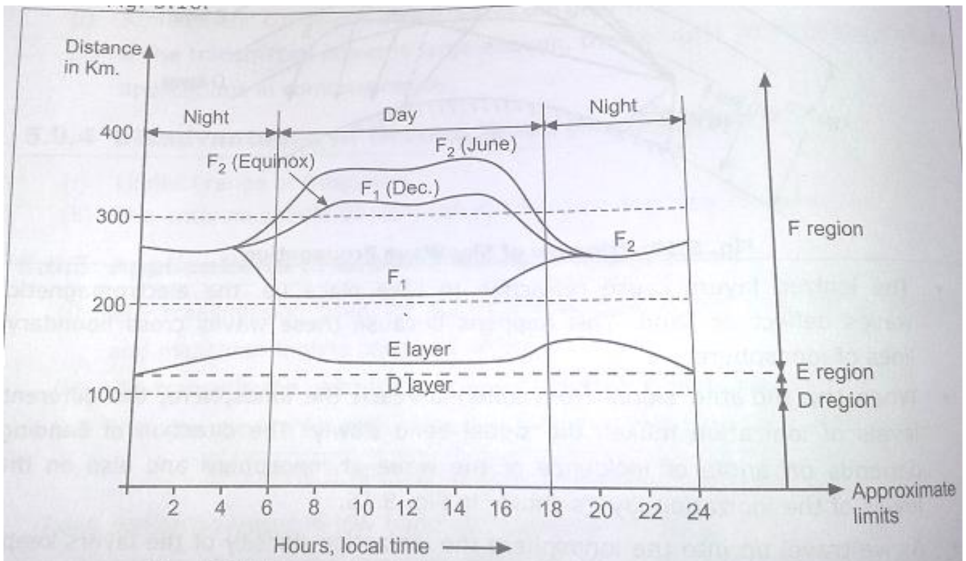


Fig. 5.16: Ionospheric Layers and Their Regular Variations

The Ionosphere is the upper portion of the atmosphere. The ultra violet radiation from the sun will ionize the upper layer of the atmosphere. Due to ionization these part of the atmosphere becom3es electrically charged. In this layer free electrons and positive and negative ions are present and hence this layer of ions is known as ionosphere.

There are four layers: D, E, F1 and F2.

1. D Layer: It is lowest layer at an height of 70 kms with thickness 10 km. The ionization density is maximum at noon and disappears at night.
2. E Layer: It is the next layer at an height of 100 kms with thickness 25 km. The layer disappears at night due to recombination of ions and molecules.
3. F1Layer: It is the next layer at an height of 180 kms with thickness 20 km. It provides more absorption for HF waves.
4. F2Layer: It is the next layer at an height of 250-400 kms with thickness 200 km. It is having highest electron density of all layers, due to this F2 layer remains present at night time.

Ionosphere Propagation:

In this propagation, the transmitted signal transmits into the upper atmosphere where it is bent i.e reflected back to earth. This bending of the signal takes place due to the presence of the ionosphere layer.

Its Frequency Range is from 3 MHz to 30 MHz
Polarization: Vertical

Applications: (optional)

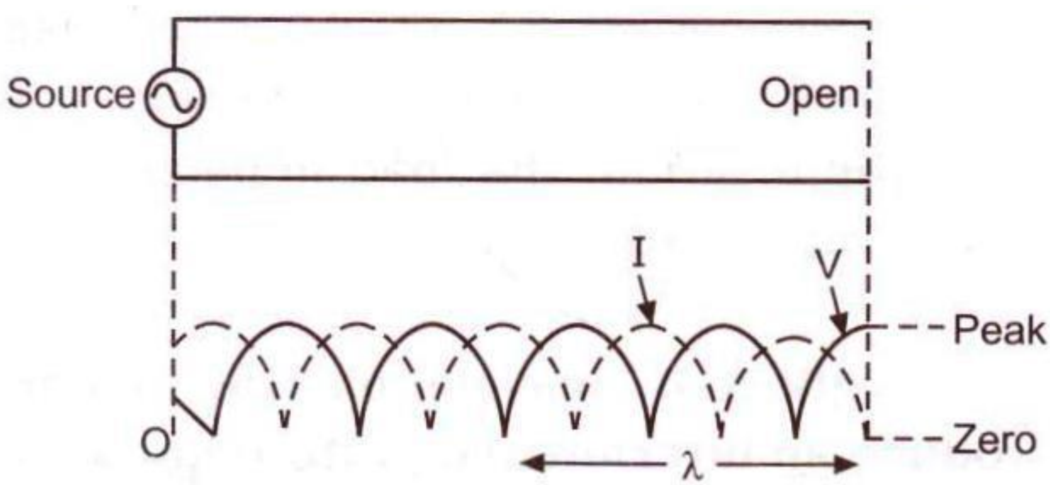
- Radio Broadcasting (SW Range)
- Range of Communication: More (OR) Few Thousand Km
- Limitations: Skip Distance, Power loss due to absorption of energy in layers.
- Fading Problem is Severe

f) What is the value of SWR for open circuited transmission line? Describe the effect on transmitted wave in this case.

Ans: **(Value- ½ M, Diagram 2M, Explanation 1 ½ M)**

The value of SWR for open circuited transmission line is ∞

Open Circuit:



- It means infinite impedance, so that voltage at the end of the line is maximum and the current is zero.
- All the energy is reflected, thereby setting up this stationary pattern of voltage and current standing waves.
- Practically, transmission line won't have a short or open.
- Instead, the load impedance will not be equal to the transmission line (characteristics) impedance.

Q.4 Attempt any 4 of the following: (16 M)

a) What is stub? What do you mean by single stub matching and double stub matching?

Ans:

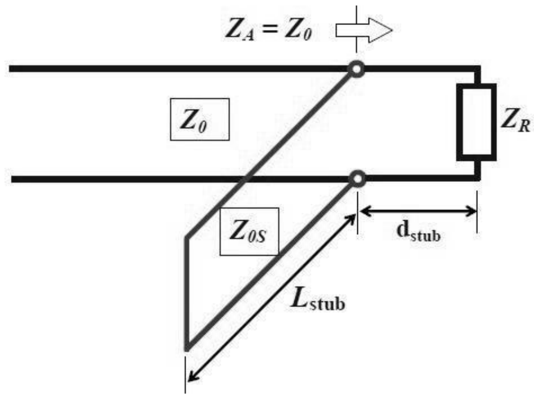
(Definition 1 M, Single stub matching 1M diagram, ½ M explanation, Double stub matching 1M diagram, ½ M explanation)

Stub:-

Stub is the piece of short circuited transmission line which is used to tune out the reactance of the load when connected across the transmission line as close as possible.

Single stub:

Stub is the piece of short circuited TL which is used to tune out the reactance of the load when connected across the TL as close as possible.



1. The most important feature of single stub matching is that the stub should be located as near to the load as possible.

2. The characteristic admittance of the stub so connected in shunt should be same as that of the main line.

3. The main element of this transmission line is a short circuited section of line whose open end is connected to the main line at a particular distance from the load end.

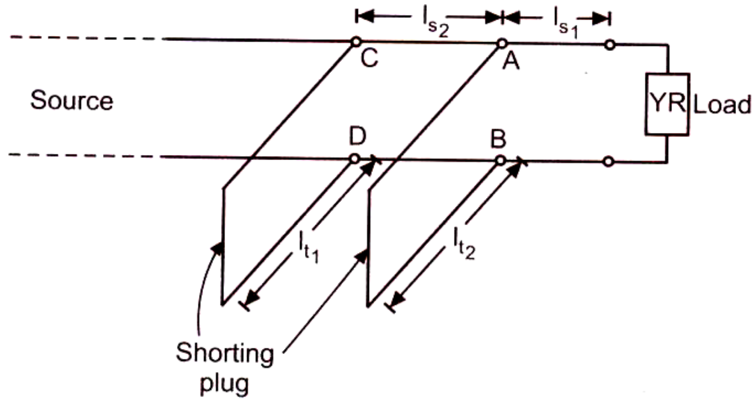
4. Where the input conductance at that point is equal to the characteristic conductance of the line, and the stub length is adjusted to provide a susceptance equal in value but opposite in sign, to the input susceptance of the main line at that point.

5. So the total susceptance of the main line at that point is zero.

6. The combination of stub and the line will thus present a conductance which is equal to the characteristic impedance of the line, i.e. the main length of the HF transmission line will be matched.

Double stub:

- The disadvantages of single stub matching are overcome by using double stub matching as shown in fig.



Here, two short circuited stubs at two fixed point usually $\lambda/4$ apart are utilized.

- Their positions are fixed but lengths are independently adjustable.
- The double stub matching provides wide range of impedance matching.

b) Define selectivity and sensitivity of radio receiver.

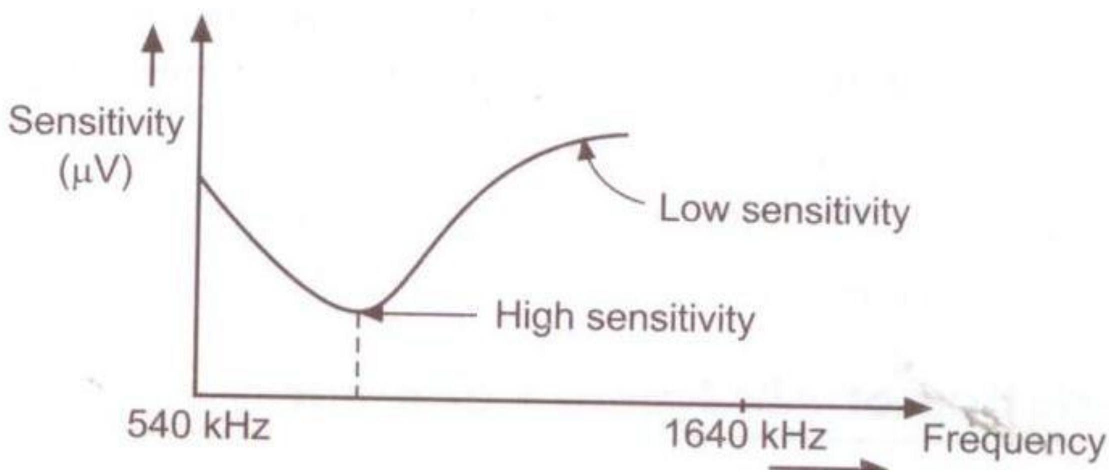
Ans:-

Sensitivity: **01M**

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.

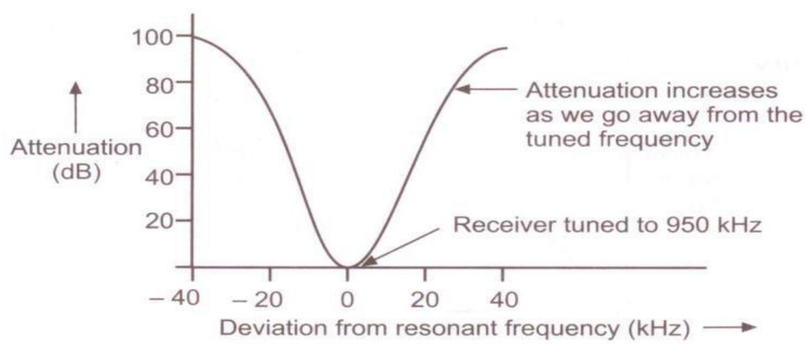
Graph: **01M**



Selectivity: **1M**

The ability of radio receiver to reject the unwanted signals is called selectivity. It shows that the receiver offers a minimum rejection at 950 kHz but the rejection increases as the input signal frequency deviates on both sides of 950 kHz. The selectivity decides the adjacent channel rejection of a receiver.

Graph- **01M**



c) Explain the concept of pre-emphasis with neat circuit diagram.

Ans :

(Definition 1 M, Need 1 M, Circuit Diagram 2 M)

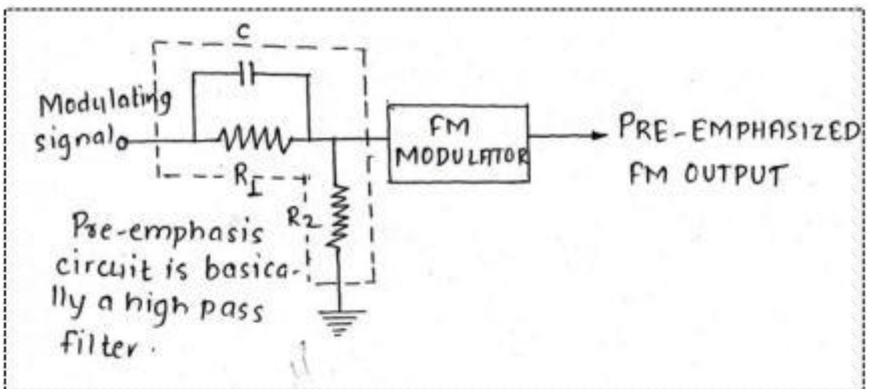
Definition-

The artificial boosting of higher modulating frequencies to reduce the effect of noise is called as pre-emphasis.

Need:-

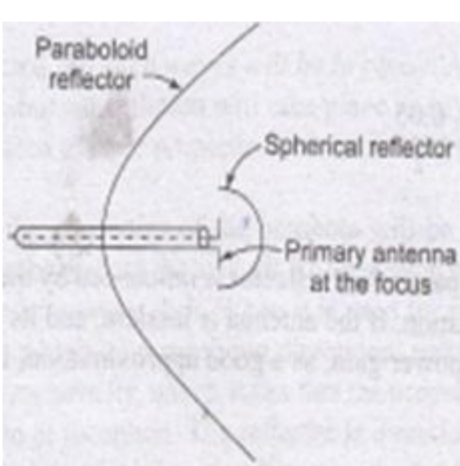
- The artificial boosting of higher audio modulating frequencies in accordance with prearranged response curve is called pre-emphasis.
- In FM, the noise has a greater effect on the higher modulating frequencies. This effect can be reduced by increasing the value of modulation index (mf).
- This can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

Circuit diagram

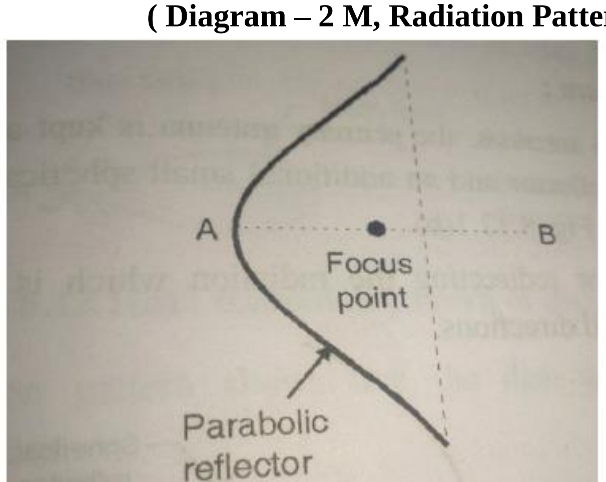


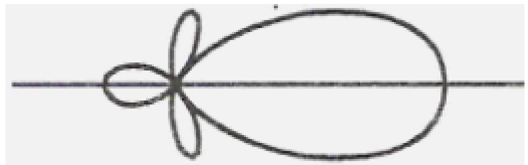
d) Draw the structure and radiation pattern of parabolic dish antenna.

Ans:- **(Diagram – 2 M, Radiation Pattern-2 M)**



(OR)





e) For a transmission line, if R is the reflection coefficient. What will be its value?

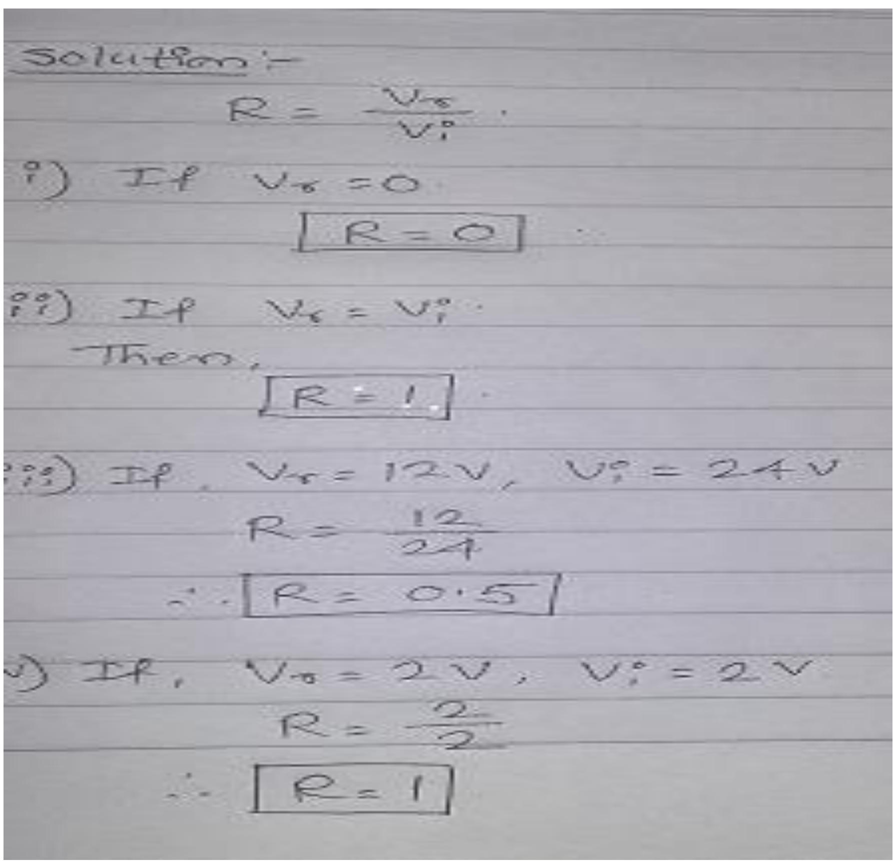
i) If there is no reflected voltage.

ii) If reflected and incident voltages are same.

iii) If reflected voltage = 12 V and incident voltages = 24 V.

iv) If reflected voltage = 2 V and incident voltage = 2 V.

Ans: **(1M for each point)**



Solution :-

$R = \frac{V_r}{V_i}$.

i) If $V_r = 0$

$R = 0$.

ii) If $V_r = V_i$.

Then,

$R = 1$.

iii) If, $V_r = 12V$, $V_i = 24V$

$R = \frac{12}{24}$

$\therefore R = 0.5$

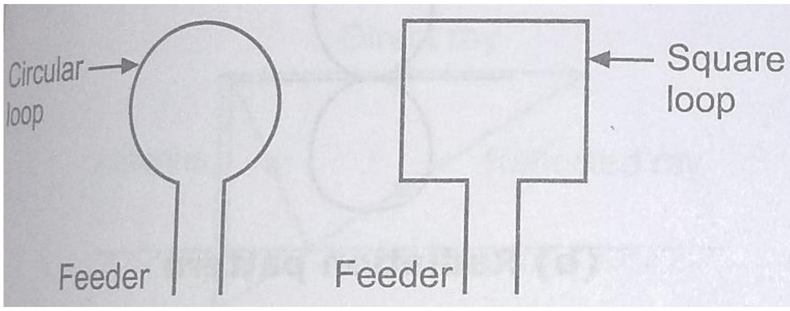
iv) If, $V_r = 2V$, $V_i = 2V$

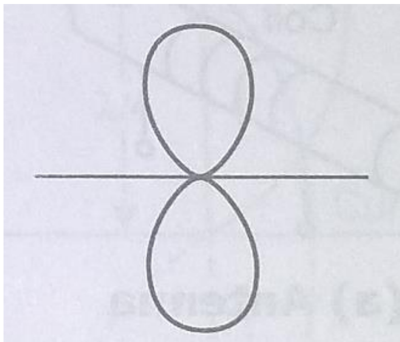
$R = \frac{2}{2}$

$\therefore R = 1$

f) Draw a neat sketch of loop antenna with its radiation pattern. Explain how they are used for direction feeding.

Ans: **(Sketch 1 M , Radiation pattern 1M, Explanation 2 M)**





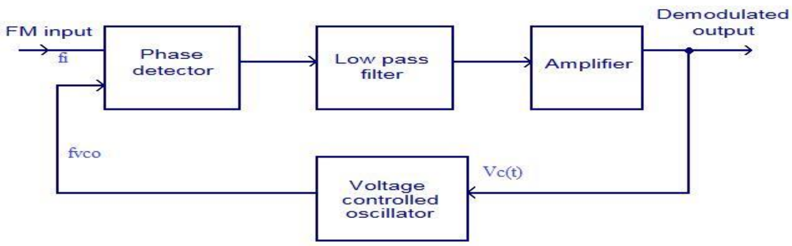
- The circular and square loop antennas have the same radiation pattern as above.
- No radiation is received that is normal to the plane of the loop, because the radiation pattern is a doughnut pattern.
- Thus it makes the loop antenna suitable for direction finding applications.
- A simple direction finder consists of a small loop, a vertical and rotatable about a vertical axis that may be mounted on the top of a portable receiver, whose output is connected to the meter.

Q 5 Attempt any four of the following: - **(16 M)**

a) Draw and explain PLL as FM demodulator.

Ans:- **(Diagram 2 M ,Explanation 2 M)**

Diagram:-



PLL FM demodulator circuit

Explanation:-

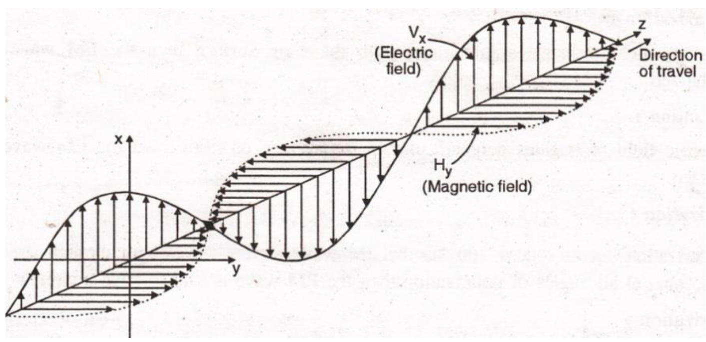
- FM signal which is to be demodulated is applied to input of PLL.VCO output must be identical to input signal if PLL is to remain locked.
- As PLL is locked, VCO starts tracking the instantaneous frequency in the FM input signal
- The error voltage produced at the output of the amplifier is proportional to the deviation of the input frequency from the center frequency FM.
- Thus AC component of the error voltage represents the modulating signal. Thus at the error amplifier output we get demodulated FM output.

b) Describe electromagnetic polarization? Explain types of polarization.

Ans: - **(Describe electromagnetic polarization with diagram 02M, Explain types of polarization 02M)**

<u>NOTE:-</u> 1 mark should be given if list of types is written by students

Transverse electromagnetic wave:-



- The polarization of a plane EM wave is simply the orientation of the electric field vector with respect to the surface (i.e. looking at the horizon)
- If the polarization remains constant then it is called as the linear polarization . The linear polarization can be of two types :
  1) Horizontal polarization
  2) Vertical polarization

Horizontal Polarization:- If the electric field propagates in parallel with the earth surface then EM wave is said to be horizontally polarized

Vertical polarization:- If the electric field propagates in perpendicular to the surface of the earth then EM wave is said to be vertically polarized

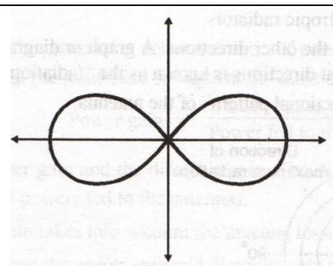
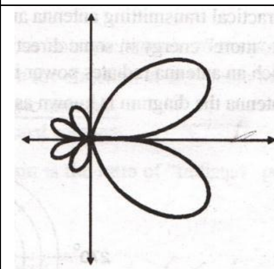
Circular polarization:- If the polarization vector rotates 360^0 as the Em wave travels wavelength through the space and the filed strength is equal at all angles of polarization then the EM wave is said to have a circular polarization.

Elliptical polarization:- In the circular polarization if the field strength varies with change in polarization the wave is said to have an elliptical polarization

c) Compare resonant and non-resonant antenna on the basic of

1. **Definition**
2. **reflection coefficient**
3. **radiation pattern**
4. **application**

Ans:- **(Each point 1M)**

Parameter	**Resonant antenna**	**Non resonant antenna**
i) Definition	It is transmission Line of length equal to multiples of λ2 and open at both and.	It is transmission line whose length is not a multiple of λ2
ii) Reflection Pattern	Standing wave present	Standing wave not present
iii) Radiation Pattern		
iv) Applications	i) Portable receiver ii) Direction finding equipment	i) TV broadcasting ii) wave propagation

d) State the need of AGC? Explain its type.

Ans:- **(Need of AGC 2M and types of AGC 2M) ,**

***Note:-* 01m should be given even if list of AGC types is written**

Need of AGC:-

- The need or purpose of AGC circuit is to maintain the output voltage level (volume) of radio receiver constant over a wide range of RF input signal level.
- AGC also helps to smooth out the rapid fading which may occur with long distance short wave reception & prevents overloading of the last IF amplifier which might otherwise have occurred

Types of AGC:-
1) Simple AGC
2) Delayed AGC

Graphical representation of AGC:- (optional)

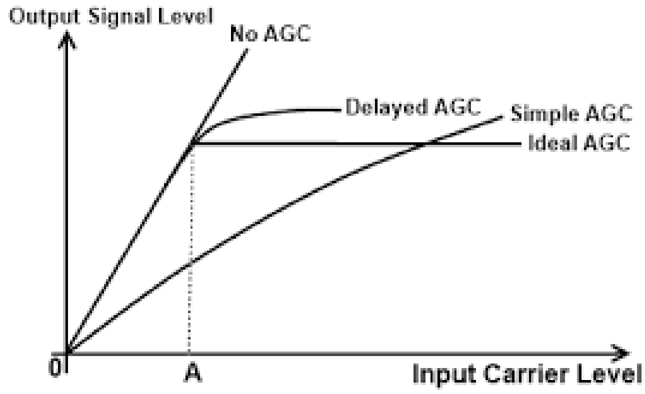


Figure (c): AGC Characteristics for Various Techniques

1) **Simple AGC:-**

- Simple AGC is a system by means of which overall gain of a radio receiver is varied , automatically with the changing strength of the receiver signal to keep the output substantially constant.
- Hence the receiver gain is automatically reduced as the input signal becomes more & more strong.

2) **Delayed AGC:-**

- As soon in the diagram AGC biased is not applied until the input signal strength reaches the predetermined level of point B
- After this level, the point B AGC bias is applied just like simple AGC but more strongly
- The problem of reducing the receiver gain for weak signal is avoided . the delayed AGC is not used in low cost radio receiver.
- It is used in high quality receiver like communication receiver.

e) Explain quarter wave and half wavelength line

Ans:- (**Quarter wave 2 M and Half wave length 2 M)**

Quarter wavelength line:-

- Its physical length equal to λ/4 meters at the operating frequency.
- It reflects the opposite of its load impedance
- If a λ/4 wavelength line is connected to impedance, then the normalized input
- impedance of this line is equal to the normalized load admittance
- It is used for impedance matching

Half wavelength

- Its physical length equal to λ/2 meters at the operating frequency
- The λ/2 line reflects its load impedance directly
- It also works as an impedance matching
- It is also possible to find the velocity factor and dielectric constant of the insulation.

f) The equation of an angle modulated voltage is e = 10sin (10^8t + 3 sin10^4t).what form of angle modulation is this? Calculate the carrier and modulating frequencies, the modulation index, deviation and power dissipated in 100Ω resistor.

Ans:- **(Carrier Freq 1M ,Modulating Freq 1M, Maximum deviation 1M, power dissipation 1M)**

NOTE:-* *Mark should be given even if only formula is written

This is FM or PM. The standard expression of FM wave is

$e_{FM} = A\sin[(2\pi f_c t) + m_f \sin(2\pi f_m t)]$

compare this expression with given expression

$=10\sin(10^8 t + 3\sin 10^4 t)$

Carrier frequency f_c

$2\pi f_c = 10^8$

$f_c = 10^8 / 2\pi$

f_c = 15.912MHz OR 15923.566 KHz

Modulating frequency FM

$2\pi f_m = 10^4$

$f_m = 10^4 / 2\pi$

f_m = 1592.35Hz

Modulation Index, deviation

$m_f = 3$

$\delta = m_f * f_m$

= 3*1592.35

δ=4774.05 Hz OR 4.774 KHz

Power dissipation in 100Ω resistance

$$P_t = \frac{A_c^2}{2R}\left[1 + \frac{m_f^2}{2}\right]$$

$$= \frac{10^2}{2 \times 100}\left[1 + \frac{3^2}{2}\right]$$

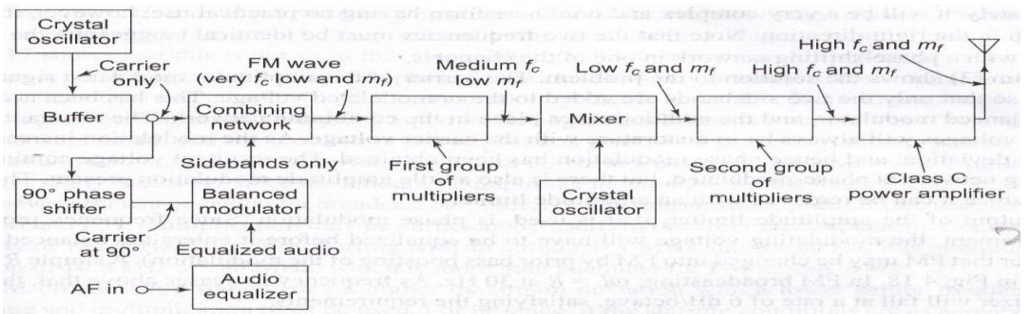
$$= 2.75$$

P_t=2.75 Watts

Q.6 Attempt any two of the following: - (16M)

a) Draw the neat block diagram of Armstrong method of FM generation and explain its working in detail.

Ans:- **(Diagram 4 M and working 4 M)**



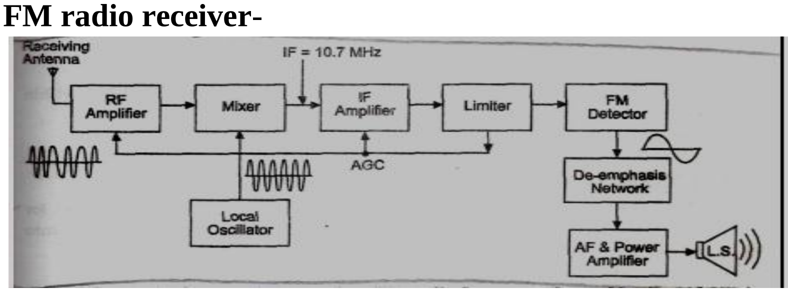
Explanation:

- The crystal oscillator generates the carrier at low frequency typically at 1 MHz This is applied to the combining network and a 90o phase shifter.
- The modulating signal is passed through an audio equalizer to boos the low modulating frequencies for the reason discussed earlier. The modulating signal is than applied to a balanced modulator.
- The balanced modulator produces two sidebands such that their resultant is 90o phase shifted with respect to the un-modulated carrier
- The un-modulated carrier and 90o shifted sidebands are added in the combining network.
- As discussed earlier, at the output of the combining network we get FM wave. This FM wave has a low carrier frequency fc and low value of the modulation index mf.
- The carrier frequency and the modulation index are then raised by passing the FM wave through the first group of multipliers. The carrier frequency is then raised by using a mixer and then fc and mf both are raised to the required high values using the second group of multipliers. The effect of multiplication and mixing is as discussed earlier.
- The FM signal with high fc and high mf is then passed through a class C power amplifier to raise the power level of the FM signal.

b) Draw the superhetrodyne type of FM radio receiver. How it differs from superhetrodyne type AM receiver. State two function of each block.

Ans:- (Draw superhetrodyne FM receiver 3 M, difference 2M, function of each block 3 M)

Superhetrodyne FM radio receiver-



How superhetrodyne receiver differs from FM and AM radio receiver are as follows:-

1) Operating frequency in FM are much higher than in AM
2) FM receiver needs the circuits like limiter and de emphasis
3) The FM demodulators are different from AM receiver
4) The method to obtain AGC is different in FM receiver

Explanation of each block:-

RF amplifier:
There are two important functions of RF amplifier:

1) To increase the strength of weak RF signal.

2) To reject image frequency signal. In FM broadcast the channel bandwidth is large as compared to AM broadcast. Hence the RF amplifier must be design to handle large bandwidth.

Frequency Mixer:

The function of frequency mixer is to heterodyne signal frequency fs and local oscillator frequency fo. At the output, it produces the difference frequency known as intermediate frequency fi. The intermediate frequency used in FM receiver is higher than that in AM receiver. Its value is 12MHz (practical value of IF is 10.7MHz).

Local oscillator:
Since FM broadcast operates in VHF and UHF band, a separate local oscillator is used in FM receiver The local oscillator frequency fo is kept smaller than the signal frequency fs by an amount equal to the intermediate frequency fi (fi = fs-fo).

IF amplifier:
Two or more stages of IF amplifier are used to provide large gain to the receiver. This increases the sensitivity of a receiver. If amplifier should be designed to handle large bandwidth.

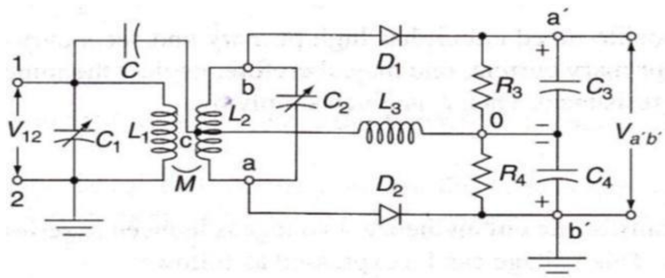
Amplitude limiter:
The function of amplitude limiter is to remove all amplitude variation of FM carrier voltage that may occur due to atmospheric disturbances. Use of amplitude limiter makes the system less noisy.

FM Discriminator or detector:
It separates modulating signal from frequency modulated carrier signal. Thus it produces audio signal at its output.

Audio frequency voltage and power amplifier:
Audio amplifier increases voltage and power level of audio signal to a suitable level.in FM broadcast, the maximum modulating frequency is 15 kHz. Hence the audio amplifier must have large bandwidth.

C) i) With the help of neat diagram explain the working of Phase discriminator.

Ans **:** **(Diagram 2 M, Working 2 M)**



Explanation-

- This discriminator is also known as the center tuned discriminator or the Foster Seeley discriminator after its inventors. It is possible to obtain the same S- Shape response curve from a circuit in which the primary & the secondary winding are both tuned to the center frequency of the incoming signal. This is desirable because it greatly simplifies alignment & also because the process yields far better linearity.
- Thus although the individual component voltage will be the same at the diode input at all frequencies, the vector sums will differ with the phase difference between primary & secondary windings. The result will be that the individual output voltage will be equal only at f.
- At all other frequencies the output of one diode will be greater than that of the other. Which diode has the larger output will depend entirely on whether fm is above or below fc. As for the output arrangements, it will be positive or negative according to the input frequency. As required the magnitude of the output will depend on the deviation of the input frequency from fc.

ii) In FM, If maximum deviation is 65 KHz and the maximum modulating frequency is10KHz. Calculate the deviation ratio and bandwidth of FM

Ans: **(Deviation 2 M and bandwidth 2 M)**

Note :- mark should be given even if only formula is written

Given data :-

δmax = 65KHZ

fm (max) = 10KHZ

deviation ratio denoted by D

D = δmax/ fm (max)

= 65KHz/ 10KHz

D = 6.5

Bandwidth is denoted By B

B = 2{ δmax + fm (max)}

= 2 (65+10)

= 150KHz

Bandwidth = 150KHz.