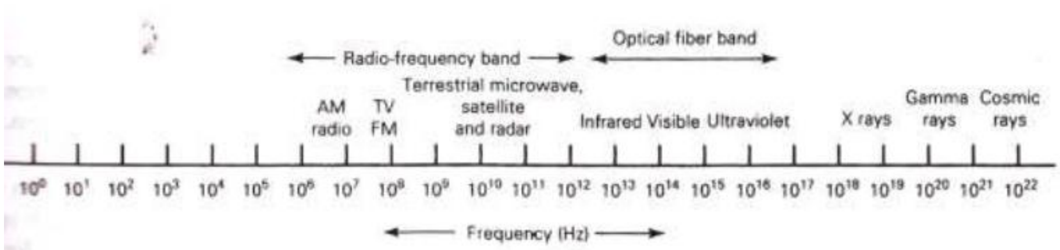
MODEL ANSWER

SUMMER– 17 EXAMINATION

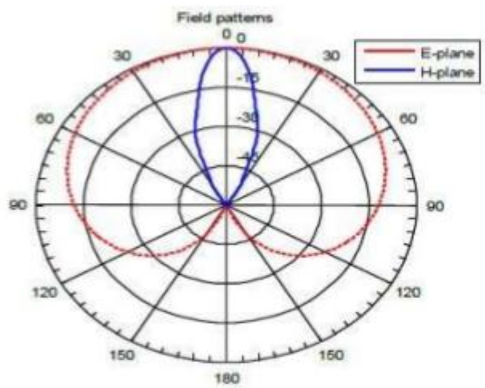
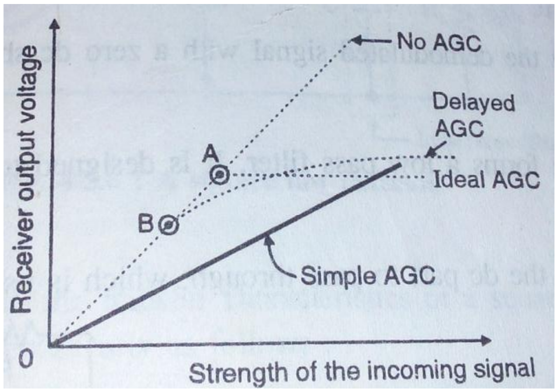
Subject Title:Radio Reception Subject Code: 17437

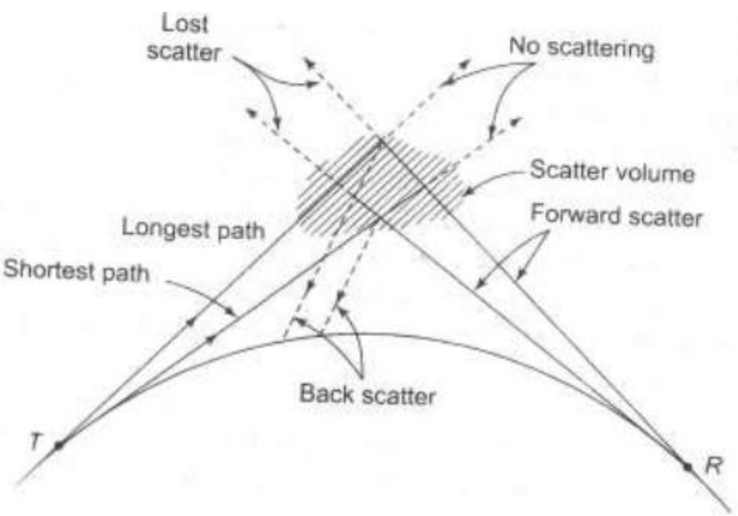
Important Instructions to examiners:

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 anyequivalent 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. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	(A)	**Attempt any SIX :**	**12-Total Marks**
	(a)	**Explain :** **(i)Polarization** **(ii)Absorption**	**2M**
	Ans:	**Polarization**: Polarization of an antenna refers to the direction in space of the E field (electric vector) portion of the electromagnetic wave being radiated by the transmitting system. **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.	**1M each**
	(b)	**Draw electromagnetic spectrum.**	**2M**
	Ans:	 **Fig. Electromagnetic spectrum.**	**2M**
	(c)	**A lossless transmission line has a shunt capacitance of 100 pf/m and series inductance of 4 mH/m. What is its characteristics impedance?**	**2M**

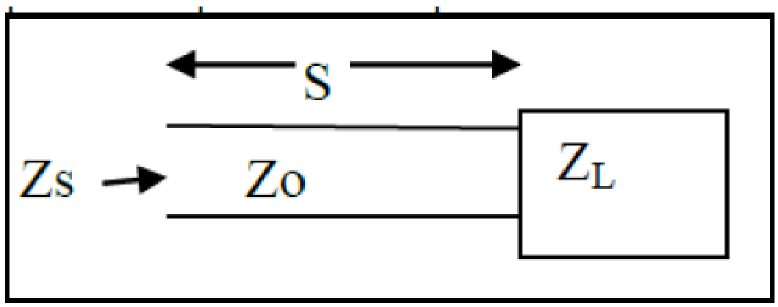
	Ans:	**Given:** L= 4 mH C= 100 PF Z_o = ? **Solution:** $$Z_o = \sqrt{L/C}$$ $$= \sqrt{\frac{4 * 10^{-3}}{100 * 10^{-12}}}$$ $$= \sqrt{40 * 10^{6}}$$ $$= 6.32\ K\Omega$$	**2M**
	(d)	**Define beam width and antenna gain with respect to antenna.**	**2M**
	Ans:	**Beamwidth:** The beamwidth of an antenna is described as the angles created by comparing the half-power points (3db) on the main radiation lobe to it' s maximum power point. **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 $$\text{Antenna gain} = P / P_{ref}$$ Where P = power density at some point with the given antenna Pref = power density at same point with the reference antenna	**1M each**
	(e)	**State the function of antenna and draw horn antenna radiation pattern.**	**2M**
	Ans:	**Function of antenna:** • An antenna is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. • It is usually used with a radio transmitter or radio receiver. • In transmission, a radio transmitter supplies an electric current oscillating • at radio frequency to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). • In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals, that is applied to a receiver to be amplified.	**1M**

	Horn antenna radiation pattern: The H-plane pattern is much narrower than the E-plane because of the flaring and larger dimensions of the horn in that direction  	**1M**
(f)	**List the different methods used for FM detection.(any four)**	**2M**
Ans:	**FM detection Method:** 1. Simple slope detector 2. Balanced slope detector 3. Phase discriminator 4. Ratio detector	**½ M each**
(g)	**What is IF for AM and FM receiver?**	**2M**
Ans:	**IF for AM:** 455KHz to 470 KHz **(for M.W. band)** , 1.6 to 2.3 MHz **(for S.W. band)** **IF for FM :** 10.7 MH	**1M each**
(h)	**Draw the graph of simple and delayed AGC.**	**2M**
Ans:	 	**2M**
B)	**Attempt any TWO :**	**8M**

	(a)	**Describe Tropospheric scatter propagation with diagram.**	**4M**
	Ans:	**Diagram :**  	**2M**
		Explanation: • 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 5000MHz. • This method of propagation is used in long distance telephone and other communication links, as an alternate to microwave links or coaxial cables.	**2M**
	(b)	**Describe the function of quarter wave transformer for impedance matching.**	**4M**
	Ans:	**Quarter wave transformer:** • 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 • 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 $\lambda/4$ transformer will also	**4M**

vary accordingly, so that load may be matched to characteristics impedance of the main line.

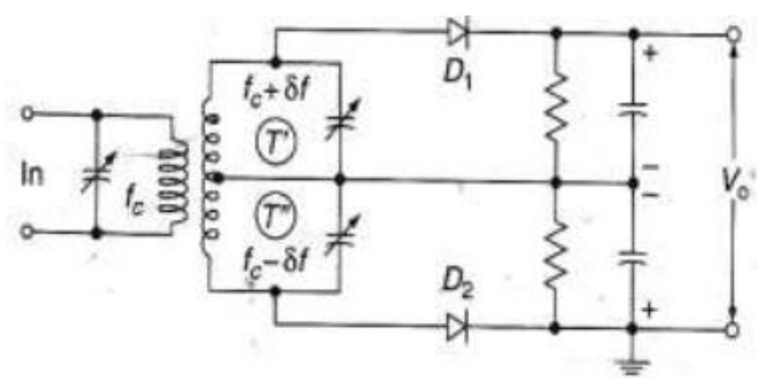
- This is similar to varying turns ratio of a transformer to obtain the required value of input impedance to match the load impedance.
- Quarter wave transformer works as filter to prevent unwanted frequencies from reaching the load such as antenna.



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

(c) **Draw and explain the operation of Balanced slope detector.** **4M**

Ans: **<u>Balanced slope detector:</u>** **2M**



<u>Explanation:</u> **2M**

- It consists of two slope detector circuits.
- The input transformer has centre tapped secondary. Hence the input voltages to the two slope detectors are 180^0 out of phase.
- There are three tuned circuits. Out of them the primary is tuned to IF that is to fc. The upper tuned circuit of the secondary is tuned above fc by Δf. i.e (fc + Δf). The lower tuned circuit of the secondary is tuned below fc by Δf. i.e (fc - Δf)
- R_1C_1 & R_2C_2 are the filters used to bypass the RF ripple.
- The final output voltage V_0 is obtained by taking the subtraction of the individual output voltages V_{01} and V_{02}
- When fin = fc, the induced voltage in the input transformer's secondary upper winding is exactly equal to that of lower winding of secondary of input transformer. The input to both diodes D_1 and D_2 are identical and output voltage V_0 = 0
- When fc < fin < (fc + Δf), the induced voltage in upper secondary winding is higher

than that induced voltage of lower half winding. The input to D_1 is higher than D_2 thus output V_0 is positive.

- When (fc - Δf) < fin < fc, the induced voltage in upper secondary winding is lower than that induced voltage of upper half winding. The input to D_2 is higher than D_1 thus output V_0 is Negative.

Q 2		Attempt any FOUR:	16M

(a) **Define the following with respect to wave propagation :**
(i)Virtual height
(ii)Critical frequency
(iii)Maximum usable frequency
(iv)Skip distance — 4M

Ans: (1M each)

Virtual height: It 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

Critical frequency: It 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.

Maximum usable frequency: It is also called a limiting frequency, but for some specific angle of incidence other than normal. If the angle of incidence is θ, it follows that

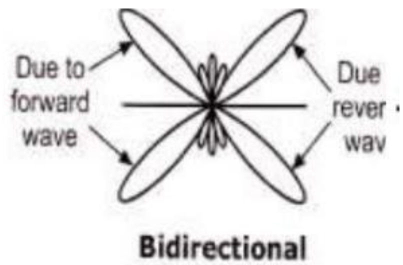
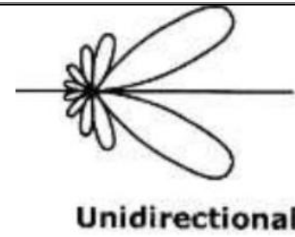
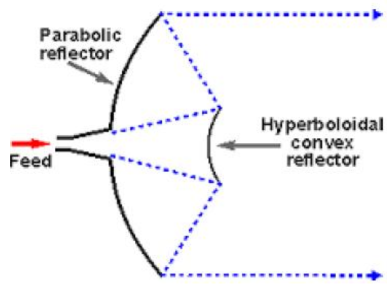
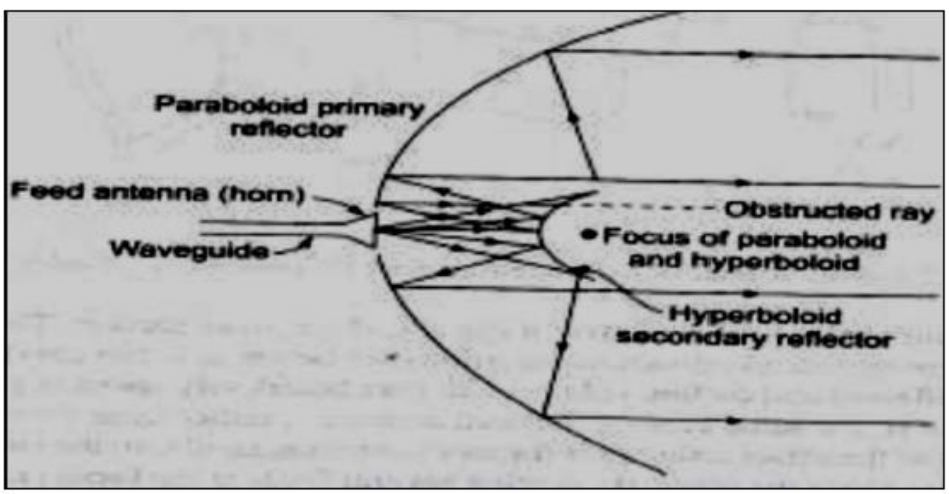
$$MUF = \frac{Critical\ frequency}{cos\theta}$$
$$= fc * Sec\ \theta$$

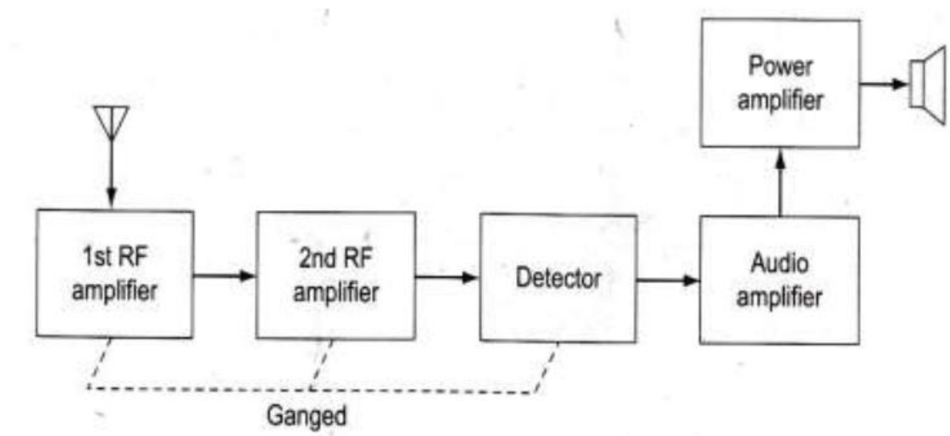
Skip distance: It is defined as the minimum distance from a transmit antenna that a sky wave at a given frequency will be returned to earth.
The point where the first wave returns to earth is called skip zone, because there is no reception in this region.

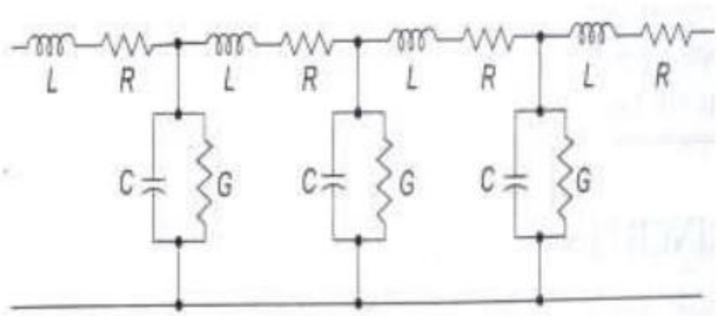
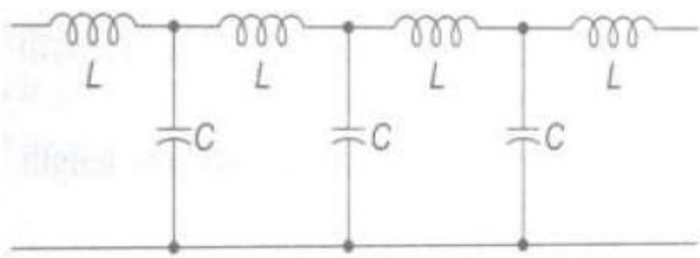
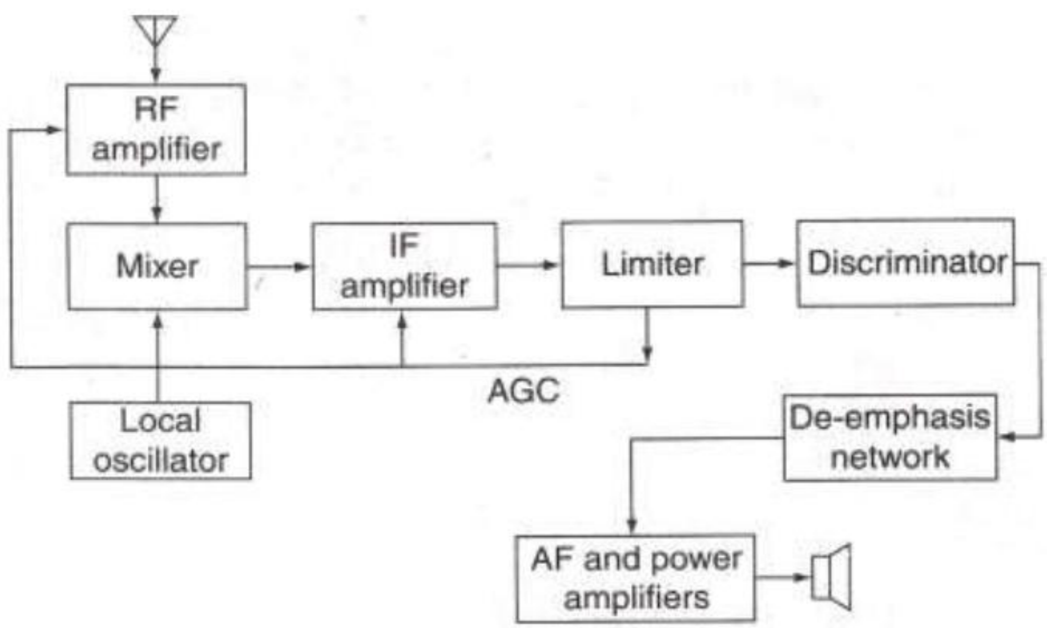
(b) **Distinguish between resonant and non resonant antennas.** — 4M

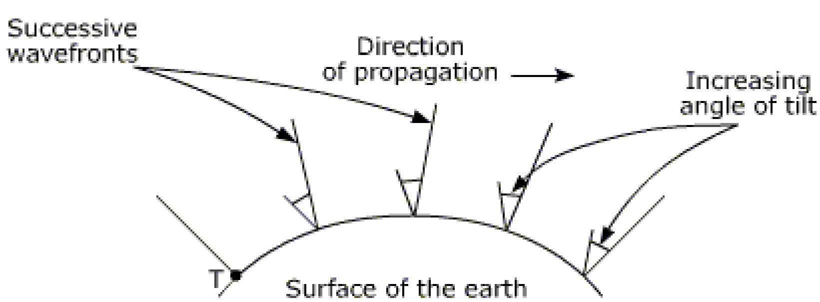
Ans: (1M each)

Resonant antenna	Non resonant antenna
Its length is exactly equal to multiples of half wavelength (λ / 2)	Its length is not exactly equal to multiples of half wavelength (λ / 2)
The radiation pattern is of figure of eight	The radiation pattern is of figure of eightbut it is unidirectional antenna.
The standing wave is present because it is open at both ends.	The standing wave is not present because it is terminated in correct impedance at both ends.
The reflection of signal occurs.	The reflection of signal does not occurs.
Radiation pattern:	**Radiation pattern:**

	 		
	(c)	**Describe the working principle of parabolic reflector antenna with Cassegrain feed.**	**4M**
	Ans:	**Diagram :**  **OR** 	**2M**
		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 focus. • The rays emitted from the primary antenna are reflected from the Cassegrain sub-reflector and then illuminate the main parabolic reflector just as if they had originated at the focus. • The sub-reflector must have a hyperboloidal curvature to reflect the rays from the primary antenna in such a way as to function as a virtual source at the paraboloidal	**2M**

		focus. • The Cassegrain feed is commonly used for receiving extremely weak signals or when extremely long transmission lines or waveguide runs are required and it is necessary to place low-noise preamplifiers as close to the antenna as possible.	
	(d)	**Draw block diagram of TRF radio receiver and state its operation.**	**4M**
	Ans:	**Diagram:**  **Fig. Block diagram of 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.	**2M** **2M**
	(e)	**Draw the equivalent circuit of transmission line for low and radio frequency. What are the different component in it ?**	**4M**

	Ans:	 **Figure:-Equivalent circuit of Transmission line for low frequency**  **Figure:- Equivalent circuit of Transmission line for radio frequency**	2M each
	(f)	**Draw the block diagram of FM radio receiver and describe its operation.**	4M
	Ans:	**<u>Block diagram of FM radio receiver-</u>**  **Fig. Block diagram of FM radio receiver** **<u>Operation :</u>** **<u>RF amplifiers:</u>**	2M 2M

		Its main purpose is to reduce the noise figure, which could otherwise be a problem because of the large bandwidth needed for FM. It also required matching the input impedance of the receiver to that of the antenna. **Local oscillators and Mixers:** The oscillator circuit takes any of the usual forms, with the colpitts and clap predominant, being suited to VHF operation. A very satisfactory for the front end of an FM receiver consists of FET's for the RF amplifier and mixer, and a bipolar transistor oscillator. **Intermediate frequency and IF amplifiers:** Typical figures for receivers operating in the 88- to 108-MHz band are an IF of 10.7MHz and a bandwidth of 200 kHz. Two IF amplifiers stages are often provided ,in which case the shrinkage of bandwidth as stages are cascaded must be taken into account.	
Q. 3		**Attempt any four FOUR :**	**16M**
	(a)	**Define the term standing wave radio. Why is a high value of SWR undesirable?**	**4M**
	Ans:	**Definition of SWR:** It is defined as the ratio of the maximum voltage to the minimum voltage or the maximum current to the minimum current of a standing wave on a transmission line. $$SWR = \frac{V_{max}}{V_{min}} \ (unitless)$$ **Why is a high value of SWR undesirable:** When incident and reflected waves are equal in amplitude (a total mismatch), SWR is infinity. This is the worst case condition. This means that complete transmitted wave is reflected back to the source which is not desirable.	**2M** **2M**
	(b)	**Draw and explain ground wave propagation.**	**4M**
	Ans:	**Diagram :**  **Explanation:** • 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.	**2M** **2M**

		• 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.	
	(c)	**Define :** **(i)Directivity** **(ii)ERP** **(iii)Antenna resistance** **(iv)Bandwidth w.r.t Antenna**	**4M**
	Ans:	**<u>Directivity :-</u>** It is the maximum directive gain which is obtained in only one direction in which the radiation is maximum. Thus Directivity = Max. directive gain **<u>ERP:</u>** It is the output power of the transmitter, plus the gain of the antenna, minus the attenuation and losses incurred by cable runs and connectors in-between the transmitter and antenna. **<u>Antenna resistance:</u>** The antenna resistance has two components: (i) **Radiation resistance:** it is defined as the ratio of the power radiated by the antenna to square of the current at the input of the antenna feed point. $Rr = \frac{Pt}{I^2}$ Where Pt is radiated power by antenna I is the current at feed point (ii) Resistance due to actual losses in the antenna **<u>Bandwidth w.r.t Antenna:</u>** It is defined as the frequency range over which the operation of antenna is satisfactory. It is the frequency difference between half power points.	**1M each**
	(d)	**With the help of diagram explain the operation of Yagi Uda antenna.**	**4M**
	Ans:	**<u>Diagram :</u>**	**2M**

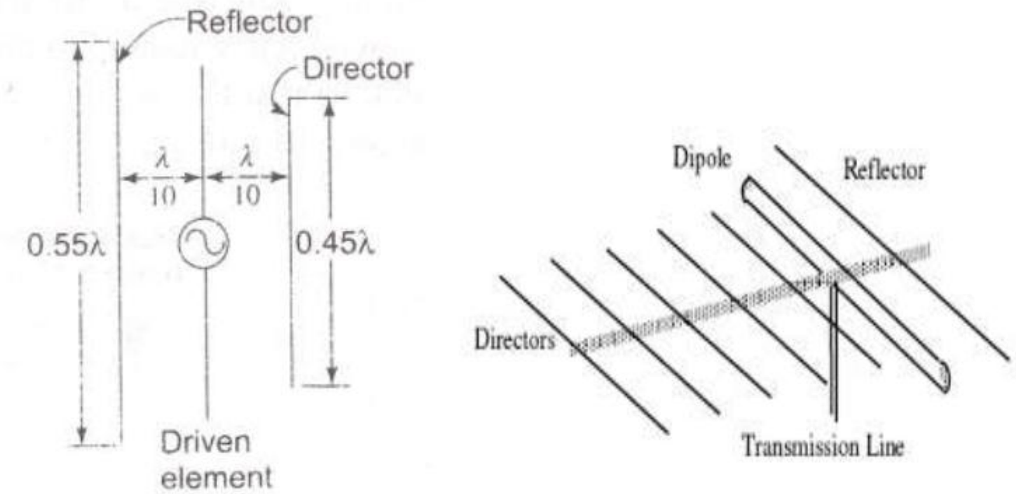
		 **Fig.Yagi uda antenna** **<u>Explanation :</u>** • A yagi antenna is a linear array consisting of a dipole and two or more parasitic elements; one reflector and one or more directors. • The driven element is a half-wavelength folded dipole; it is connected to the transmission lines however, it is generally used for receiving only. • The reflector is a straight aluminum rod approximately 5% longer than the dipole, and the director is cut approximately 5% shorter than the driven element. • There are one or more directors in Yagi antenna, which guide the required signal to dipole for proper reception by enhancing the signal strength.	**2M**
	(e)	**What is AGC? Draw and explain the circuit of simple AGC.**	**4M**
	Ans:	**<u>Concept:</u>** An AGC circuit compensates for minor variations in the received RF signal level. The AGC circuit automatically increases the receiver gain for weak RF input levels and automatically decreases the receiver gain when a strong RF signal is received. **<u>Explanation:</u>** • The circuit shown below is a negative peak detector and produces a negative voltage at its output. The greater the amplitude of the input carrier, the more negative the output voltage. • The negative voltage from the AGC detector is fed back to the IF stage, where it controls the bias voltage in the base of Q_1. When the carrier amplitude increases, the voltage on the base of Q_1 becomes less positive, causing the emitter current to decrease. • As a result, **re'** increases and the amplifier gain decreases, which in turn causes the carrier amplitude to decrease. When the carrier amplitude decreases, the AGC voltage becomes less negative, the emitter current increases, **re'** decreases. And the amplifier gain increases. • Capacitor C_1 is an audio bypass capacitor that prevents changes in the AGC voltage due to modulation from affecting the gain of Q_1.	**1M** **1½M**

Diagram : 1½M

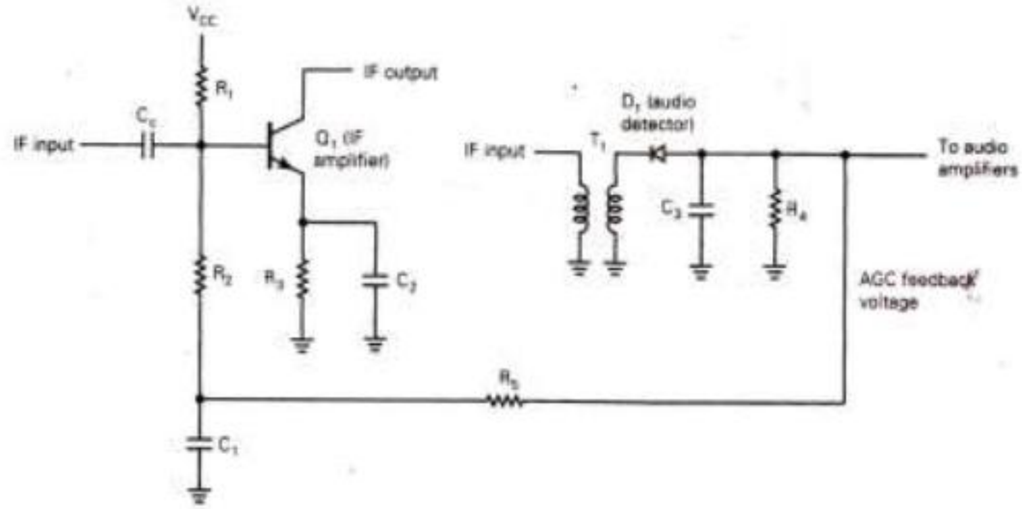
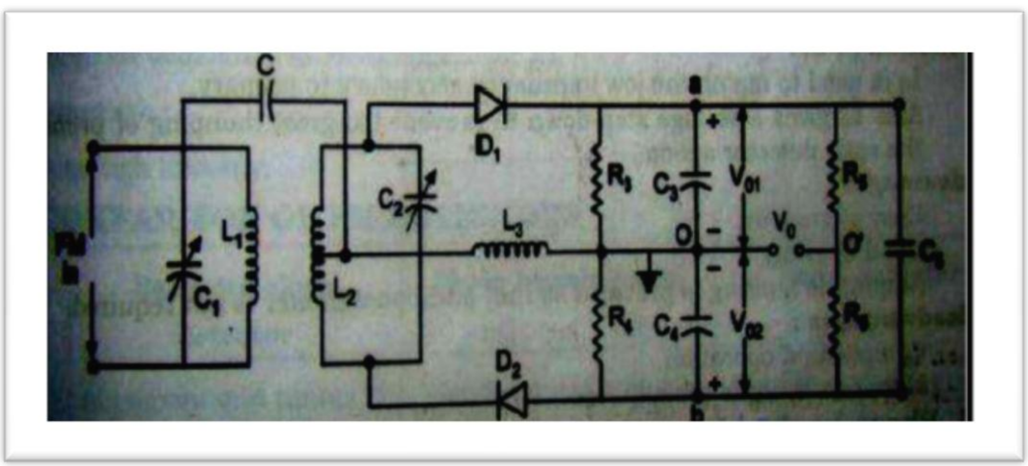


Fig. AGC circuit diagram

(f) **Draw and explain the operation of Ratio detector.** **4M**

Ans: **Diagram :** **2M**

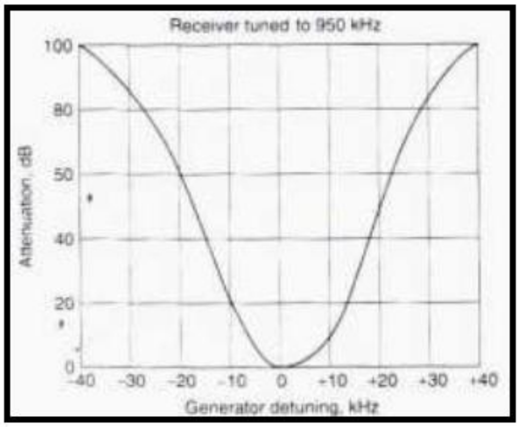
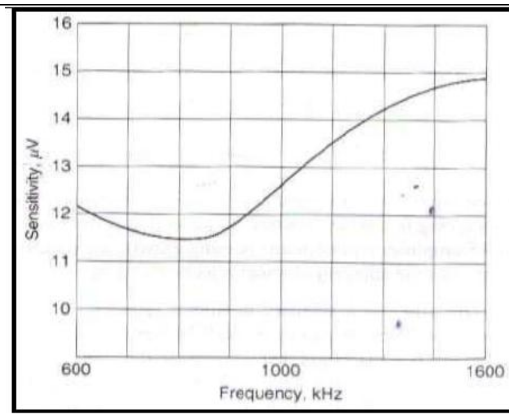
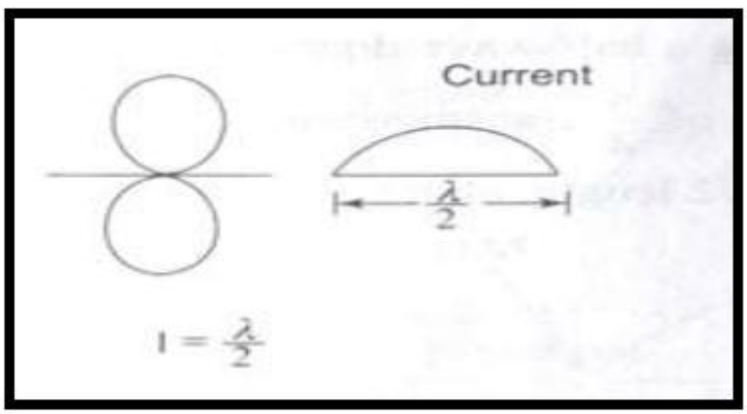
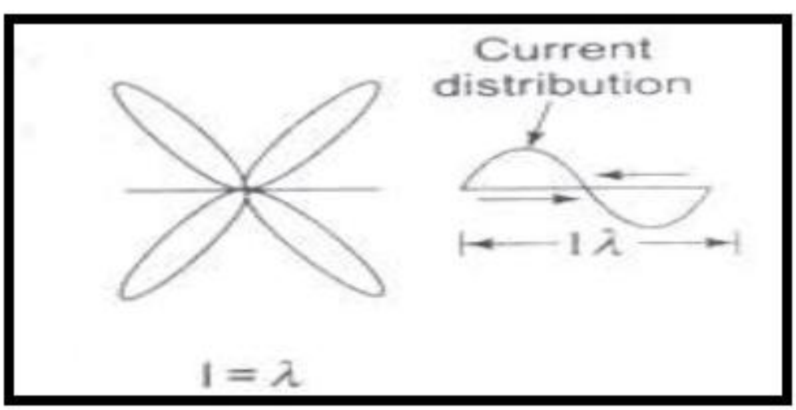


Operation: **2M**

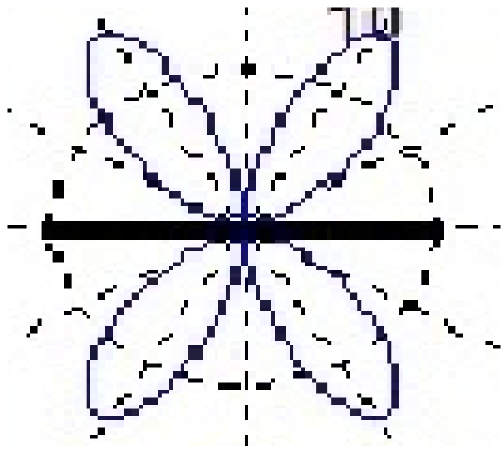
- With diode D_2 reversed biased, point O is now positive with respect to b, so that Vab is now sum voltage.
- Large capacitor C_5 is connected to keep the o/p sum voltage constant, even though the load current increases. Thus provides the amplitude limiting.
- Output voltage Vo is equal to half of the difference between the output voltages from the individual diodes

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

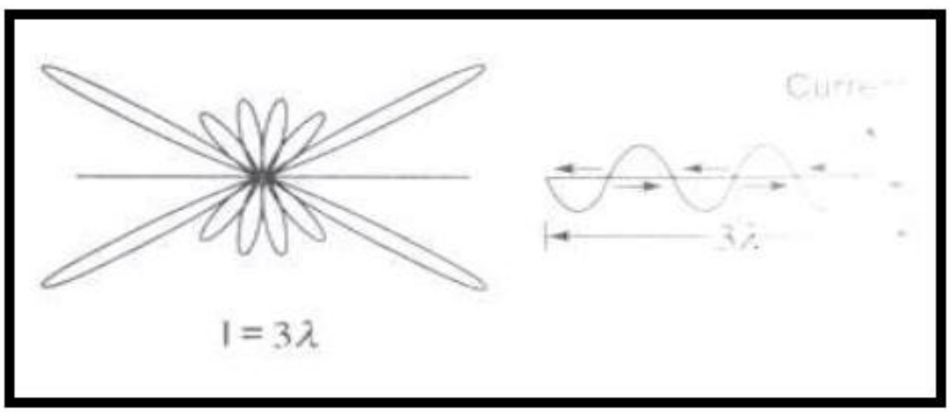
		• Thus output voltage is proportional to the difference between the individual output voltages. • L_3 matches the low impedance secondary to primary and also it provides voltage step down to prevent too great damping of primary by the ratio detector action.	
Q. 4	**A)**	**Attempt any FOUR :**	**16M**
	(a)	**What is fading? List its causes.**	**4M**
	Ans:	**<u>Fading :</u>** In wireless communications, fading is deviation of the attenuation affecting a signal over certain propagation media. **<u>Causes :</u>** In wireless systems, fading may either be due to multipath propagation, referred to as multipath induced fading, or due to shadowing from obstacles affecting the wave propagation, sometimes referred to as shadow fading.	**2M** **2M**
	(b)	**Explain radiation and dielectric losses in transmission line.**	**4M**
	Ans:	**<u>Radiation Loss:</u>** Radiation losses occur because a transmission line may act as an antenna if the separation of the conductors in an appreciable fraction of wavelength. This applies more to parallel wire lines than to co-axial lines. Radiation losses are difficult to estimate, being normally measured rather than calculated. They increase with frequency for any given transmission line, eventually ending that line's usefulness at some frequency. **<u>Dielectric Loss:</u>** Dielectric heating 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 of gradually worsening properties with increasing frequency for any given dielectric medium. For air, dielectric heating remains negligible.	**2M** **2M**
	(c)	**Define the terms sensitivity, selectivity w.r.t AM Receiver and draw its characteristic curve.**	**4M**
	Ans:	**<u>Sensitivity of AM receiver:</u>** It is defined as its ability to amplify weak signals. 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 It is measured in μv or dB below 1V **<u>Selectivity of AM receiver:</u>** It is the ability to reject unwanted signals.	**(Each Definition 1M, each characteristic curve 1M each)**

		 **Fig. Selectivity:**  **Fig. Sensitivity**	
	(d)	**Draw the radiation pattern for resonant dipole with following lengths :** **(i) L = λ/2** **(ii) L = λ** **(iii) L = 2λ** **(iv) L = 3λ**	**4M**
	Ans:	**Radiation pattern for resonant dipole L = λ/2**  **Radiation pattern for resonant dipole L = λ**  	**1M each**

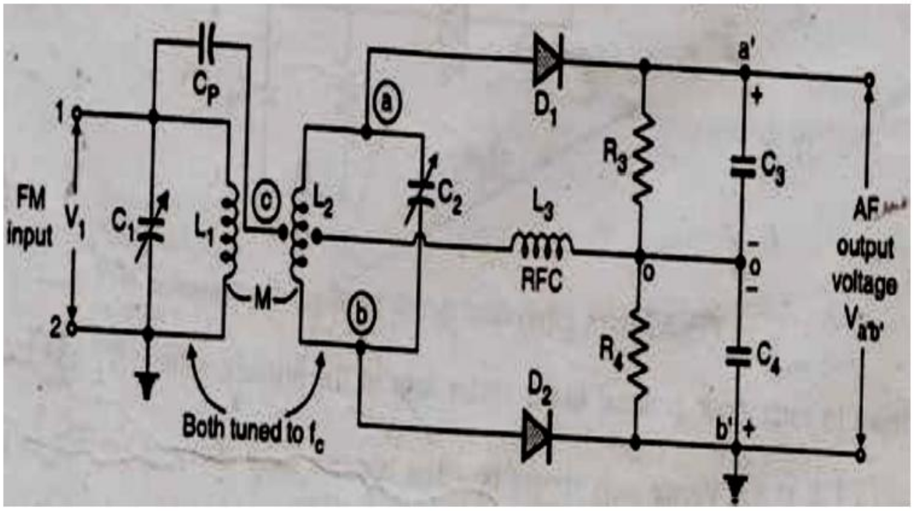
Radiation pattern for resonant dipole L = 2λ



Radiation pattern for resonant dipole L = 3λ



	(e)	**State various factors influencing the choice of IF for radio receivers.**	**4M**
	Ans:	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. Thus the choice of the IF depends on the following factors. **Factors influencing the choice of IF for radio receivers :** • IF should not be too high as it will result poor selectivity and therefore poor adjacent channel rejection • If IF is too high the tracking problem increases. • If IF is lowered then the image frequency rejection is poorer. • A very low IF can make the selectivity too sharp cutting the sidebands. • For very low IF, the frequency stability of L.O must be very high. Because a small drift in L.O frequency results in large error. • 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. • In the standard broadcast AM receivers IF is within the range of 438 to 465 KHz being the most popular Frequency	**(Any four 1M each)**
	(f)	**Draw and explain the operation of Foster seeley discriminator.**	**4M**
	Ans:	**Diagram :**	**2M**



Explanation:

(i) Output voltage at fin=fc: — 2M

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. 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 center frequency fc, secondary voltage V_{ab} leads the primary voltage V_1 by less than 90^0.

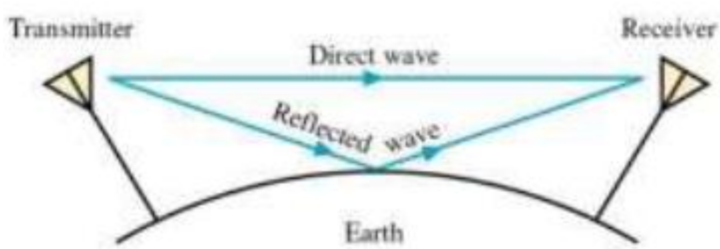
Hence input voltage to D_1 V_{ao} is higher than input to D_2 i.e V_{bo}. The output voltage therefore be positive for fin>fc.

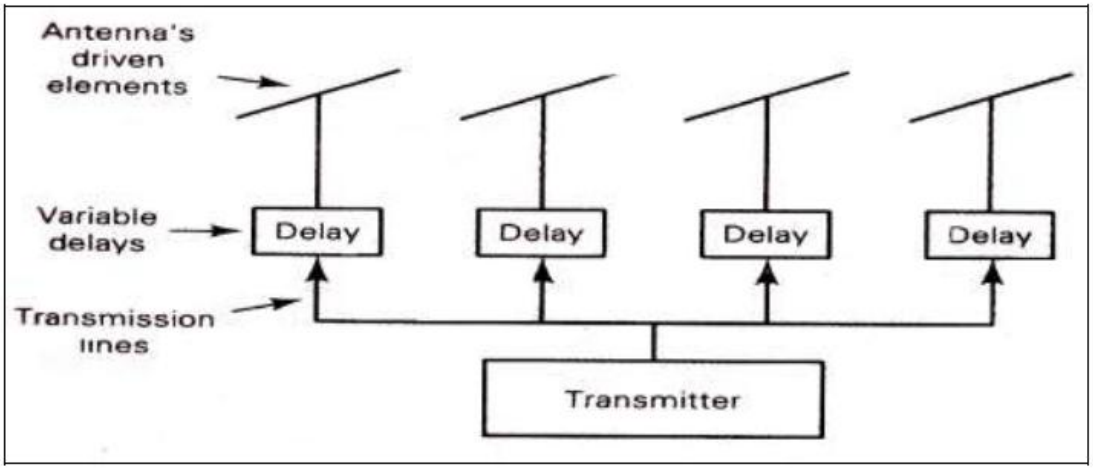
(iii) Output voltage for fin < fc:

For input frequencies below the center frequency fc, the secondary voltage Vab leads the primary voltage V_1 by more than 90^0.

Hence input voltage to D_1 is less than input voltage to D_2. Therefore the output voltage will be negative for fin < fc.

Q.5		**Attempt any FOUR :**	**16M**
	(a)	**Derive the relation between reflection coefficient and standing wave ratio.**	**4M**

	Ans:	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.**	**4M**
	Ans:	**<u>Diagram :</u>**  **<u>Explanation:-</u>** • 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.	**2M** **2M**

	(c)	**Draw and explain the operation of phased arrays.**	**4M**
	Ans:	**Diagram :** ***Note: Any other relevant diagram should be considered***  **Fig. Phased Array.**	**2M**
		Operation : • 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:** i. 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. ii. 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.	**2M**
	(d)	**Draw the block diagram of super-heterodyne AM receiver and describe the function of each block**	**4M**
	Ans:	**Diagram:**	**2M**

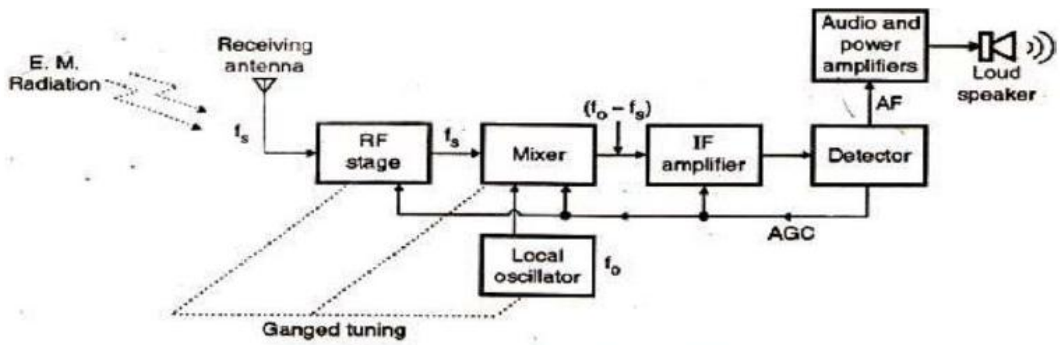


Fig.: The superheterodyne receiver

<u>OR</u>

<u>Note: Any other relevant diagram to be considered</u>

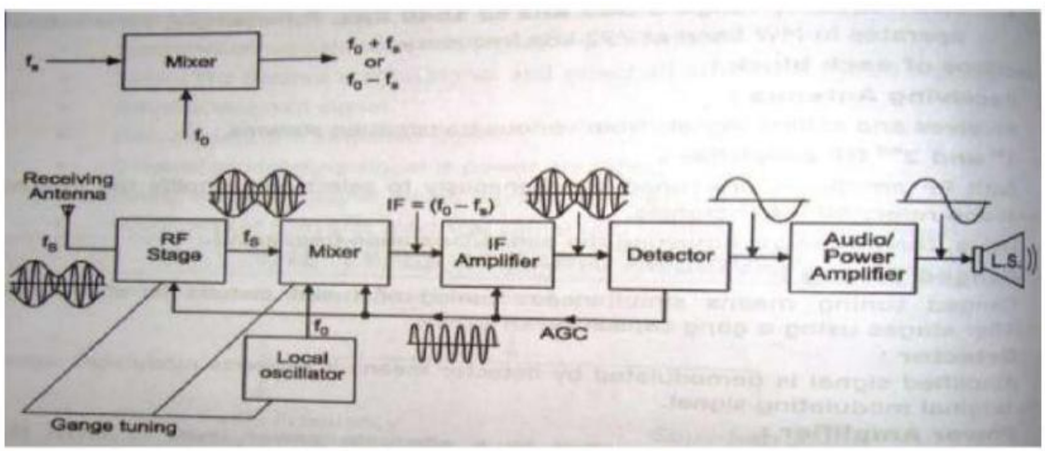


Fig.Block diagram of super-hetrodyne receiver

<u>Function:</u>

The received signal is in the form of electromagnetic waves, it induces very small voltage into the receiving antenna.

<u>RF stages:</u> 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.

<u>Mixer:</u> 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.

<u>Intermediate Frequency (IF):</u> 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 provides most of the gain and bandwidth of the receiver.

<u>Detector:</u> The amplified IF signal is detected by the detector to recover the original modulating signal. This is then amplified and applied to the loudspeaker.

2M

	(e)	**Describe frequency tracking in AM receiver.**	**4M**

	Ans:	**<u>The frequency tracking in AM radio receiver:-</u>** • 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. Hence 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. f_0= fs + I.F. If the tuning is not done correctly then f_0 – fs = I.F. • Stations will appear away from their current position on frequency dial of the receiver. The Process in which the local oscillator frequency follows or tracks the signal frequency to have a correct frequency difference is called as frequency tracking.	**4M**
	(f)	**Describe the concept of AFC and its necessity in FM receiver.**	**4M**
	Ans:	**<u>Concept of AFC:-</u>** In radio equipment, Automatic Frequency Control (AFC), also called Automatic Fine Tuning (AFT), is a method or circuit to automatically keep a resonant circuit tuned to the frequency of an incoming radio signal. It is primarily used in radio receivers to keep the receiver tuned to the frequency of the desired station. **<u>Necessity of AFC in FM receiver:</u>** In radio communication, AFC is needed because, after the band pass frequency of a receiver is tuned to the frequency of a transmitter, the two frequencies may drift apart, interrupting the reception. This can be caused by a poorly controlled transmitter frequency, but the most common cause is drift of the center band pass frequency of the receiver, due to thermal or mechanical drift in the values of the electronic components. Assuming that a receiver is nearly tuned to the desired frequency, the AFC circuit in the receiver develops an error voltage proportional to the degree to which the receiver is mistuned. This error voltage is then fed back to the tuning circuit in such a way that the tuning error is reduced. In FM receiver, the local oscillator frequency stability is a great problem, due to drift in frequency may take place because of temperature changes or aging of the components. So in order to correct the frequency of local oscillator automatically the AFC is used.	**2M** **2M**
Q.6		**Attempt any FOUR :**	**16**
	(a)	**Describe the properties of lines of different length for open and short circuit.**	**4M**
	Ans:	**<u>Explanation:</u>** At the higher frequency, it is not possible to use lumped components for impedance	**Diagram -1M, Explanation-3M**

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.

Diagram:

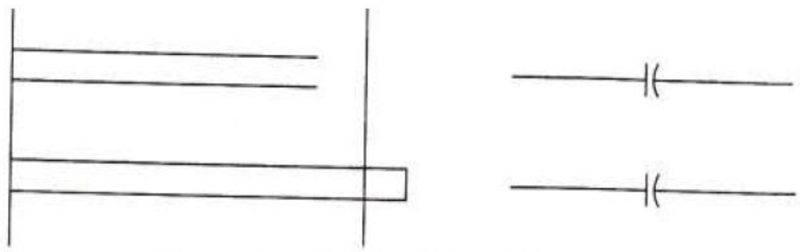


Figure: short length transmission line

(b)	**Explain fidelity and dynamic range of AM radio receiver.**	**4M**

Ans:

Fidelity :

It is the ability of receiver to reproduce all modulating frequency equally. Fidelity depends on frequency response of AF amplifier. High fidelity is essential to reproduce good quality music faithfully. **2M**

Dynamic Range:

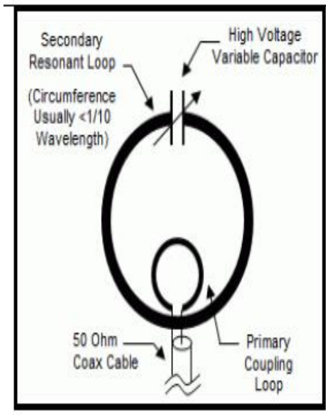
The dynamic range of a receiver is defined as the difference in decibels between the Minimum input level necessary to discern a signal and the input level that will overdrive the receiver and produce distortion. In simple terms, dynamic range is the input power range over which the receiver is useful **2M**

(c)	**Draw and explain the operation of loop antenna.**	**4M**

Ans:

Diagram :

Note:Any one diagram can be considered **2M**



OR

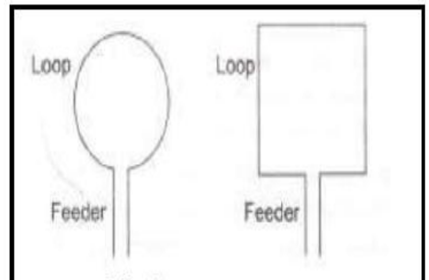
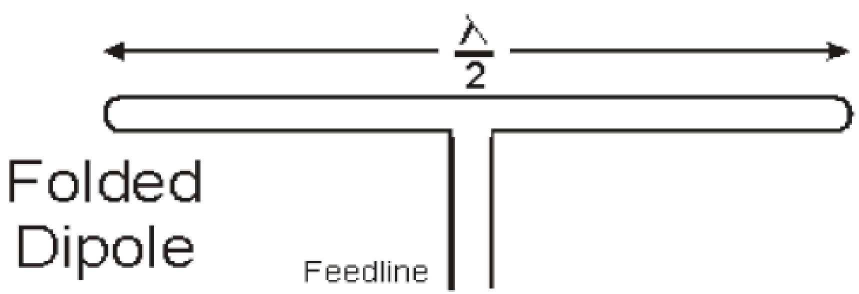


Fig.Loop antenna

Explanation: — 2M

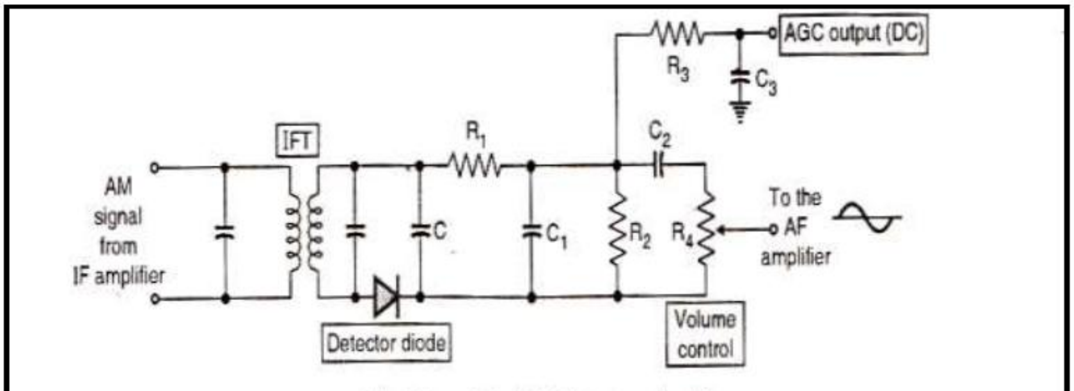
- The most fundamental loop antenna is simply a single turn coil of wire that is significantly shorter that one wavelength and carries RF current.
- A loop can be thought of as many elemental dipoles connected together.
- As dipoles are straight, therefore a loop is actually a polygonal rather than circular.
- 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.

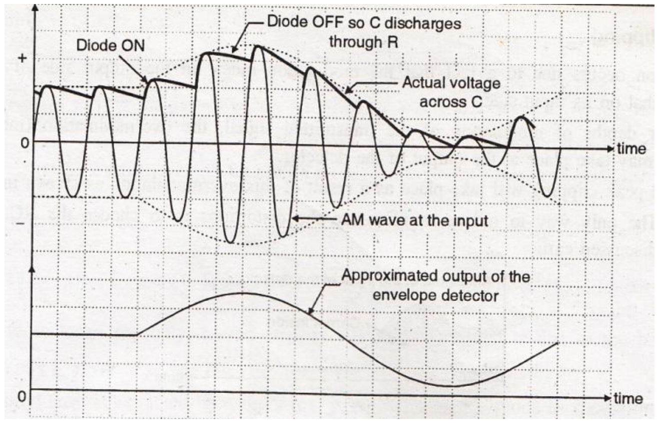
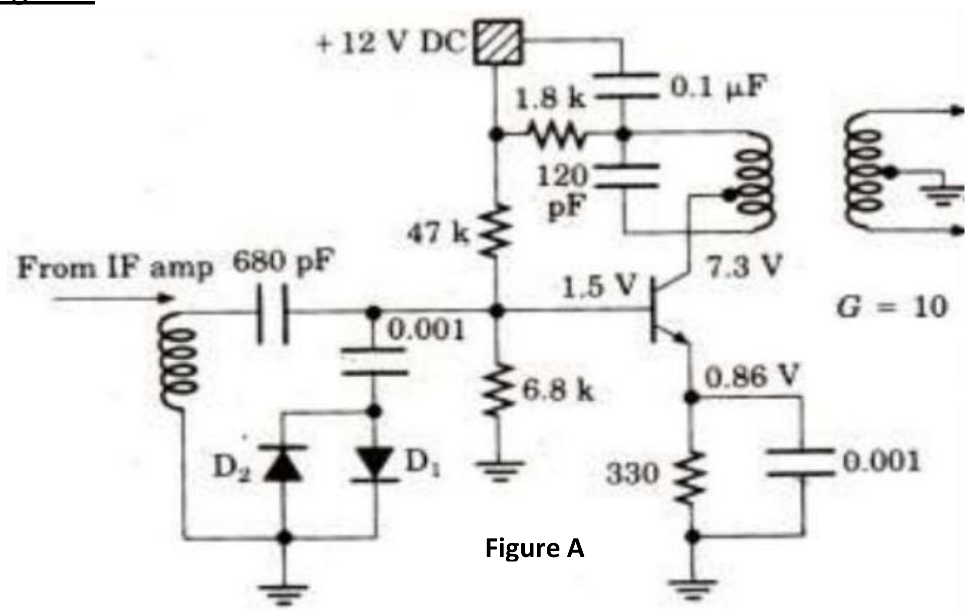
(d)	**Draw and explain the operation of dipole antenna.**	**4M**
Ans:	**Diagram :**	**2M**



Explanation: — **2M**

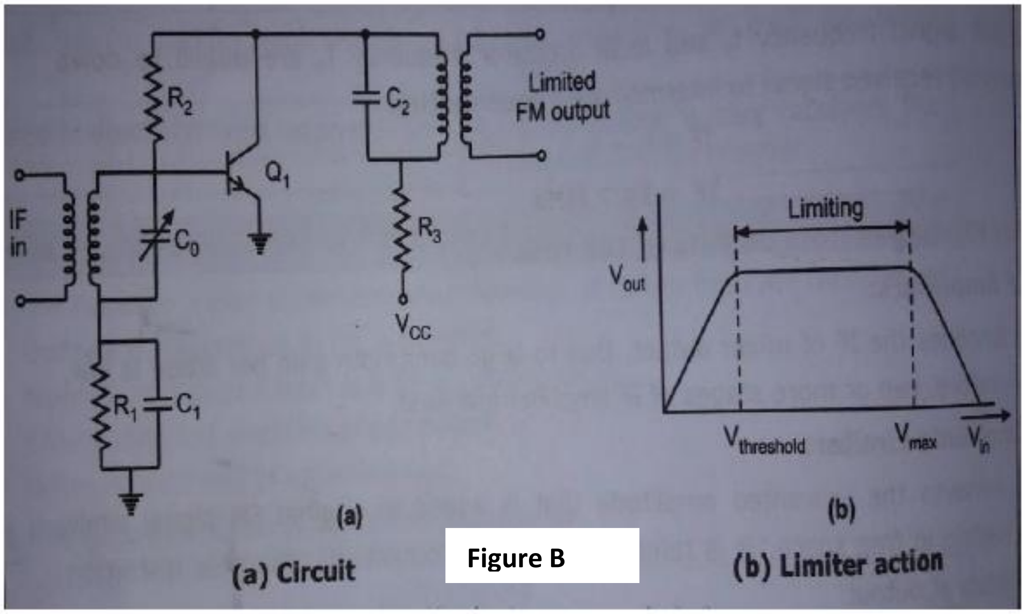
- Half wave dipole is one of the widely used antennas at frequencies above 2MHz.
- It is generally referred as hertz antenna.
- It is a resonant antenna.
- It is multiple of quarter wavelength line and open circuited at far end.
- Standing waves of voltages and current exist along the resonant antenna.
- Each pole of the antenna looks as if its an open quarter wave line section of transmission line.

		• There is voltage maximum and current minimum at the ends and voltage minimum and current maximum in the middle. • Assuming that the feed point at the centre, the input impedance is a minimum value. • The impedance at the ends of the antenna is a maximum value.	
	(e)	**Draw and explain the working of practical diode detector with waveform.**	**4M**
	Ans:	**Diagram:**  Fig. Practical diode detector circuit	**2M**
		Working : • 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. R_1 and R_2 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 R_4. • Hence across R_4 we get the demodulated signal with a zero dc shift. This signal is then applied to the AF amplifier. • The R_3-C_3 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 the AM signal higher is the dc AGC voltage.	**1M**

			**1M**
	(f)	**Draw and explain the operation of amplitude limiter used in FM receiver.**	**4M**
	Ans:	**Diagram:**  **Figure A** **Operation:- (Figure A)** • 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 greater than 0.7V on the positive peak, and diode D_2 will conduct on the portion of the negative half-cycle that exceeds -0.7Vp 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	**2M**

of the alternately driven into saturation and cutoff, it limits the signal amplitude.

OR



Operation:- (Figure B)

- The limiters remove any amplitude variations on the FM signal, before it being applied to demodulator.
- The limiter is a conventional class A IF amplifier. It is a band pass limiter which is used to remove any amplitude variations on the FM signal before it is applied to demodulator.
- To occur amplitude limiting it requires an IF input signal sufficient enough to drive the transistor into both saturation & cutoff.
- The output tank circuit is tuned to the IF center frequency.
- By driving the transistor between saturation cutoff, the positive & negative peaks of input signal is clipped off& thus any amplitude variation are removed.
- As shown in figure the output of the collector is a square wave, which is made up of many undesirable harmonics, is filtered back into sine wave by the tuned circuit at the collector.
- As shown in the wave form when Vin reaches Vthreshold limiting action begins & for input amplitudes above Vmax , There decreasing Vout with increasing Vin.