
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 judgement 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.

Q.1 (A) Attempt any SIX 12 Marks

(a) Explain.

(i) Radiation (ii) Absorption

Ans.:

(1 Mark for Radiation, 1 Mark for Absorption Definition)

Radiation:

Radiation is a process in which electromagnetic waves (EMR) travel through a vacuum or through matter-containing media; the existence of a medium to propagate the waves is not required.

Absorption:

The reduction in power density due to non free space is called absorption.Since absorption of energy is dependent on the collision of the particles, the greater the particle density, the greater the probability of collision and greater the absorption.

(b) What is transverse electromagnetic wave?

Ans:

(Correct Definition- 2 Mark, Diagram is optional)

- The wave in which electric field, magnetic field and direction of propagation are mutually perpendicular to each other.
- Electromagnetic waves are energy propagated through free space at the velocity of light, which is approximately $3x10^8$ m/s.
- Electromagnetic waves comprises of electrical and magnetic components.

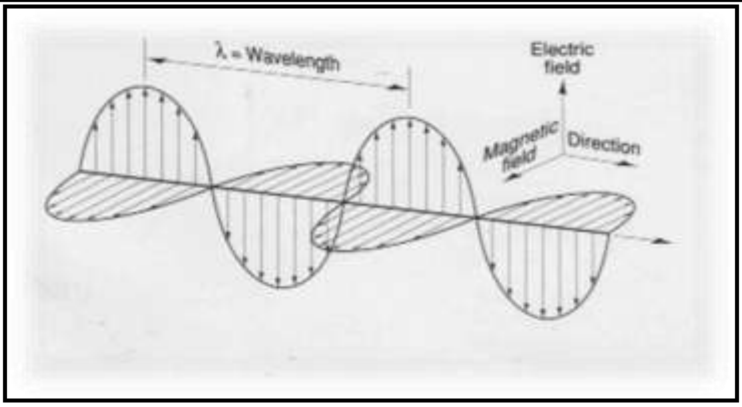


Fig. Transverse electromagnetic wave

(c) Define.
(i) Antenna Gain (ii) Antenna resistance
Ans:
(Each definition- 1 Mark)

- **Antenna Gain:**
  Antenna gain is defined as the ratio of the power density radiated in a particular direction to the power density radiated to the same point by the reference antenna.

  It is mathematically given by,

  $$Anteena\ Gain = \frac{P}{P_{ref}}$$

  Where
  P = power density at some point with the given antenna
  P_{ref} = power density at same point with the reference antenna

- **Antenna Resistance:**
  Radiation resistance is the AC antenna resistance and is equal to the ratio of the power radiated by the antenna to the square of the current at its feed point.

  It is given by,

  $$R_r = \frac{P_{rad}}{i^2}$$

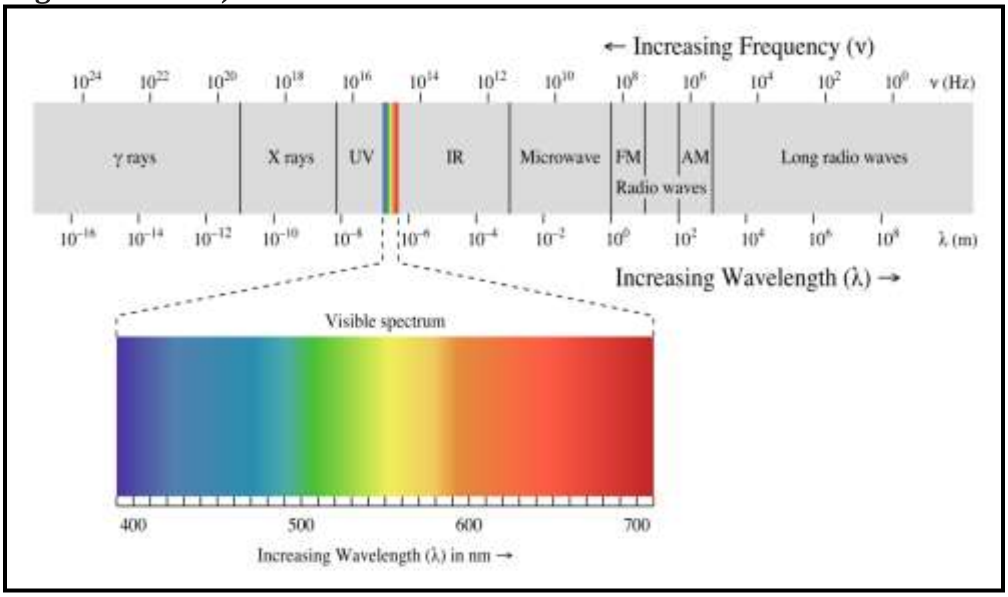
(d) Explain the function of Baluns.
Ans:
(Correct function-2 Mark)

- A balun is a type of transformer: it's used to convert an unbalanced signal to a balanced one or vice versa.
- Baluns isolate a transmission line and provide a balanced output. A typical use for a balun is in a television antenna. The term is derived by combining balanced and unbalanced.

(e) Draw the spectrum of electromagnetic wave

Ans:

(Correct diagram-2 Mark)



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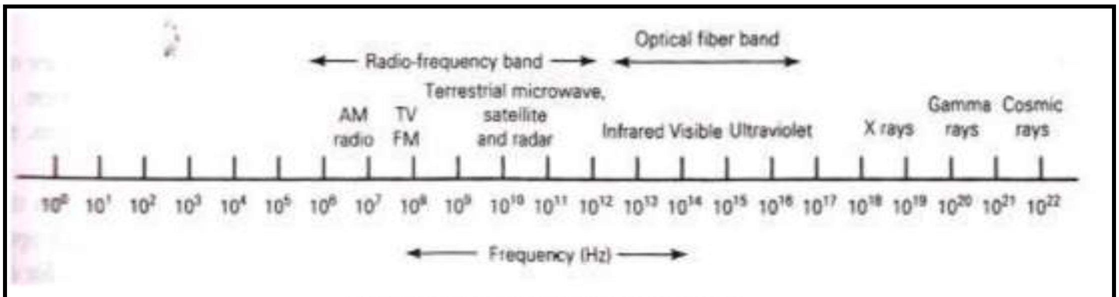


Fig. Electromagnetic spectrum.

(f) State the different FM demodulation method.

Ans:

(1/2 Mark for each method)

- Slope detector
- Balanced slope detector
- Foster-seeley discriminator
- Ratio detector

(g) Draw the circuit diagram of simple AGC circuit

Ans:

(Correct diagram-2 Mark)

Diagram:

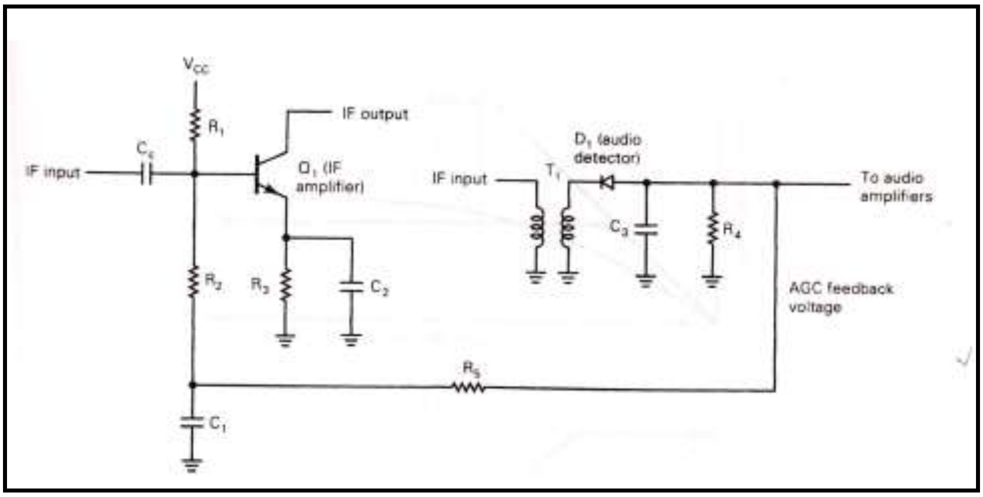


Fig. AGC circuit

(h) Define IF frequency and write IF frequency for FM and AM radio receiver
Ans:

(Definition- 1 Mark, IF of FM-1/2 Mark, IF of AM-1/2 Mark)

- In communications and electronic engineering, an intermediate frequency (IF) is a frequency to which a carrier frequency is shifted as an intermediate step in transmission or reception. The intermediate frequency is created by mixing the carrier signal with a local oscillator signal in a process called heterodyning, resulting in a signal at the difference or beat frequency.

  - IF of **AM= 455 KHz** (for M.W. band) **OR** IF of AM**=1.6 to 2.3 MHz (for S.W. band)**

  - IF of FM **10.7 MHz**

Q.1 (B) Attempt any TWO 8 Marks

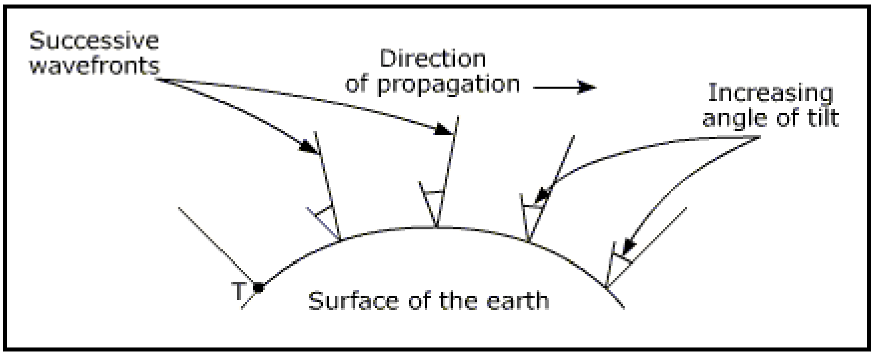
(a) Draw and explain ground wave propagation. State its advantages.

Ans:

(Diagram-1.5 Marks, Explanation-1.5 Marks, Any two advantages-1/2 Mark each)

- Ground waves propagates along the surface of the line, also it is vertically polarized to avoid short circuiting the electrical component.
- A wave induces current in the ground over which it passes and thus losses some energy by absorption.

Diagram:



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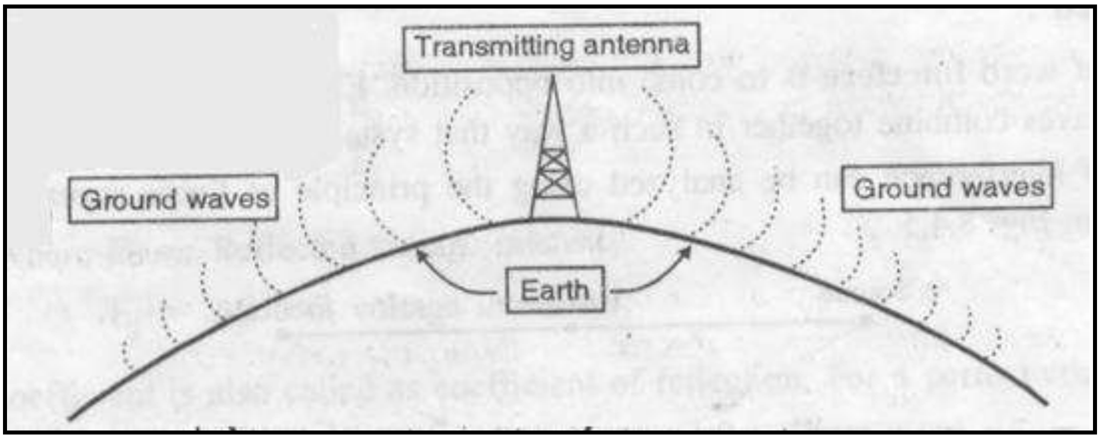


Fig.Ground wave propagation

Explanation:

- As the wave propagates over the surface of the earth, it tilts over more and more and the increasing tilt causes greater short circuiting of the electric field component of the wave and hence field strength decreases.
- It is important to realize this, since it shows that maximum range of such transmitter depends on its frequency as well in its power.
- Thus in VLF band, insufficient range of transmission can be cured by increasing the transmitting power.
- This will not work for MF range, since propagation is limited to tilt.
- Thus the angle of tilt is the main determining factor in the long distance propagation.

Advantages of Ground wave propagation:

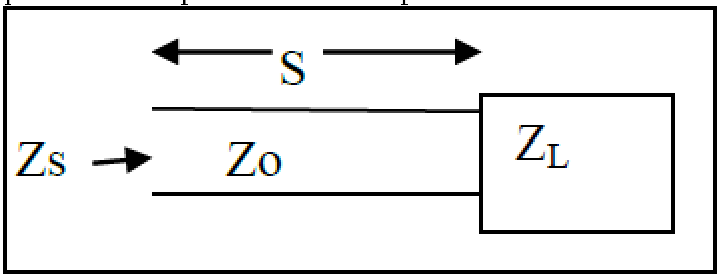
- Ground wave tends to follow the curvature of the Earth and enables coverage to be achieved beyond the horizon.
- Given enough power they can be used to communicate between any two points in the world
- They are relatively unaffected by changing atmospheric conditions like sky waves.

(b) How can a quarter wave transformers be used for impedance matching.

Ans:

(2 Marks for correct diagram, 2 Marks for explanation)

- 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,



$$Z_s = \frac{Z_0^{\ 2}}{Z_L}$$

- 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.

(c) Draw and explain the operation of foster-seeley discriminator. Draw circuit diagram of foster-seeley discriminator and explain its operation

Ans:

(Diagram-2 Mark, Explanation-2 Mark)

Diagram:

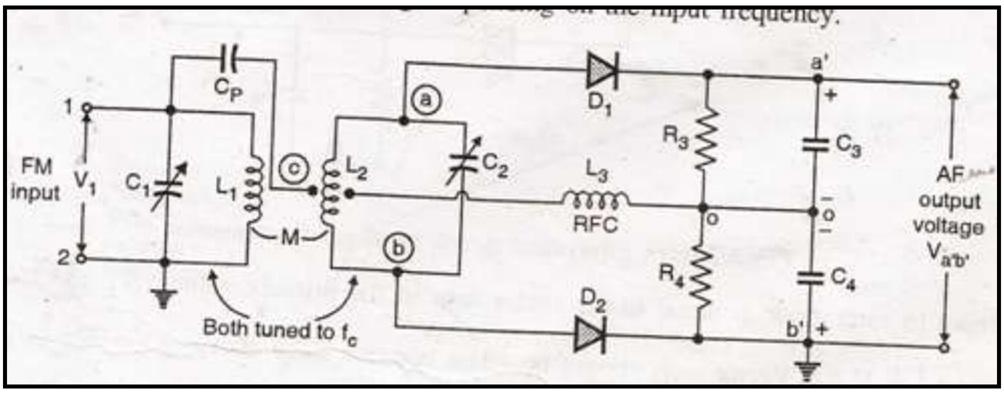


Fig. Foster-seeley discriminator

Operation:

(i) Output voltage at fin=fc:

- When the input frequency is equal to the center frequency fc, the phase shift between the primary and secondary voltages is exactly 90^0.
- Therefore the input voltages to the both diodes will be equal as shown in fig. below. Therefore the outputs of both the diodes will be equal. Hence the net output voltage will be zero.

(ii) Output voltage for fin > fc:

- At input frequencies above the centre frequency fc, secondary voltage Vab leads the primary voltage V1 by less than 90^0.
- Hence input voltage to D1 Vao is higher than input to D2. The output voltage therefore be positive for fin>fc.

(i) Output voltage for fin>fc:

- For input frequencies below the center frequency fc, the secondary voltage Vab leads the primary voltage V1 by more than 90^0.
- Hence input voltage to D1 is less than input voltage to D2. Therefore the output voltage will be negative for fin<fc.

Q.2 Attempt any FOUR. 16 Marks

(a) Define the following w.r.t (i) Virtual Height (ii) Critical frequency (iii) Maximum usable frequency (iv) Skip distance.

Ans:

(1 Mark for each correct definition)

(i) Virtual Height: Virtual height is the height above earth's surface from which a refracted wave appears to have been reflected

OR

- The maximum height that the hypothetical reflected wave would have reached is the virtual height.

(ii) Critical Frequency: Critical frequency is the highest frequency that can be propagated directly upward and still be returned to earth by the ionosphere.

OR

- The highest frequency that will be returned to earth in the vertical direction is the critical frequency.

(iii) Maximum Usable Frequency: Maximum usable frequency (MUF) is also a limiting frequency, but for some specific angle of incidence other than normal. If the angle of incidence is θ, it follows that,

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

$$= f_c\ sec\theta$$

OR

- It is defined as the highest frequency that can be used for sky wave propagation between two given points on earth.

(iv) **Skip Distance:** Skip distance is defined as the minimum distance from a transmit antenna that a sky wave at a given frequency will be returned to earth.

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

Ans:

(1 Mark for each loss and explain at least 2 points for each loss)

Radiation losses:

- It occurs because a transmission line may act as an antenna if the separation of the conductor is an appreciable fraction of the wavelength.
- This applies more to parallel lines than to coaxial lines.
- This loss is difficult to estimate, being normally measured than calculated.
- They increase with frequency for any given transmission line.

Conductor heating or I^2R loss:

- It is proportional to current and therefore inversely proportional to characteristic impedance.
- As resistance is distributed throughout the transmission line, this loss in directly proportional to the square of the line length.
- To reduce this loss simply reduces the length of the transmission line or use a larger diameter wire.
- It also increases with frequency because of skin effect.

Dielectric loss:

- **Dielectric heating** is proportional to the voltage across the dielectric and hence inversely proportional characteristic impedance.
- It again increases with frequency.
- For air dielectric heating remains negligible.

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) Draw and explain operation of horn antenna.

Ans:

(Diagram (any one) -2 Mark, Explanation-2 Mark)

Diagram:

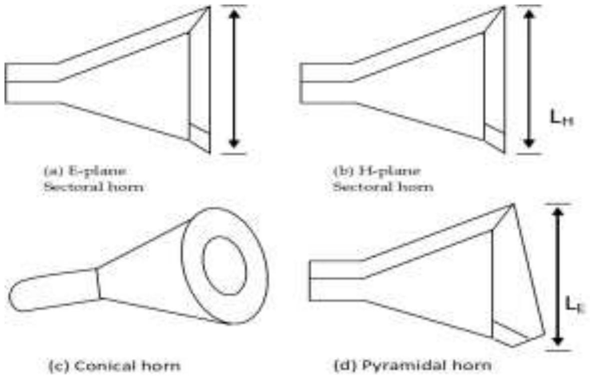


Fig. Horn antenna

Explanation:

- With a horn feed mechanism, the primary antenna is a small horn antenna rather than a simple dipole or dipole array.
- The horn is simply a flared piece of waveguide material that is placed at the focus and radiates a somewhat directional towards the parabolic reflector.
- When the propagating electromagnetic field reaches the mouth of the horn, it continues to propagate in the same general direction.
- The horn structure can have several shapes, such as pyramidal, conical, sectoral etc.
- As with the centre feed, a horn feed presents somewhat of an obstruction to waves reflected from the parabolic dish.
- In horn feed impedance matching is very properly.
- All energy travelling forward is radiated.
- Directivity is improved.
- Diffraction is reduced.

(d) Explain sensitivity and selectivity of radio receiver.

Ans:

(Sensitivity- 2 Marks, Selectivity-2 Mark (Graph 1 mark, explanation 1 mark))

Sensitivity:

- Sensitivity of a radio receiver is defined as the ability to amplify weak signals.
- It is often defined in terms of the input voltage that must be applied at the input receiver to obtain a standard output power.
- It is measured in µV or decibels
- Sensitivity can be improved by increasing the gains of RF and IF amplifier stages.

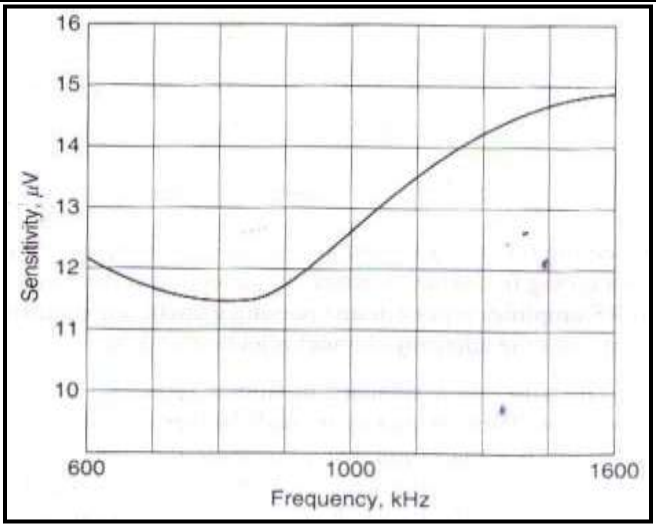


Fig. Sensitivity

Selectivity:

- The selectivity of a radio receiver is its ability to reject unwanted signals.
- The selectivity decides the adjacent channel rejection of a receiver.
- Selectivity depends on the IF amplifier, higher the "Q" of the tuned circuit used in the IF amplifier.

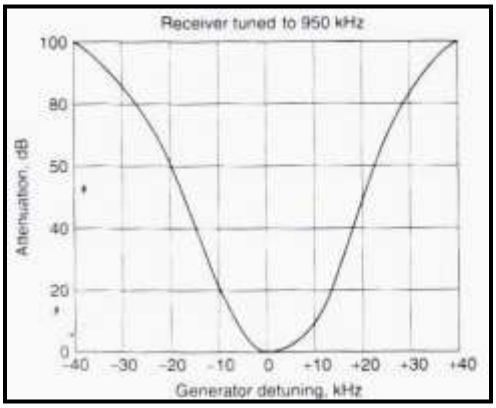


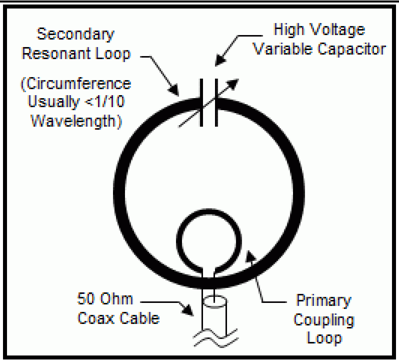
Fig. Selectivity:

(e) Draw and explain operation of loop antenna

Ans:

(Diagram (any one)-2 Mark, Explanation-2 Mark)

Diagram:



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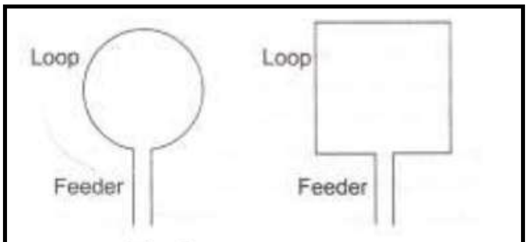


Fig.Loop antenna

Fig. Operation of loop antenna

Explanation:

- The most fundamental loop antenna is simply a single turn coil of wire that is significantly shorter that one wavelength and carries RF current.
- A loop can be thought of as many elemental dipoles connected together.
- As dipoles are straight, therefore a loop is actually a polygonal rather than circular.
- A loop is surrounded with magnetic field that is at right angles to the wire.
- The radiation pattern is essentially the same as that of a short horizontal dipole.
- The polarization of loop antenna is linear, however a vertical loop is vertically polarized and horizontal loop is horizontally polarized.
- Small vertically polarized loops are very often used in direction finding antenna.
- The direction of the received signal can be found by orienting the loop until a null value is found.
- It is easily adapted to mobile communication application.

(f) Draw the circuit diagram of ratio detector and explain its working.

Ans: **(Diagram-2 Marks, Explanation-2 Mark)**

Diagram:

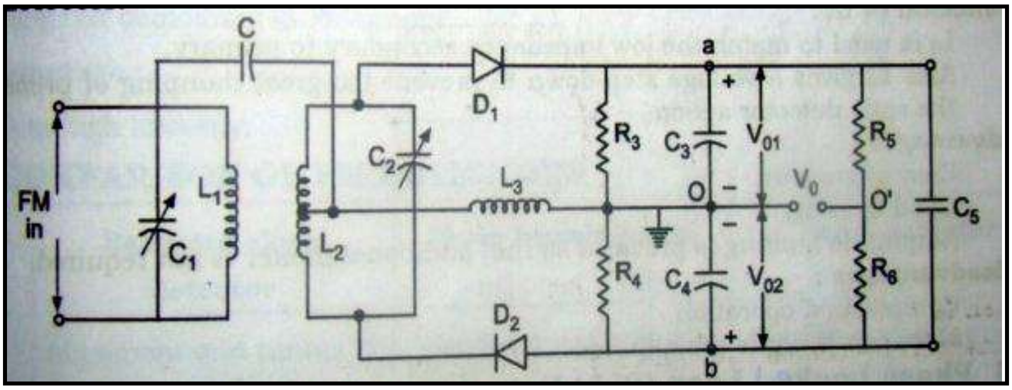


Fig. Ratio detector

Explanation:

- 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.

$$V_o = \frac{(V_{o1} - V_{o2})}{2}$$

- 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.

Q3) Attempt any FOUR:- **16 Marks**

a)Draw and explain duct propagation..

Ans:

(Diagram 2Marks, Explanation 2 Marks)

Diagram:

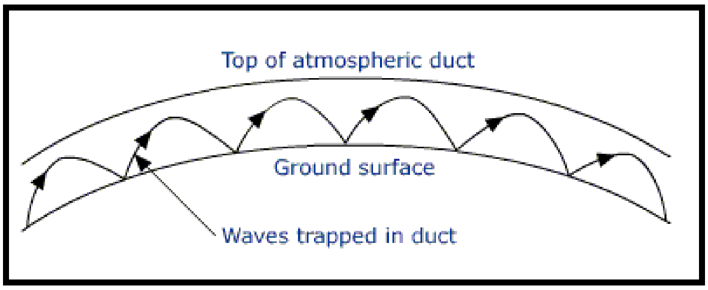


Figure:- Duct propagation

Explanation:

- At such short wavelengths everything tends to happen very rapidly. Refraction and absorption tend to be accentuated.
- One new phenomenon which occurs is super refraction, also known as ducting.
- As air density decreases and refractive index increases with increasing height above ground. The change in refractive index is normally linear and gradual.
- But under certain atmospheric conditions a layer of warm air may be trapped above cooler, often over the surface of water.
- The result is that the refractive index will decrease far more rapidly with height than is usual.
- The rapid in refractive index will do to microwave what the slower reduction of these quantities, in an ionized layer, does to HF waves; Complete bending down takes place.
- Microwaves are thus continuously refracted in the duct and reflected by the ground, so that they are propagated around the curvature of the earth.

b) Draw the equivalent circuit of transmission line for low frequency and radio frequency .

Ans:

(2 Marks each)

Diagram:-

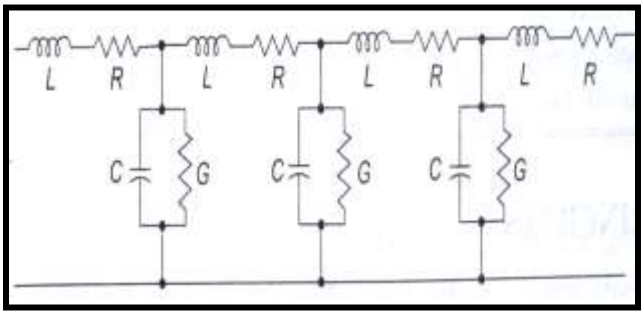


Figure:-Equivalent circuit of Transmission line for low frequency

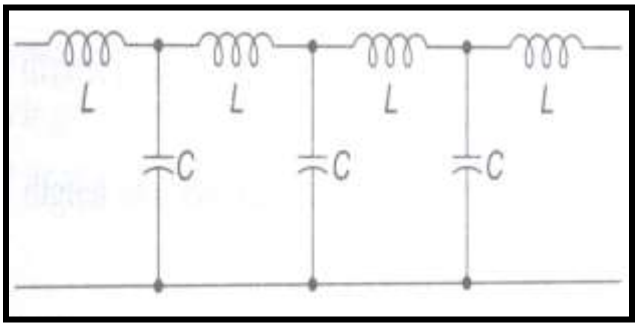


Figure:- Equivalent circuit of Transmission line for radio frequency

c)Draw Yagi-Uda antenna. Draw its radiation pattern. Explain its Operation.

Ans:

(Antenna 1M, Radiation pattern 1M, Operation 2M)

Diagram:

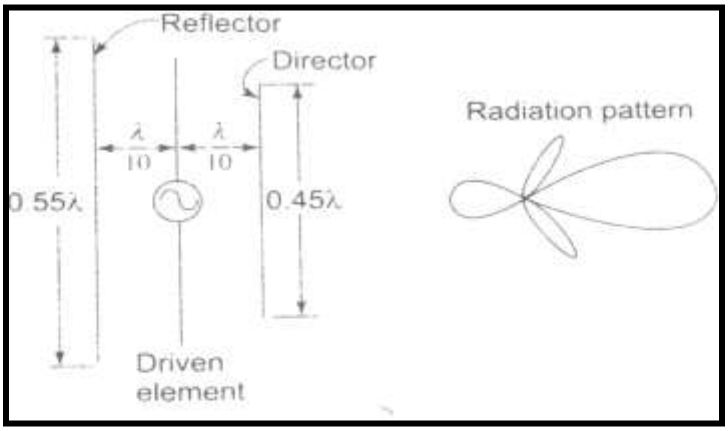


Figure:-Yagi-uda antenna

Operation:-

- It is a widely used antenna that uses a folded dipole as the driven element.
- It is a linear array that consisting of a dipole and two or more parasitic elements: one reflector and one or more directors.
- A simple 3 element yagi uda antenna is shown above
- The driven element is half wave folded dipole.
- The reflector is a straight aluminium rod approximately 5% longer than the dipole.
- The director is approximately 5% shorter than the dipole or driven element.
- The spacing between the elements is generally $1/10^{th}$ of wavelength.
- The typical directivity is between 7dB to 9dB.
- The bandwidth of this antenna can be increased by using more than one folded dipole, each cut at slightly different lengths.
- This antenna is commonly used for VHF television reception because of its wide bandwidth.

d) State various factors influencing the choice of IF for radio receivers.

Ans:

Explanation:- 4M(any four points)

- The Intermediate frequency of a radio receiver is compromise, as there are reasons why it should be neither low nor high nor in a range between the two.
- The choice of the IF depends on the following factors.
  i) IF should not be too high as it will result selectivity and therefore poor adjacent channel reaction. This is due to difficulty in obtaining high a Q in high frequencies.
  ii) If the If is too high the tracking problems increases.
  iii) If the IF is lowered than then the image frequency rejection is poorer.
  iv) A very low IF can make the selectivity too sharp cutting the sidebands.
  v) For very low IF, the frequency stability of the local oscillator must be very high. Because small drift in the local oscillator frequency will result in a larger error.
  vi) The IF must not fall within the tuning range of the receiver. Otherwise instability will occur and heterodyne whistles will be heard. This will make the tuning impossible.
  vii) In the standard broadcast AM receivers IF is within the range of 438 to 465 KHz being the most popular Frequency.

e)Draw the radiation pattern for the resonant dipole with following lengths.

i) $L= \lambda/2$

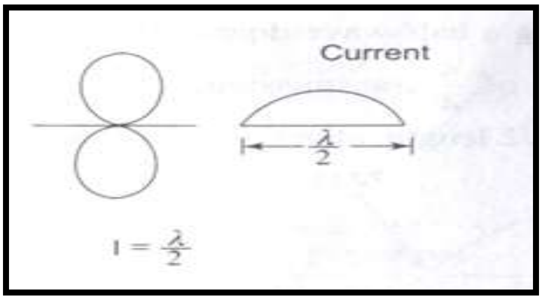
ii) $L= \lambda$

iii) $L=3 \lambda/2$

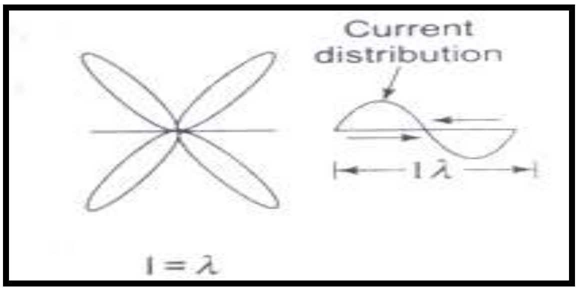
iv) $L=3 \lambda$

Ans: (1 Mark each)

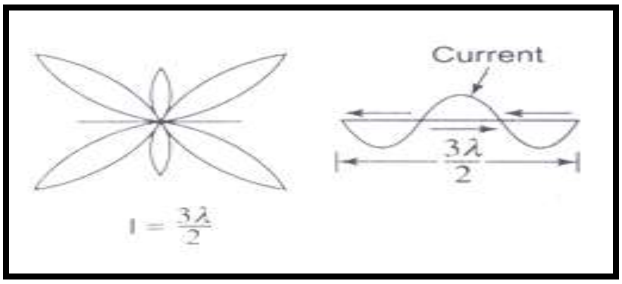
a) Radiation pattern of length L= λ/2



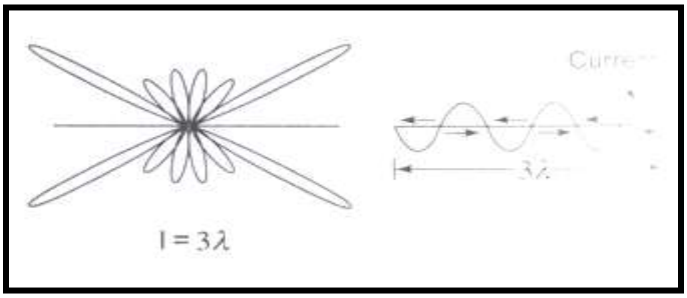
b) Radiation pattern of length L= λ



c) Radiation pattern of length L=3 λ/2



d) Radiation pattern of length L=3 λ



f) Draw the block diagram of FM radio receiver and explain.

Ans:

(Diagram 2 Marks, Explanation 2 Marks)

Diagram:

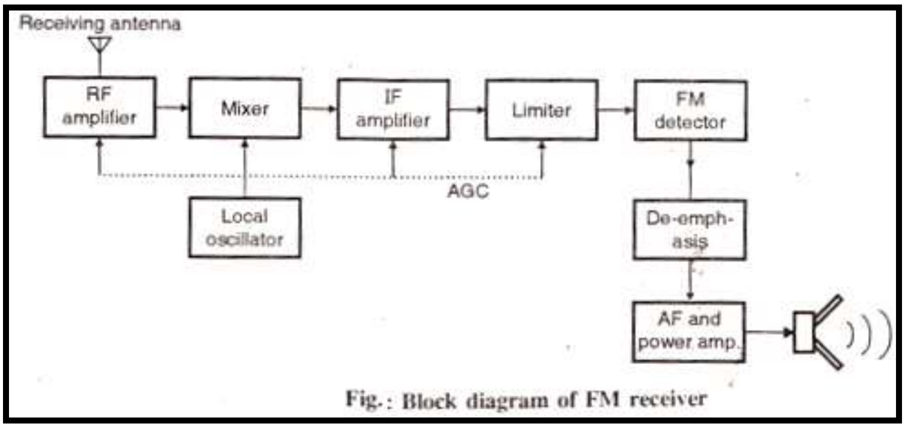


Fig. FM radio receiver

Explanation:-

- Earlier we have learnt about the FM generation & transmission. Now let us see how to receive the FM signal & demodulate it.
- Figure shows the block diagram of a FM receiver. The first thing that strikes us is its similarity with the AM receiver.
- The FM receiver also operates on the principle of ‘super heterodyning, as the AM receiver.
- However even through the AM and FM receivers operates on the same principle and the blocks up to the IF amplifier are identical.

RF Amplifier:

- In the Domestic AM receivers, the RF amplifier is not used. but in the FM receivers , the RF amplifier is always used.
- The advantages of using RF amplifier are

1. It improves the signal to noise ratio.
2. It will match the receiver input impedance to the antenna impedance.

Mixer or Frequency charger:

- Similar to the AM receiver, the mixer stage in FM receiver will down convert the received signal to intermediate frequency IF.
- This is done by mixing the input signal (f_s) with the local oscillator signal (f_o). the local oscillator frequency is higher than the signal frequency.

IF amplifiers:

- The IF amplifier is used in FM receivers are similar to those used in the AM receiver but the IF and the bandwidth required are much higher than those in the AM receivers. Here the IF is 10.7 MHz and the bandwidth is 200 KHz.
- Due to the large bandwidth the gain per stage will be low. Therefore two or more IF amplifiers are required to be used. these amplifier are cascaded together.

Q4) Attempt any FOUR : **16 Marks**

a) Derive the relation between reflection coefficient and standing wave ratio.

Ans:

Relation between reflection coefficient and standing wave ratio:

Relation between reflection co-efficient (e) and VSWR:

$SWR = \frac{V_{max}}{V_{min}}$ **1M**

$V_{max} = Ei + Er$ **1/2M**

$V_{min} = E_i . E_r$ **1/2M**

Therefore equation can be written as

$e E_i = E_r$

$SWR = \frac{Ei + Ei\, e}{Ei - Ei\, e}$ **1M**

$SWR = \frac{Ei\,(1+e)}{Ei\,(1-e)} = \frac{(1+e)}{(1-e)}$

SWR(1-e)= (1+e)

SWR= SWR e= 1+e

SWR= 1+e+(SWR)e

`SWR-1= e(1+SWR)

$E = \frac{SWR-1}{SWR+1}$ **1M**

b) Describe space wave propagation with neat sketch.

Ans:

(Diagram 2 Marks, Explanation 2 Marks)

Diagram:-

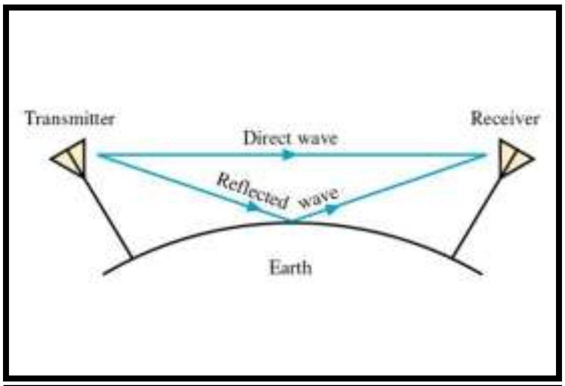


Figure:- Space wave propagation

Explanation:-

- Space wave propagation of electromagnetic energy includes radiated energy that travels in the lower few miles of earth's atmosphere.
- Space waves include both direct and ground reflected waves.
- Direct waves travel in a straight line between the transmitter and receiver antenna.
- Space waves propagation with direct is commonly called line of sight transmission.

- Ground reflected waves are waves reflected by earth's surface as they propagate between the transmitter and receiver antenna.
- The field intensity at the receive antenna depends on the distance between the two antennas and whether the direct and ground waves are in phase.
- The curvature of the earth presents a horizon to space wave propagation commonly called the radio horizon.
- The radio horizon can be lengthened simply by elevating the transmit or receive antennas above earth's surface with towers or by placing them on top of mountains or high buildings.

c) Draw and explain the operation of TRF radio receiver.

Ans:

(Diagram 2 Marks, Operation 2 Marks)

Diagram:-

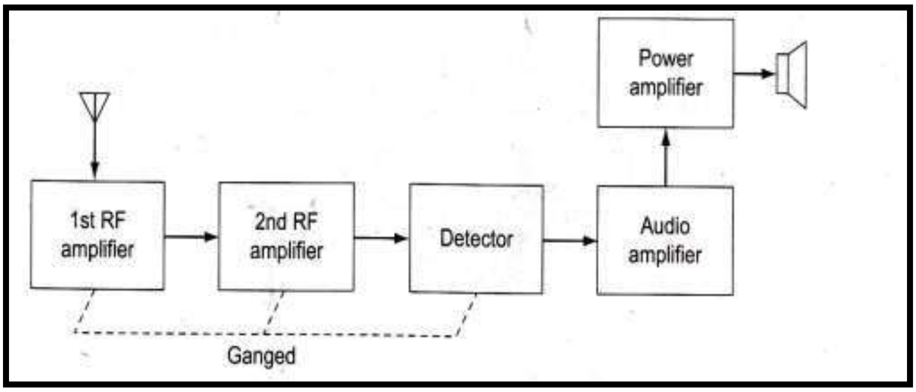


Figure:- TRF radio receiver

Operation :-

- Due to EM waves passing over the receiving antenna, voltage is induced in it.
- The RF amplifiers are tuned simultaneously to select and amplify the desired signal and reject all the other.
- Ganged tuning means simultaneous tuning of tuned circuits in all the RF amplifier stages.
- The amplified signal is then demodulated by the detector, the carrier signal is then bypassed and only the modulating signal is recovered in this process.
  The detected signal is amplified to the adequate power level using the audio amplifier and power amplifier and given to the loudspeaker

d) Describe the importance of frequency tracking in AM radio receiver.

Ans:

(Explanation 4 Marks)

Explanation:

- The AM receiver has number of tunable circuits (e.g. antenna, mixer, local oscillator, tuned circuit etc.)
- All these circuits must be tuned correctly. If any station is to be tuned.
- Capacitor in the various tuned circuit are ganged.
- Due to the arrangement it is possible to used only one tuning control to vary the tuning capacitors simultaneously. The local oscillator frequency (f0) must be precisely adjusted to a value which is above the signal frequency (fs) by IF.
  i.e. f0 = fs+I.F.

- If the tuning is not done correctly then

  f0-fs ≠ I.F.
- Stations will appear away from their current position on frequency dial of the receiver.
- Process in which the local oscillator frequency follows or tracks the signal frequency to have a correct frequency difference is called as tracking.

e) Draw the circuit diagram of amplitude limiter and describe its operation .

Ans:

(Diagram 2 Marks, Operation 2 Marks)

Diagram:-

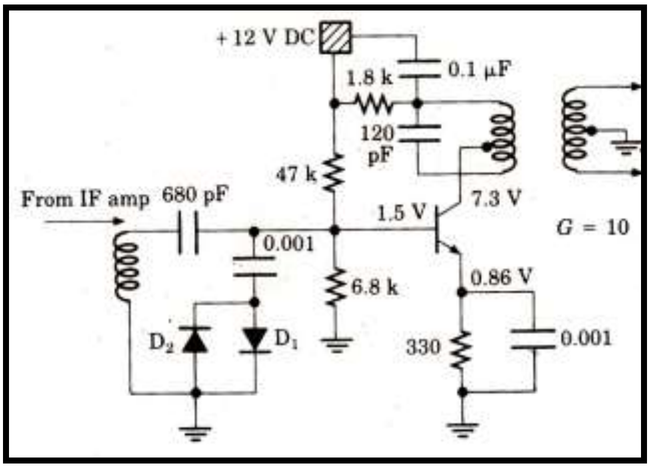


Figure:- Amplitude limiter

Operation:-

- In frequency modulation, the signal amplitude is held constant while the carrier frequency is varied.
- Any noise that contaminates the signal will manifest itself as a change in amplitude.
- The first limiter is a pair of back-to-back diodes D_1 and D_2.
- Diode D_1 will conduct when the input signal is grater than 0.7V on the positive peak, and diode D_2 will conduct on the portion of the negative half-cycle that exceeds $-0.7V_{pK}$ of the input signal.
- The second form of limiting in the figure is the transistor amplifier itself, which has a gain of 10.
- When the base signal reaches 1.4V p-p, the collector voltage becomes ten times larger.
- The collector and emitter currents increase, raising the emitter voltage at the same time that the collector is going lower.
- The total collector change is 9.4 V, limiting the output signal to 9.4 V p-p instead of the alternately driven into saturation and cutoff, it limits the signal amplitude.

f) Draw and explain the operation of Cassegrain feed parabolic reflector.

Ans: (Diagram 2 Marks, Explanation 2 Marks)

Diagram:-

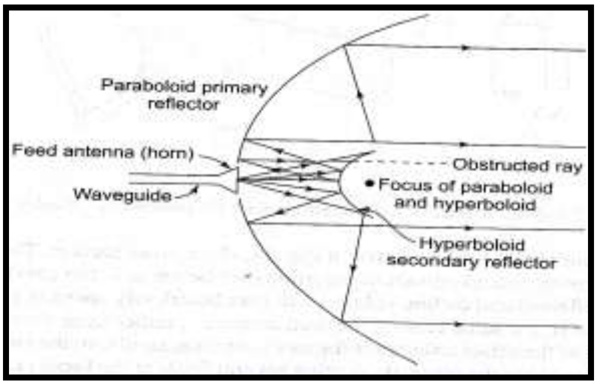


Figure:- Cassegrain feedback parabolic reflector

Explanation:

- The primary radiating source is located in or just behind a small opening at the vertex of the paraboloid rather than at the focus.
- The primary antenna is aimed at a small secondary reflector located between the vertex and the focus.
- The rays emitted from the primary antenna are reflected from the cassegrain subreflector and then reaches the main parabolic reflector just as if they had originated at the focus.
- The rays are construct together by the parabolic reflector in the same way as in centre fed mechanism.
- The secondary reflector is a hyperboloid.
- Cassegrain feed shortens the length of the transmission line.
- Some waves are obstructed because of the hyperboloid reflected.
- Dimension of hyperboloid is determined by its distance from the feed antenna and its frequency.

Q5. Attempt any FOUR: 16M

a) Draw and describe the operation super heterodyne radio receiver.

Ans: : (Diagram-2 marks, Explaination-2 marks)

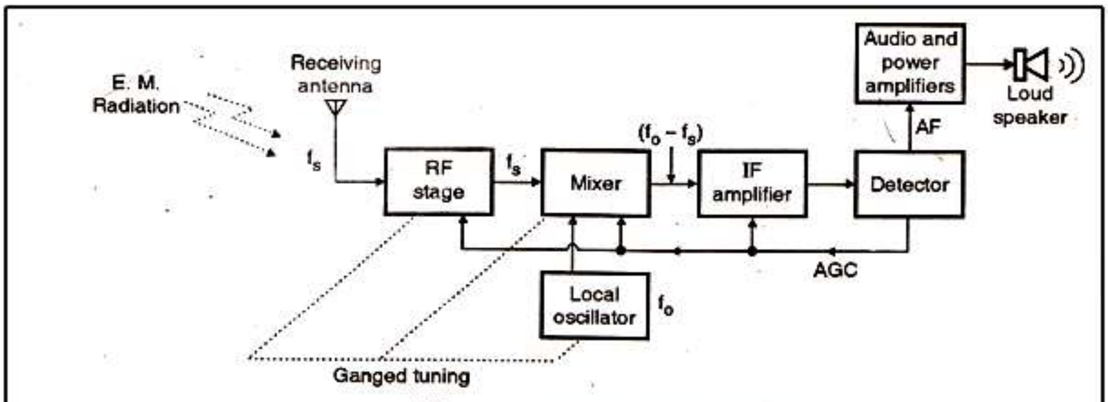


Fig.: The superheterodyne receiver

[Note: Any other relevant diagram should be considered]

Explanation: **1M**

- The problems of TRF receiver are solved in this receiver by converting every selected RF signal to a fixed lower frequency called as the "intermediate frequency"(IF).
- The IF signal is then amplified and detected to get back the original modulating signal.
- As the IF is lower than the RF signal frequency, the possibility of oscillation and instability is minimized.

Working: **1M**

- The received signal is in the form of electromagnetic waves, it induces very small voltage into the receiving antenna.
- **RF stages:** The RF stage is an amplifier which is used to select the wanted signal and reject other out of many, and reduces the effect of noise.
- **Mixer:** The mixer receives signals from the RF amplifier at frequency (fs) and from local oscillator at frequency (fo) such that fo > fs, and produces fs,fo,fo+fs and fo-fs.
- **Intermediate Frequency (IF):** Out of these the difference of frequency component i.e (fo-fs) is selected and all others are rejected. This is called IF frequency.
- Therefore IF =fo-fs
- The **Intermediate Frequency** is then amplified by one or more IF amplifier stages.
- IF amplifier provide most of the gain and bandwidth of the receiver.
- **Detector:** The amplified IF signal is detected by the detector to recover the original modulating signal. This is then amplified and applied to the loudspeaker.

b) Explain the need of AGC and delayed AGC.

Ans:

(Explaination-2 marks each)

Automatic Gain Control (AGC):

- The signals from various radios reaching at the receiver input are not of same strength.
- The signals from the strong stations are strong and those from the weak stations are weak.
- If the receiver gain is constant then the receiver output will fluctuate proportional to the input signal.
- This is not desirable.
- So the automatic gain control (AGC) is used to adjust the receiver gain automatically so as to keep the receiver output constant irrespective of the strength of input signal.

Delayed AGC:

- Fig shows that the AGC bias is not applied until the input signal strength reaches a predetermined level 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 the weak signals is thus avoided.
- The delayed AGC is not used in the low cost radio receiver. It is used in the high quality receivers like communication receivers.

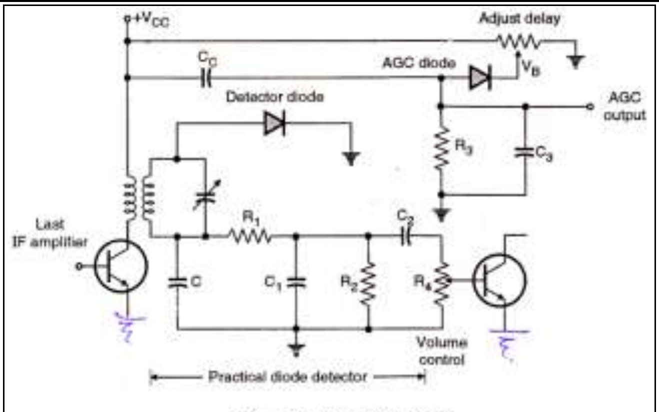


Fig. : Delayed AGC circuit

[Note: Any other relevant diagram should be considered]

c) Draw and explain tropospheric scatter propagation.

Ans:

(Diagram-2 marks, Explaination-2 marks)

<u>Tropospheric scatter propagation:</u>

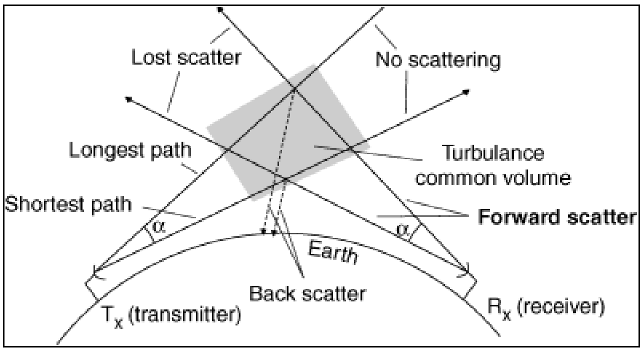


Fig. Tropospheric scatter propagation

[Note: Any other relevant diagram should be considered]

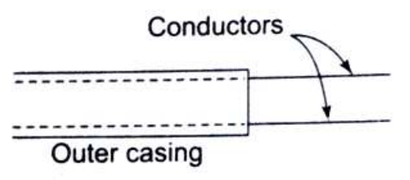
- It a method of communicating with microwave radio signals over considerable distances – often up to 300 km, and further depending on terrain and climate factors.
- Here radio waves at particular frequencies are randomly scattered as they pass through the upper layers of the troposphere
- As the signals pass through the troposphere, some of the energy is scattered back toward the Earth, allowing the receiver station to pick up the signal.
- The area within which the scattering takes place is called the scatter volume.
- This scattering mode of propagation enables vhf and uhf signals to be transmitted far beyond the normal line-of-sight.
- Also known as troposcatter, forward scatter propagation or beyond the horizon propagation for UHF signals.
- The reason for the scatter is not fully understood, but there are two theories. One suggests reflection from “blobs” in the atmosphere, similar to scattering by dust particles.

- The other suggests that reflections are from atmospheric layers.
- The best frequencies which are also the most often used, are centered on 900, 2000 and 5000 MHz
- This method of propagation is used in long distance telephone and other communication links, as an alternate to microwave links or coaxial cables.
-

d) Describe the working principle of transmission line and describe the balanced line with diagram.

Ans:

(Diagram-2 marks, Explaination-1 mark each)



(a) Parallel-wire (balanced) line

[Note: Any other relevant diagram should be considered]

Basic principle of transmission line:

- Transmission lines are considered to be impedance matching circuits designed to deliver power (RF) from the transmitter of an antenna, and maximum signal from antenna to the receiver.
- Any system of wires can be considered as forming one or more transmission lines.
- All practical transmission lines are arranged in some uniform pattern.
- This simplifies calculations, reduces costs and increases convenience.

Balanced line:

- The **parallel wire** is employed where balanced properties are required like in connecting a folded dipole antenna to a TV receiver.
- Here both the conductors carry current; however, one carries signal, and the other conductor is the return path.
- The two currents are equal in magnitude with respect to electrical ground but travel in opposite direction.

e) Draw and explain the operation of phased array.

Ans:

(Diagram-2 marks, Explaination-2 marks)

Phased array:

- A phased array is a group of antenna arrays or a group of arrays that, when they are connected together, functions as a single antenna.
- The beam width and direction can be changed electronically without physically moving any antenna within the array.
- They eliminate the need for mechanically rotating antenna elements.
- The radiation pattern can be also adjusted and changed electronically.
- When electromagnetic energies from different sources occupy the same space at the same time, they combine, sometimes constructively and sometimes destructively.
- There are two basic kinds of phased array.
- In the first type, a single high power output device supplies power to large number of antennas through a set of power splitters and phase shifters.
- The second type, phased antenna array uses approximately as many low power variable output devices as there are radiating elements.
- In both the types the radiation pattern is selected by changing the phase delay introduced by the phase shifters.

Diagram:

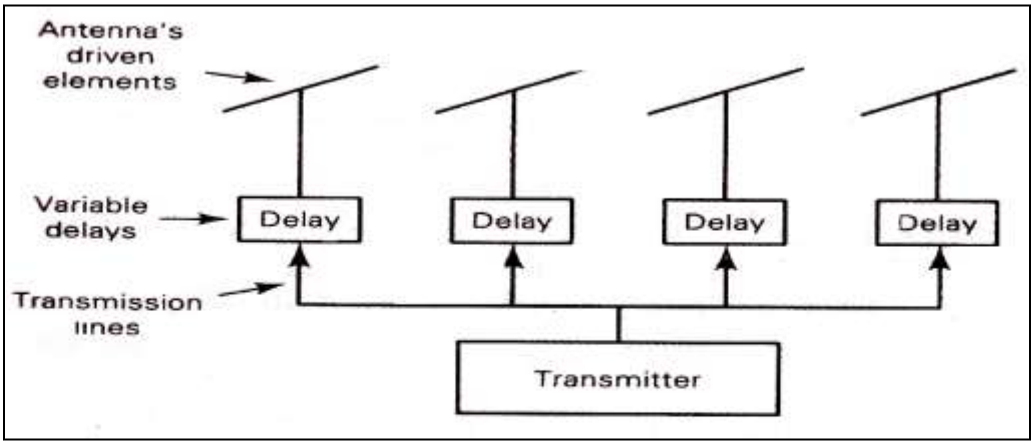


Fig. Phased Array.

[Note: Any other relevant diagram should be considered]

f) Explain the role of AFC in radio receiver.

Ans:

(Diagram-2 marks, Explaination-2 marks)

Diagram:

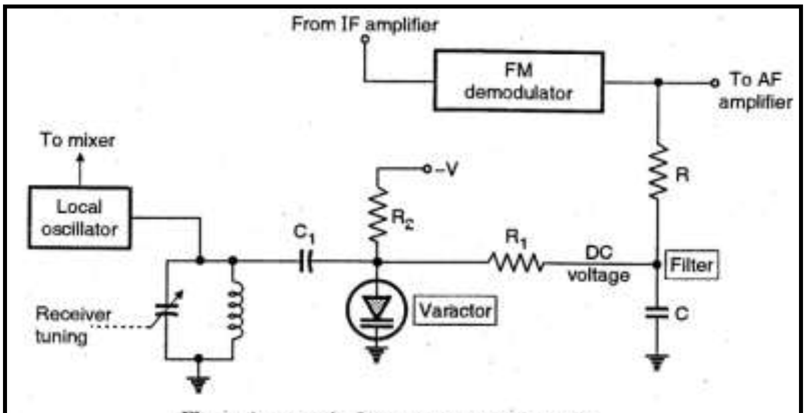


Fig. : Automatic frequency control (AFC)

[Note: Any other relevant diagram should be considered]

Automatic Frequency Control (AFC):

The purpose of the AFC is to achieve near-crystal stability of the transmit carrier frequency without using a crystal in the carrier oscillator. With AFC, the carrier signal is mixed with the output signal from a crystal reference oscillator in a nonlinear device, and then fed back to the input of a frequency discriminator.

Explanation:

- In AFC some of the signal from the output of demodulator is filtered to get a dc voltage. This dc voltage is then used to control a varactor diode.
- As shown in fig. the dc bias applied to the varactor will vary with the drift in frequency. It can be positive or negative.
- This dc voltage will then vary the varactor diode, which is connected across the oscillator the oscillator tank circuit.
- Thus the local oscillator frequency will be changed automatically to reduce the error to zero.
- If the local oscillator frequency increase above the desired frequency, then IF will increase. This produces a positive dc voltage at the output of the demodulator.
- This will cause the capacitance of varactor diode to increase and the local oscillator frequency to decrease.
- Thus automatic frequency control is achieved.

Q6. Attempt any FOUR: 16Marks

a) Describe the purpose of short length transmission line for open and short circuit.

Ans:

(Diagram-2 marks, Explaination-2 marks)

- At the higher frequency, it is not possible to use lumped components for impedance matching, so we use short length transmission line for matching the impedance.
- If the frequency of operation is lowered, the shunt inductive reactance of thus tuned circuit is lower and the shunt capacitive reactance is higher. Inductive current predominates, and therefore the impedance of the circuit is purely inductive.

- This piece at the new frequency is less than λ/4 long, since the wavelength is now greater than and the length of line is naturally unchanged. We thus have the important property that a short-circuited line less than λ/4 long behave as a pure inductance.
- An open-circuited line less than λ/4 long appear as a pure capacitance.

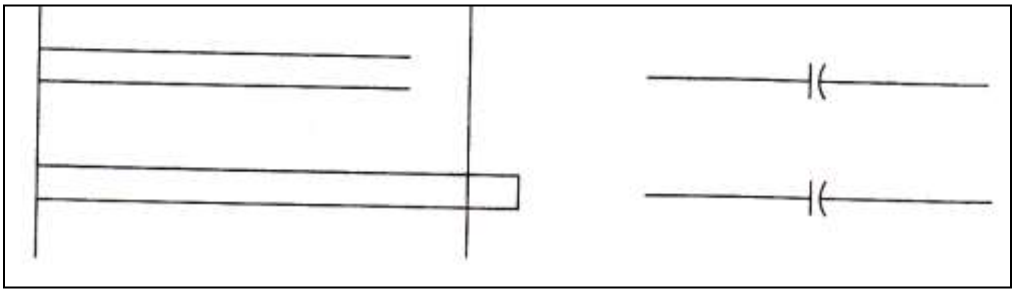


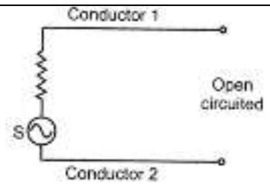
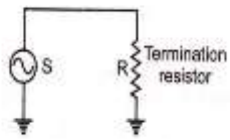
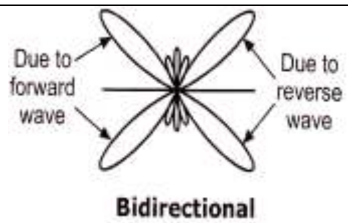
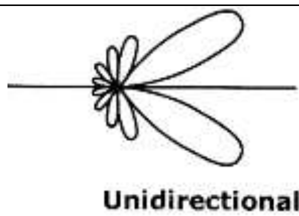
Fig. of short length transmission line

[Note: Any other relevant diagram should be considered]

b) Compare Resonant and Non-resonant Antenna. (Any four points)

Ans:

(Any four points-1 mark each)

Sr. no.	Parameter	Resonance 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 reflections so only forward waves are present.
5.	Radiation Pattern		

c) Draw and explain the working of practical diode detector circuit with waveforms.

Ans:

(Diagram-2 marks, Explaination-2 marks)

Practical diode detector:

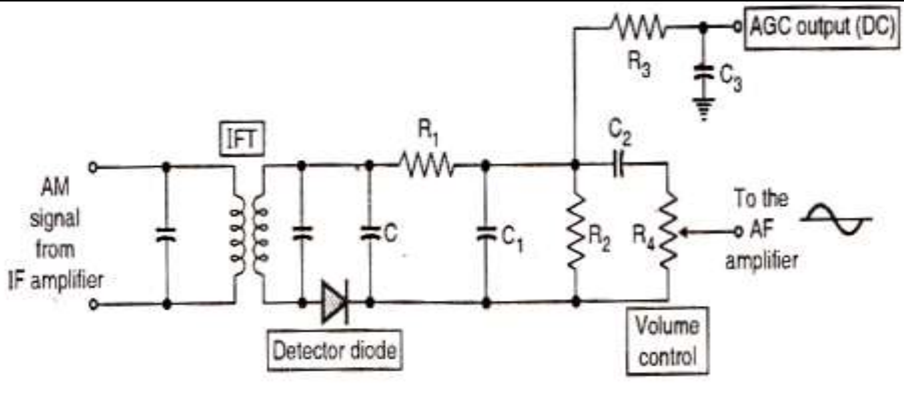


Fig. Practical diode detector circuit

[Note: Any other relevant diagram should be considered]

Explaination:

- The circuit diagram for a practical diode is as shown in Figure, as the direction of the diode has been reversed, the negative envelope will be demodulated.
- Due to this a negative AGC voltage will be developed. R1 and R2 provide a series dc path.
- $R_1 – C_2$ is the low pass filter which is used to remove the RF ripple that is still present in the detected output.
- The capacitor C_2 is a coupling capacitor which prevents the diode dc output from reaching the volume control potentiometer R4.
- Hence across R4 we get the demodulated signal with a zero dc shift. This signal is then applied to the AF amplifier.
- The R3-C3 combination forms a low pass filter. It is designed to remove the AF component from the demodulator output.
- This filter will allow only dc part to pass through, which is used as AGC voltage. This AGC voltage is then applied to the RF and IF amplifiers to control their gain automatically. Such a practical diode detector circuit is in the domestic radio receivers.

  The dc AGC voltage produced at the detector output is proportional to the signal strength. Stronger Am signal higher is the dc AGC voltage.

d) Draw and explain the operation of FM demodulator using PLL.

Ans:

(Diagram-2 marks, Explaination-2 marks)

Diagram:

FM Detection Using PLL :

A PLL can be used as FM demodulator as shown in Fig.

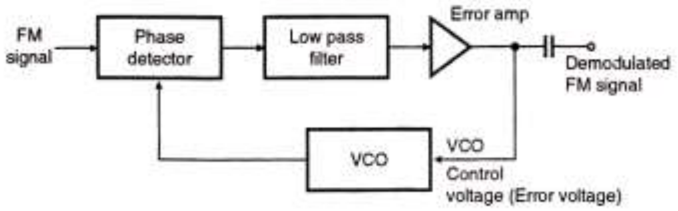


Fig. PLL used as FM demodulator

[Note: Any other relevant diagram should be considered]

Explanation:

Phase detector/ comparator:

- The two inputs to a phase detector or comparator are the input voltage V_s at frequency f_s and the feedback voltage from a voltage controlled oscillator (VCO) at frequency F_o.
- The phase detector components these two signals and produces a dc voltage V_e which is proportional to the phase difference between fs and fo. The output voltage Vo of the phase detector is called as "error voltage"
- This error voltage is then applied to a low pass filter.

Low pass filter:

- The low pass filter removes the high frequency noise present in the phase detector output and produces a ripple free dc level.
- This dc level is amplified to an adequate level and applied to a voltage controlled oscillator. The dc amplifier output voltage is called as the control voltage V_c.

Voltage Controlled Oscillator (VCO):

- The control voltage V_c is applied at the input of a VCO.
- The output frequency of VCO is directly proportional to the dc control voltage Vc. The VCO frequency "F_o" is compared with the input frequency "f_s" by the phase detector and it (VCO frequency) is adjusted continuously until it is the in out frequency f_s i.e.

The three states of operation through which the VCO undergoes are:

- **Free running:** (there is no control on VCO frequency fo).
- **Capture:** the comparison of f_o and f_s begins. The control voltage V_c starts adjusting fo to bring it closer to f_s.
- **Phase lock:** when fo is exactly equal to fs the PLL is said to be phase locked. Once locked, fo = fs except for a finite phase difference Φ.
- The FM signal which is to be demodulated is applied at the input of the PLL.
- As the PLL is locked to the FM signal, the VCO starts tracking the instantaneous frequency in the FM input signal.

- The error voltage produced at the output of amplifier is proportional to the deviation of input frequency from the centre frequency of FM, thus the ac component of the error voltage represents the modulating signal. Thus at the error amplifier output we get demodulated FM output.
- The FM demodulator using PLL ensures a high linearity, between the instantaneous input frequency and VCO control voltage (error amplifier output).

e) Explain fidelity and dynamic range of radio receiver.

Ans:

(Explaination-2 marks each)

Fidelity:

- Fidelity is a measure of the ability of a communications system to produce, at the output of the receiver, an exact replica of the original source information.
- Any frequency, phase, or amplitude variations that are present in the demodulated waveform that were not in the original information signal are considered distortion.

Dynamic Range:

- The dynamic range of a receiver is defined as the difference in decibels between the minimum input level necessary to discern a signal and the input level that will overdrive the receiver and produce distortion.
- In simple terms, dynamic range is the input power range over which the receiver is useful
- The minimum receive level is a function of front-end , noise figure, and the desired signal quality.
- The input signal level that will produce overload distortion is a function of net gain of the receiver.

f) Explain the operation of non-resonant antenna.

Ans:

(Diagram-2 marks, Explaination-2 marks)

Non-Resonant Antenna:

- Non-resonant antennas are the antennas in which the sources matched to the load(i.e. they don’t have open circuit)
- A non-resonant antenna is like a properly terminated transmission line, produces no standing waves.
- They are suppressed by the use of a correct termination resistor and no power is reflected, ensuring that only forward travelling waves will present.\
- In a correctly matched transmission line, all the transmitted power is dissipated in the terminating resistance.
- When an antenna is terminated as shown in figure. About two-third of the forward power is radiated and remaining is dissipated in the antenna.
- As shown in figure, the radiation pattern of the resonant antenna and a non-resonant antenna are same except one major difference i.e. the non-resonant antenna is unidirectional.

Diagram:

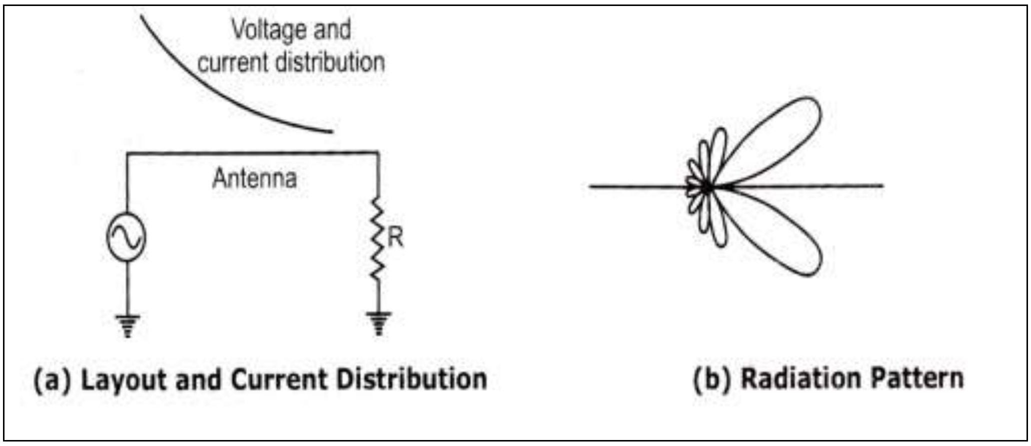


Fig. Non-Resonant Antenna

[Note: Any other relevant diagram should be considered]