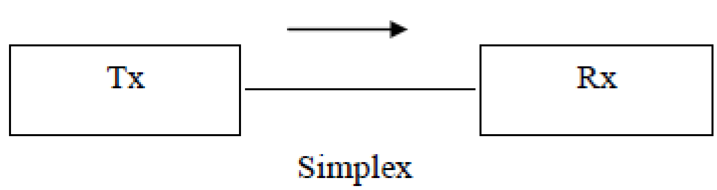
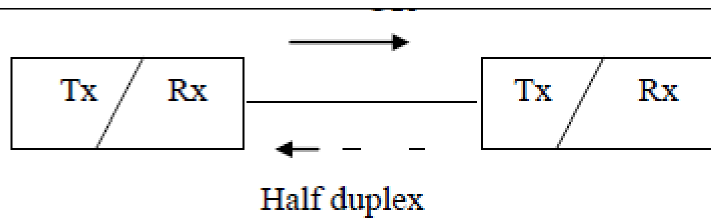
SUMMER-19 EXAMINATION

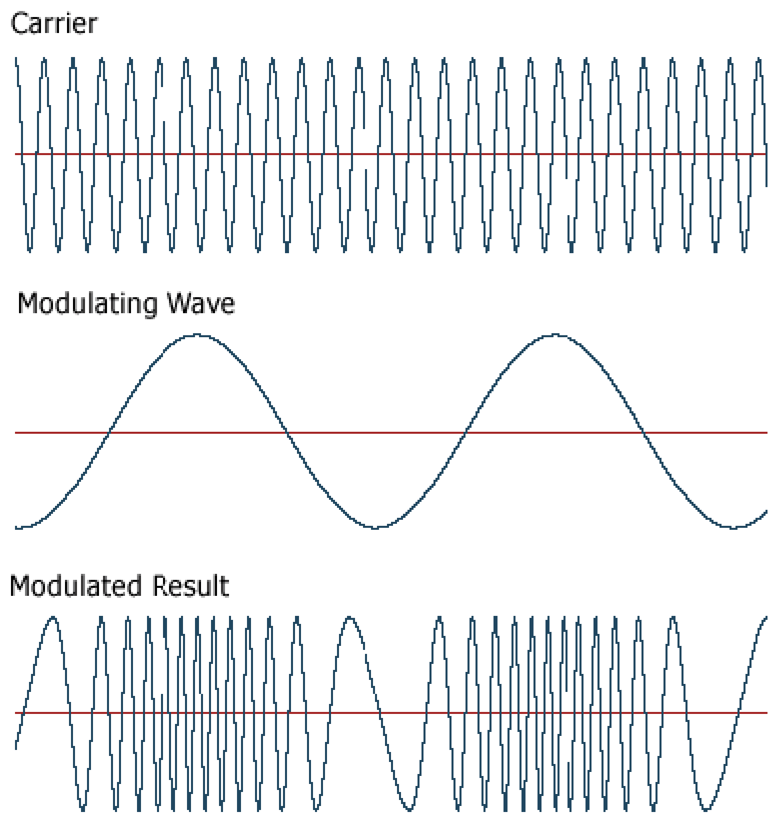
Subject Name: Principles of electronic communication **Model Answer** 22334

Important Instructions to examiners:

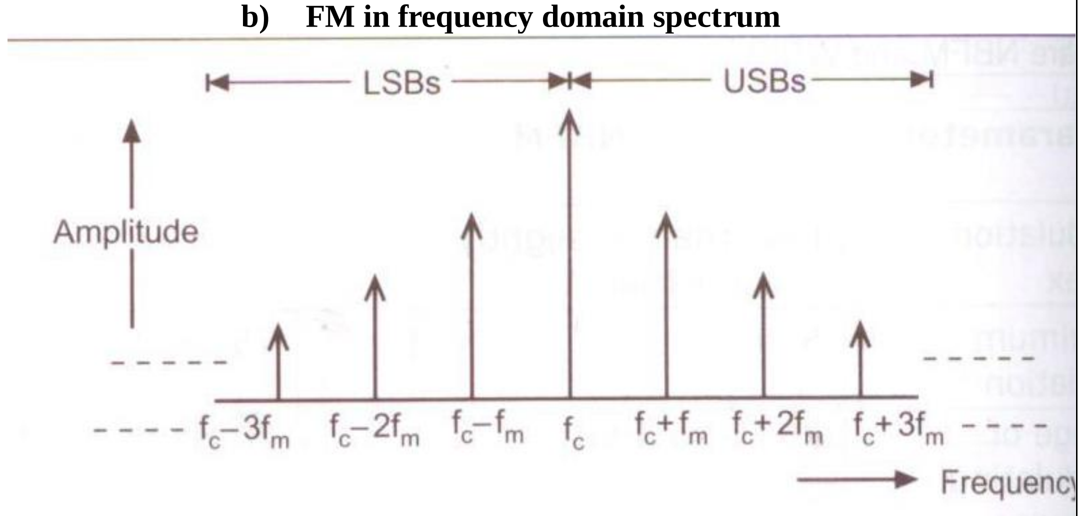
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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. No.	Sub Q. N.	Answers	Marking Scheme
1	**(A)**	**Attempt any FIVE of the following:**	**10- Total Marks**
	(a)	**Define simplex and half duplex system with neat sketch**	**2M**
	Ans:	**Simplex System**: - The system in which the information is communicated only in one direction, called as simplex system e.g. TV broadcasting or radio.  **Fig: Simplex System** **Half Duplex System**: The system which is bidirectional that is they can transmit as well receive information but one at a time is known as half duplex.	**1M per system(1/2 mark definition &1/2 mark sketch)**

		 **Fig: Half Duplex System**	
	(b)	**Define term signal to noise ratio.**	**2M**
	Ans:	**Signal to Noise ratio**: The ratio of the strength of an electrical or other signal carrying information to that of unwanted interference is called as signal to noise ratio. OR Signal to Noise Ratio is defined as the ratio of signal power to the noise power at the same point. S/N=Ps/Pn where,Ps=Signal Power Pn=Noise Power at the same point	**2 M for correct definition**
	(c)	**Represent FM wave in time domain and frequency domain**	**2M**
	Ans:	**a) FM in time domain spectrum**	**1M for each domain**



b) FM in frequency domain spectrum



(d)	**State the types of AM w.r.t. frequency spectrum**	**2M**
Ans:	Types of AM based on frequency spectrum: 1)Double side-band Full Carrier System(DSB-FC) 2) Double side-band Suppressed Carrier System (DSB-SC)	**½ mark for any 4 types**

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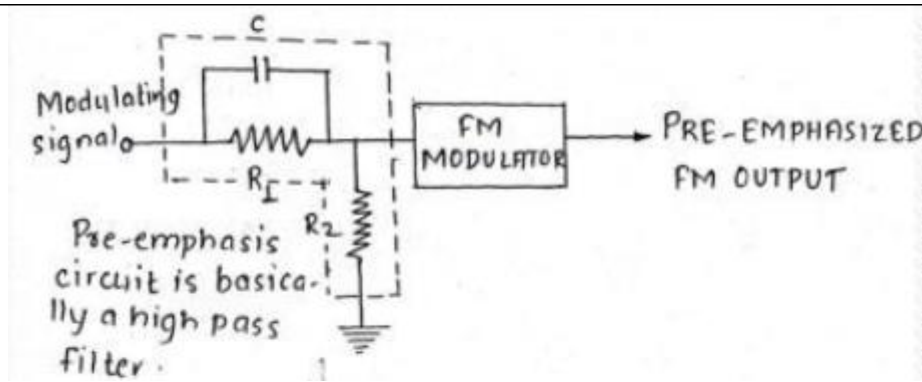
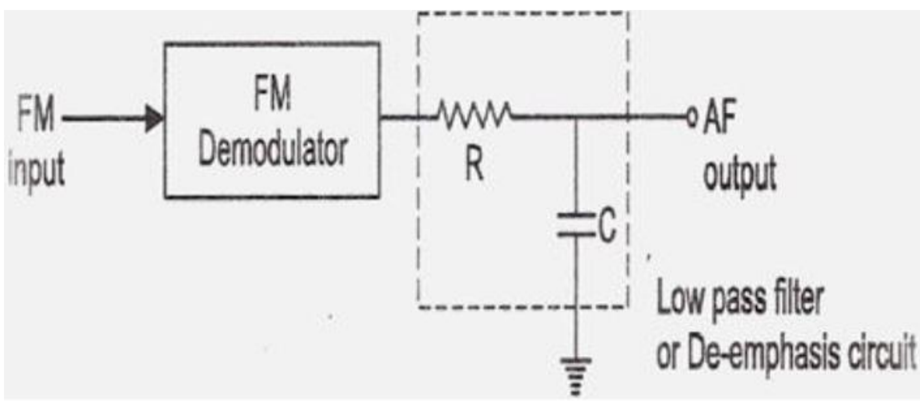
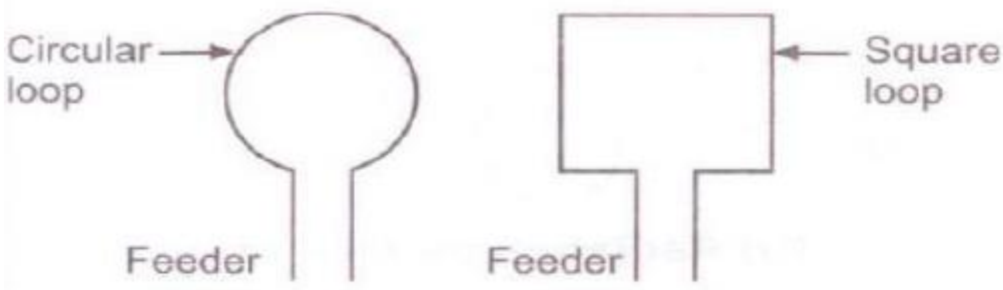
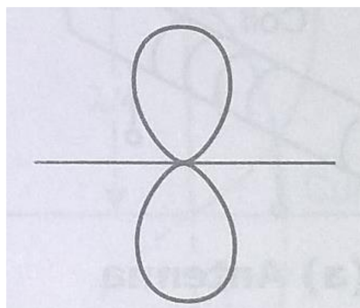
		3)Single Sideband Suppressed Carrier System(SSB-SC) 4)Independent Sideband System(ISB) 5)Vestigial Sideband System(VSB)	
	e)	**Draw pre emphasis and de emphasis circuit used in FM transmission and reception**	**2M**
	Ans:	 **Fig-Pre emphasis Circuit**  **Fig-De emphasis Circuit**	**1 M per circuit**
	f)	**Define fading w.r.t. wave propagation**	**2M**
	Ans:	**Fading:** The fluctuation in signal strength at a receiver, which is mainly due to the interference of two waves which left the same source but arrived at the destination by different paths, is known as fading.	**2M for correct definition**
	g)	**Draw sketch of Loop antenna along with its radiation pattern**	**2M**

	Ans:	 **Fig: Loop Antenna**  **Fig: Radiation Pattern**	**1M sketch & 1M radiation pattern**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total Marks**
	a)	**Explain the sources of noise in communication system**	**4M**
	Ans:	Noise: Noise is any spurious or undesired disturbances that mask the received signal in a communication system. a**) Atmospheric Noise :** Atmospheric Noise is also known as static noise which is the natural source of disturbance caused by lightning, discharge in thunderstorm and the natural disturbances occurring in the nature. **b) Industrial Noise :** Sources of Industrial noise are auto-mobiles, aircraft, ignition of electric	Any 4 source with ief explanatio m

motors and switching gear.

c) Extraterrestrial Noise : Extraterrestrial Noise exist on the basis of their originating source. They are Solar Noise
ii) Cosmic Noise

Internal Noise are the type of Noise which are generated internally or within the Communication System or in the receiver. They are as follows:

1) Shot Noise : These Noise rises in the active devices due to the random behaviour of Charge particles or carries. In case of electron tube, shot Noise is produces due to the random emission of electron form cathodes.

2) Partition Noise : When a circuit is to divide in between two or more paths then the noise generated is known as Partition noise. The reason for the generation is random fluctuation the division.

3) Low- Frequency Noise : They are also known as FLICKER NOISE. These type of noise are generally observed at a frequency range below few kHz. Power spectral density of these noise increases with the decrease in frequency. That why the name is given Low- Frequency Noise.

4) High- Frequency Noise : These noises are also known TRANSIT- TIME Noise. They are observed in the semi-conductor devices when the transit time of a charge carrier while crossing a junction is compared with the time period of that signal.

5) Thermal Noise : Thermal Noise are random and often referred as White Noise or Johnson Noise. Thermal noise are generally observed in the resistor or the sensitive resistive components of a complex impedance due to the random and rapid movement of molecules or atoms or electrons.

Dark current noise: When there is no optical power incident on the photodetector a small reverse leakage current still flows from the device terminals. This Dark current contributes to the total system noise and gives random fluctuations about the average particle flow of the photocurrent.

The Dark current noise is given by:

$$i_d^2 = 2eBI_d$$

where e is the charge on an electron

Id is the dark current

⇒Quantum noise: Discrete nature of electrons cause a signal disturbance called Quantum noise or Shot noise.It arises from the statistical nature of the production and collection of photoelectrons. It is given by

$$i_s^2 = 2eBI_p$$

		Ip is the photocurrent	
	b)	**Explain power relation in AM wave**	**4M**
	Ans:	**i) The Total power in AM (Pt) :** Pt = (Carrier power) + (Power in USB) + (Power in LSB) $P_t = P_C + P_{USB} + P_{LSB}$ $\therefore \quad P_t = \frac{Er^2 carr}{R} + \frac{Er^2 USB}{R} + \frac{Er^2 LSB}{R}$ **(1 mark)** Where, E_{rcarr}, E_{rUSB}, E_{rLSB} = R.M.S. values of the carrier and side band amplitudes R = characteristics resistance of antenna in which total power is dissipated. **OR** **ii) Carrier power (Pc):** $P_c = \frac{Er^2 carr}{R}$ $= \frac{(E\sqrt{2})^2}{R}$ $\mathbf{P_c = \frac{E^2 c}{2R}}$ Where, Ec = Peak carrier amplitude **OR**	4M for correct answer

iii) Power in sidebands:

The power in USB and LSB is same as,

$$P_{USB} = P_{LSB} = \frac{Er^2SB}{R}$$

$$\text{Peak amplitude of sideband} = \frac{mEc}{2}$$

$$\therefore \quad P_{USB} = P_{LSB} = \frac{(mEr2\sqrt{2})^2}{R}$$

$$= \frac{m^2E^2c}{8R}$$

$$\therefore \quad P_{USB} = P_{LSB} = \frac{m^2}{4} X \frac{E^2c}{2R}$$

$$\frac{E^2c}{2R} = Pc$$

$$\therefore \quad \mathbf{P_{USB} = P_{LSB} = \frac{m^2}{4} Pc}$$

Or

iv) Total power in AM :

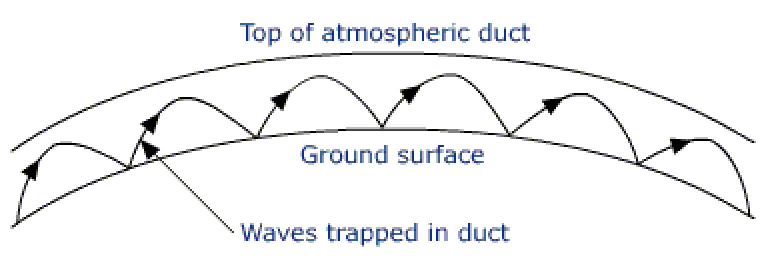
The total power in AM is,

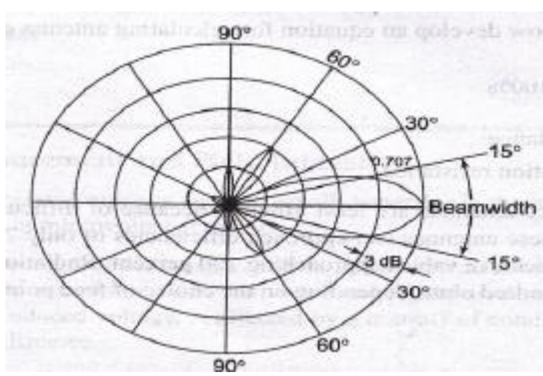
$$Pt = Pc + P_{USB} + P_{LSB}$$

$$= Pc + \frac{m^2}{4}Pc + \frac{m^2}{4}Pc$$

$$\therefore \quad Pt = (1 + \frac{m^2}{2})\, Pc$$

c)	**Explain Duct propagation with neat sketch**	**4M**
Ans:	**Duct propagation: (Microwave Space Wave Propagation)**	2M diagram & 2M explanation



		Duct propagation is the special type of phenomenon which is also called as **“super refraction”.** It is observed at very high microwave frequencies. As the height above the earth increases, the air density decreases and the refractive index increases. The change in the refractive index is normally linear and gradual. However under certain special atmospheric condition, a layer of warm air may get trapped above the cooler air. This happens usually over the surface of the water. Due to this the refractive index will decreases more rapidly with height than usual. This happens near the ground normally within a distance of 30 meters above the surface. Due to this rapid reduction of refractive index, the microwave will completely bend back towards the earth surface. Microwaves are thus continuously refracted inside the duct and reflected back by the conducting ground or water surface. These waves then then propagate around the curvature of the earth over a distance of 1000 Km. The region in which super refraction takes place is called duct.	
	d)	**Explain the term beam width related to antenna with a sketch**	**4M**
	Ans:	The beamwidth of an antenna is described as the angles created by comparing the half power points (3 dB) on the main radiation to be its maximum power points. 	2M diagram & 2M explanation
Q. No.	Sub Q. N.	Answers	Marking Scheme

<table>
<tr><td>3</td><td></td><td>Attempt any THREE of the following :</td><td>12- Total Marks</td></tr>
<tr><td></td><td>a)</td><td>A 500 watts carrier is modulated to depth of 80%
Calculate :
(i) Total power in AM
(ii) Power in side bands</td><td>4M</td></tr>
<tr><td></td><td>Ans:</td><td>Given :- $P_c = 500$ watts
$m = 80\% = 0.8$
i) Total power in AM :- — (2M)
$P_t = \left(1 + \frac{m^2}{2}\right) \cdot P_c$
$= \left(1 + \frac{0.8^2}{2}\right) \times 500$
$\therefore P_t = 660$ watt
ii) Power in side bands :- — (2M)
$P_{USB} = P_{LSB} = \frac{m^2}{4} \times P_c$
$= \frac{0.8^2}{4} \times 500$
$\therefore P_{USB} = P_{LSB} = 80$ watt
Scanned with</td><td>2M-for each calculation</td></tr>
<tr><td></td><td>b)</td><td>A frequency modulated signal is represented by the voltage equation
$e_{fm} = 10 \sin(6 \times 10^8 t + 5 \sin 1250 t)$
calculate :
(i) Carrier frequency f_c
(ii) Modulating frequency f_m
(iii) Maximum deviation</td><td>4M</td></tr>
</table>

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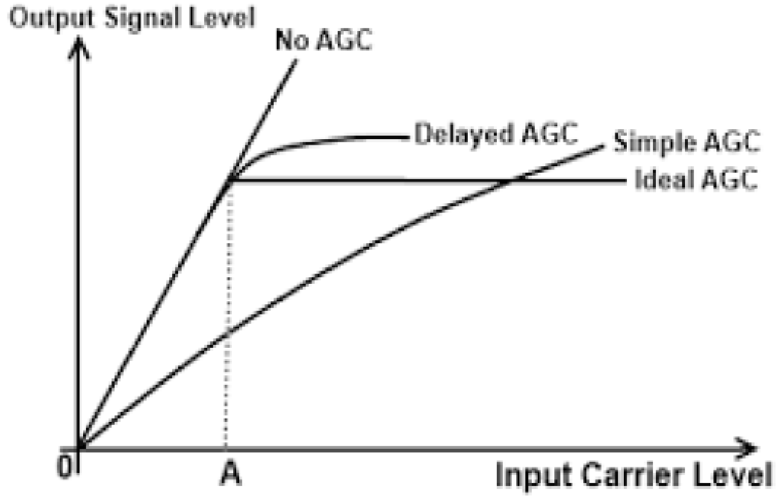
		(iv) What power will this FM wave dissipate in 20 Ω resistor	
	Ans:	Soln: A frequency modulated signal is given by– $e_{FM} = 10 \sin(6\times10^8 t + 5 \sin 1250 t)$ i) Carrier Frequency, f_c : As we know, $e_{FM} = 10 \sin(6\times10^8 t + 5 \sin 1250 t)$ -- (given) —(1) And, The standard expression for FM wave is $e_{FM} = E_c \sin[(2\pi f_c t) + m_f \sin(2\pi f_m t)]$ —(2) Comparing eqn (1) and eqn (2) ∴ $e_{FM} = 10 \sin(2\pi f_c t + \frac{\delta}{f_m} \sin \omega_m t)$ ∴ $2\pi f_c = 6\times10^8$ ∴ $f_c = \frac{6\times10^8}{2\pi} = 95.492\times10^6$ Hz ≈ 95.49 MHz ∴ Carrier Frequency = 95.5 MHz ii) Modulating Frequency, f_m : Again, $\omega_m = 2\pi f_m = 1250$ ∴ $f_m = \frac{1250}{2\pi} = 198.94$ Hz ∴ Modulating Frequency, $f_m = 198.94$ Hz iii) Maximum deviation δ : ∵ $\frac{\delta_{FM}}{f_m} = 5$ ∴ $\delta_{FM} = 5 \times 198.94$ --- (∵ $f_m = 198.94$ Hz) ∴ $\delta_{FM} = 994.72$ Hz ∴ Maximum deviation, $\delta = 994.72$ Hz iv) Power dissipation in 20 Ω resistor, P : $P = \frac{V_{rms}^2}{R} = \frac{(V_c/\sqrt{2})^2}{R}$ ∴ $P = \frac{(10/\sqrt{2})^2}{20}$ ----- (∵ Given $V_c = 10$ V, $R = 20$ Ω) ∴ $P = 2.5$ W ∴ Power dissipated in 20 Ω resistor, $P = 2.5$ W	1M for each calculation(each value)
	c)	**Compare between simple AGC and delayed AGC**	**4M**

Ans:



Parameter	Simple AGC	Delayed AGC
i) Definition	Simple AGC is a system by means of which overall gain of a radio receiver is varied automatically	Delayed AGC is a system which does not reduce the gain for weak signals but reduces the gain for strong signals only.
ii)Advantages	Simplicity,Low cost	High cost
iii)Applications	Simple AGC circuit is used in all the low cost domestic radio receiver.	Delayed AGC is used in the high quality receivers like communication receivers.
iv)Characteristics	Refer Fig Fig 3C –The AGC characteristics	Refer Fig Fig 3C –The AGC characteristics

(1M for each correct point)

d) **Compare resonant and non resonant antenna on the basis of** **4M**

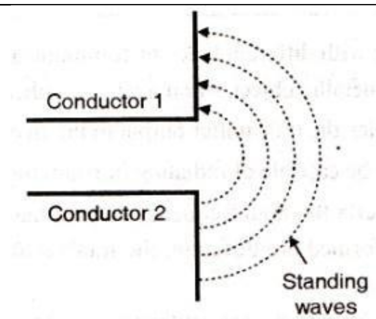
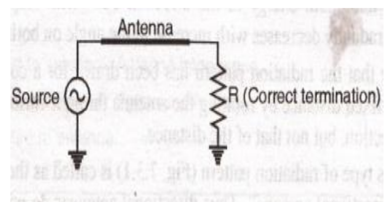
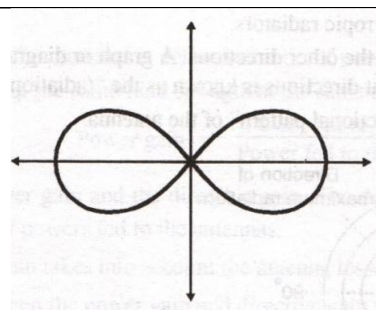
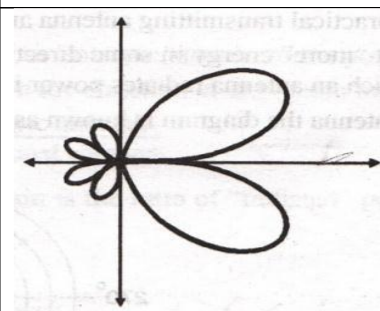
(i) Definition

(ii) Circuit

(iii) Reflection co efficient

(iv) Radiation pattern

Ans :

Parameter	Resonant antenna	Non resonant antenna
i) Definition	It is transmission Line of length equal to multiples of λ/2 and open at both end.	It is transmission line whose length is not a multiple of λ/2
ii) Circuit		
(iii) Reflection co efficient	Standing wave present	Standing wave not present
(iv) Radiation pattern		

(1M for Each Parameter)

e) Differentiate between ground wave and sky wave propagation

Ans:

Sr. No	Parameters	Ground Wave Propagation	Sky Wave Propagation
1	Frequency Range	30 kHz to 3 MHz	3 MHz to 30 MHz
2	Polarization	Vertical	Vertical

Any Four relevant correct points – 1 mark

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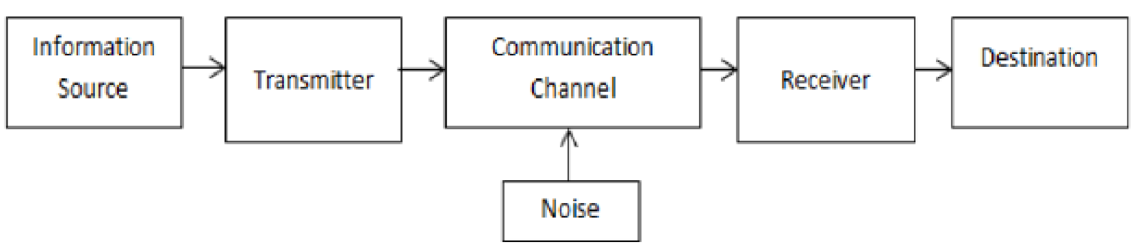
3	Applications	Radio Broadcasting (MW Range)	Radio Broadcasting (SW Range)
4	Range of Communication	Less **(OR)** Few hundred Km	More (OR) Few Thousand Km
5	Limitations	Limited Range, Tall Antenna Required, High transmission power.	Skip Distance, Power loss due to absorption of energy in layers
6	Fading Problem	Less	Severe

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any THREE of the following :**	**12- Total Marks**
	(a)	**Draw the block diagram of basic electronic communication system**	**4M**
	Ans:	 Fig: Basic electronic communication system	**4M for correct block diagram**

(b) Differentiate between AM & FM on the basis of

(i) Definition

(ii) Band width

(iii) Modulation index

(iv) Application

4M

Ans:

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

1M-Each difference

(c) Draw the circuit diagram of practical AM diode detector. Sketch its input and output waveforms

4M

Ans:

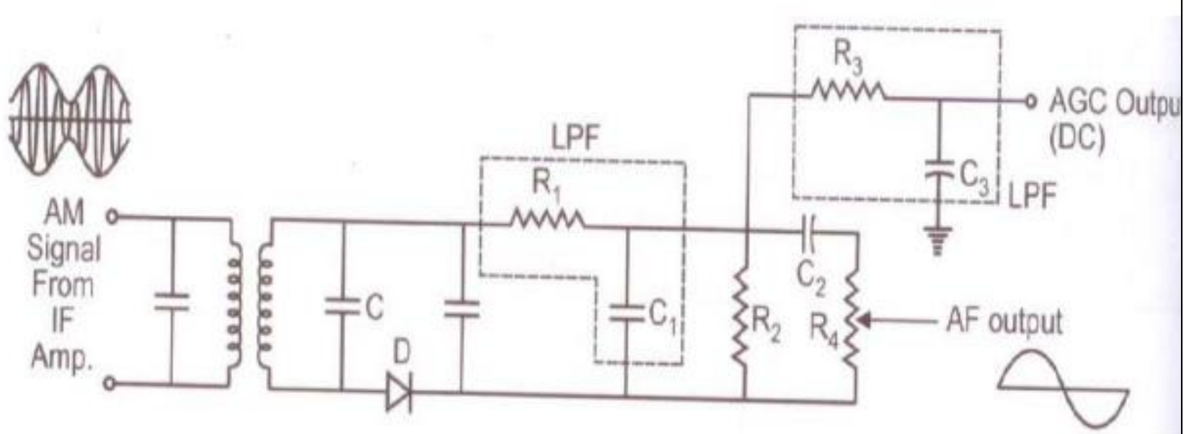
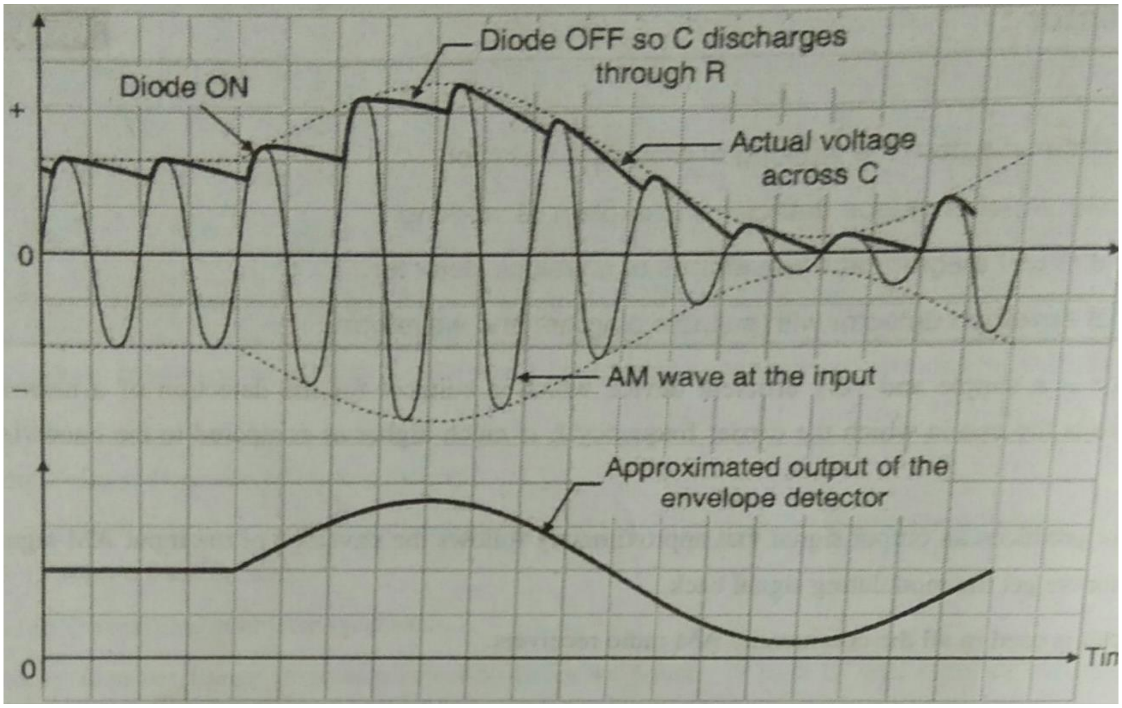
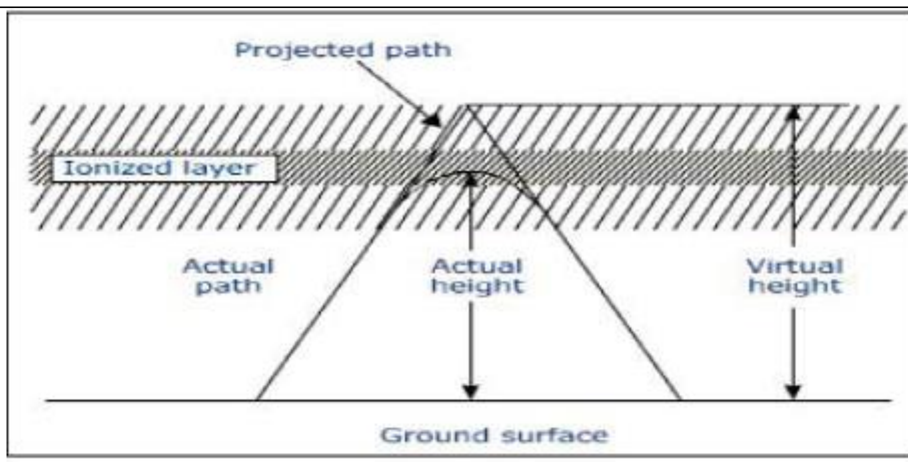
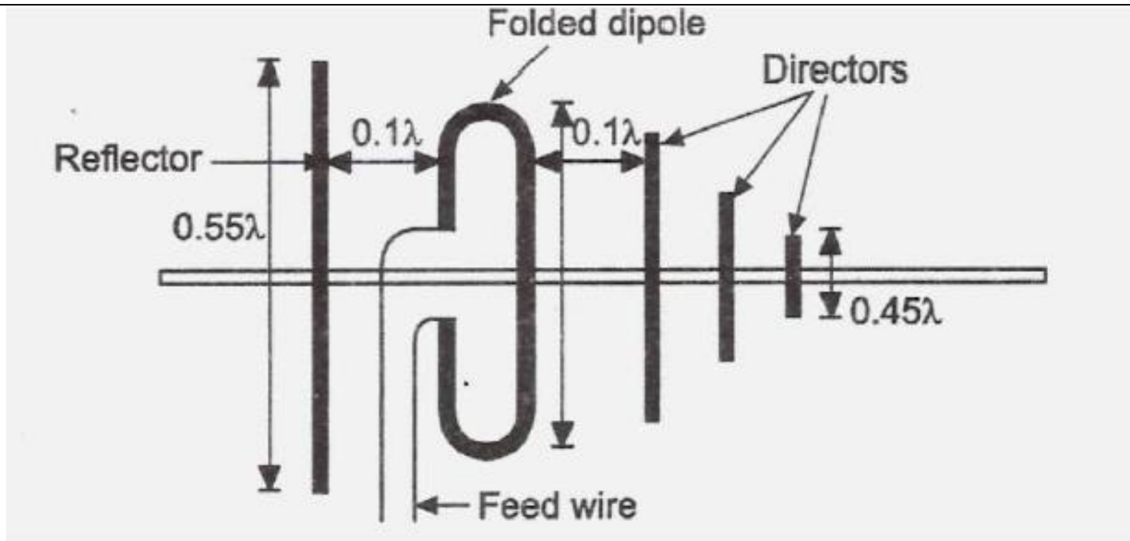
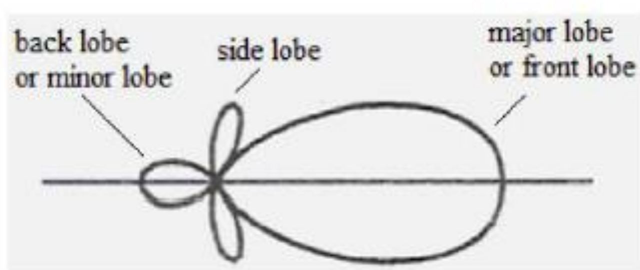


Fig: Circuit diagram of Practical AM diode detector

(2M-Circuit Diagram

2M waveforms)

		 **Fig: Input and Output waveforms**	
	(d)	**Describe the term virtual height with the help of diagram showing ionized layer and path of wave**	**4M**
	Ans:	 **Fig: Virtual height of an ionized layer** **Virtual height:** -The incident wave returns back to the earth due to refraction. In this process it bends down gradually and not sharply, but the incident and reflected rays follow exactly the same paths as those if the signal have been reflected from a surface	**2M Diagram** **2M Description**

		located at greater height. It is the height above the earth's surface from which a refracted wave appears to have been reflected. It is also defined as the maximum height that the hypothetical reflected wave would have reached.	
	(e)	**Draw the construction of Yagi Uda antenna . Draw its radiation pattern and write two applications**	**4M**
	Ans:	 **Fig: Yagi Antenna** **Radiation pattern:-**  **Application:- (any two) :- ½ M each** 1) It is used as HF transmitting antenna. 2) It is used as VHF and UHF as TV receiver antenna because of its physical size. 3) A stack of Yagi - Uda antenna can be used as a super gain antenna.	**2M construction** **1M radiation pattern** **1M application**

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5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Write down the range of different frequencies in electro magnetic spectrum for following :** **(i) Voice frequency** **(ii) High frequency** **(iii) Infra red frequency** **(iv) Visible spectrum (light)** **(v) Radio frequency** **(vi) UV frequency** **Also write one application area of each frequency**	**6M**
	Ans:	(table below)	1M each for correct range & application (1/2 M range & 1/2 M application)

Sr No.	Frequency	Range	Application
1	Voice frequency	300 Hz to 3KHz	transmission of speech
2	High frequency	3MHz to 30 MHz	SW band of AM Rx
3	Infra red frequency	3 THz to 30 THz	Used for directed links e.g. to connect different buildings via laser links.
4	Visible spectrum (light)	375 THz to 750 THz	Smart Lighting,Mobile Connectivity
5	Radio frequency	3 kHz-300 GHz	radar signals or communications

		6	UV frequency	3 - 30 PHz	Pool water purification		
	b)	**Explain why the local oscillator frequency should be always greater than signal frequency in radio receiver. A Suprehetrodine radio receiver with an IF of 455 kHz is turned to 1000kHz. Find its image frequency and local oscillator frequency.**					6M

	Ans:	**Reason for local oscillator frequency to be greater than signal frequency in radio receiver:** The local oscillator frequency is made greater than signal frequency in radio receiver. Local oscillator frequency range is 995 KHz to 2105 KHz for MW band. F_{max}/F_{min}=2105/995=2.2 If local oscillator has been designed to be below signal frequency,the range would be 85 to 1195KHz and frequency ratio is F_{max}/F_{min}=1195/85=14.0 The normal tunable capacitance ratio is C_{max}/C_{min}=10 So this capacitance ratio easily gives the frequency ratio of 2:2:1 Hence the 2:2:1 ratio required for the local oscillator operating above signal frequency is well within range whereas the other system has a frequency ratio of 14:1 whose capacitance are not practically available. **Numerical:** A signal (image) can interfere with a superheterodyne receiver if fits the following equation. Image = Signal +/- 2 x I.F. Which says that a signal has the capacity to interfere with a superhet receiver if its frequency is equal to the signal frequency (1000 kHz in our question) plus or minus twice the IF (455 kHz in our question). So one possible image is: 1000 + (2 x 455) = 1910 kHz And the other: 1000 - (2 x 455) = 90 kHz local oscillator frequency=455 + 1000 =1455 KHz	3M for correct answer & 3M for Numericals
	c)	**Name the different layers of atmosphere which satisfy following conditions :** **(i) Reflects LF, absorbs MF and HF waves to some degree**	**6M**

(ii) Helps surface waves and reflect HF waves

(iii)Partially absorbs HF waves yet allowing them to reach its upper layer

(iv) Efficiently reflects HF waves , specially in night

(v) Exists in day time only

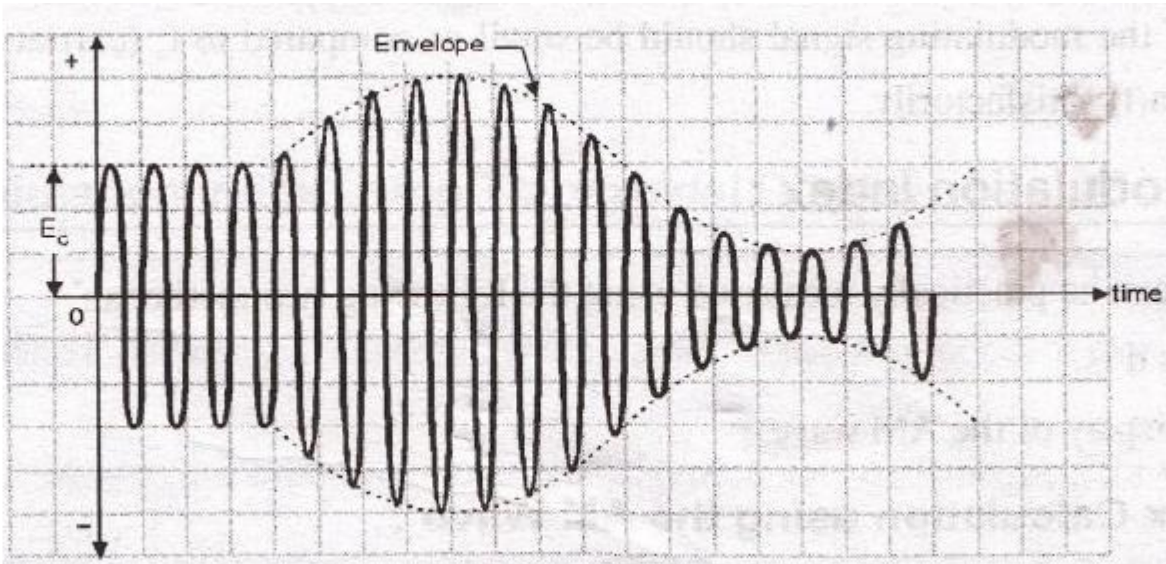
(vi) Exists in day time but merges with F2 layer in night time

Ans: (1M each)

Sr No.	Name of the layer of atmosphere	Frequencies most affected
1	D (Part of Stratosphere)	Reflects LF, absorbs MF and HF waves to some degree
2	E(Part of Stratosphere)	Helps surface waves and reflect HF waves
3	F1 (Part of mesosphere)	Partially absorbs HF waves yet allowing them to reach its upper layer
4	F2 (Thermosphere)	Efficiently reflects HF waves , specially in night
5	D & E (Part of Stratosphere)	Exists in day time only
6	F1 (Part of mesosphere)	Exists in day time but merges with F2 layer in night time

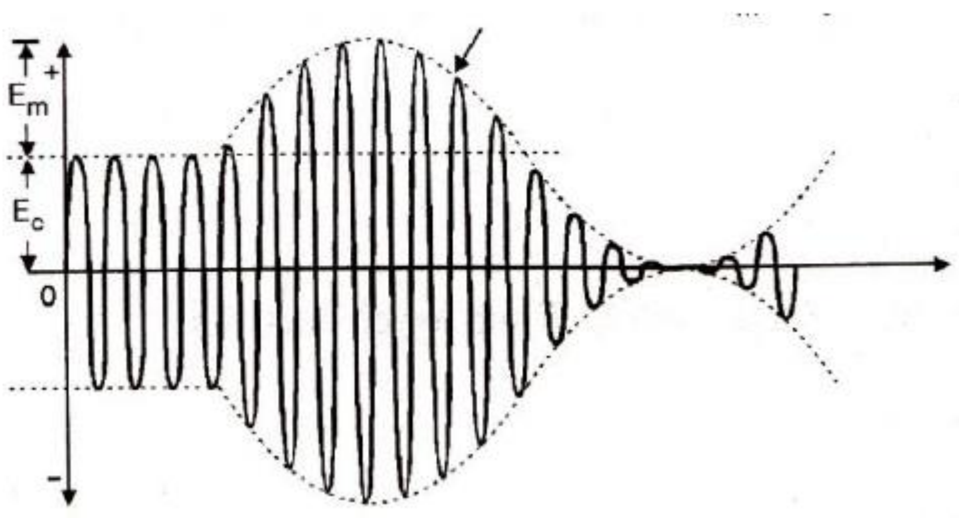
Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**Explain the effect modulation index on AM wave with waveforms for** **(i) m<1** **(ii)m=1** **(iii)m>1**	**6M**
	Ans:	**i) m< 1** • If m < 1 or if the percentage of modulation is less than 100% then this type of modulation is known as **under modulation .**	(2 M for each effect with waveform

- The amplitude of modulating signal less than carrier amplitude, no distortion will occur.



ii) m = 1

- If m = 1 or percentage of modulation is 100 this type modulation is **100% modulation**
- The ideal condition for AM is m =1, since this will produce the greatest output at the receiver with no distortion.

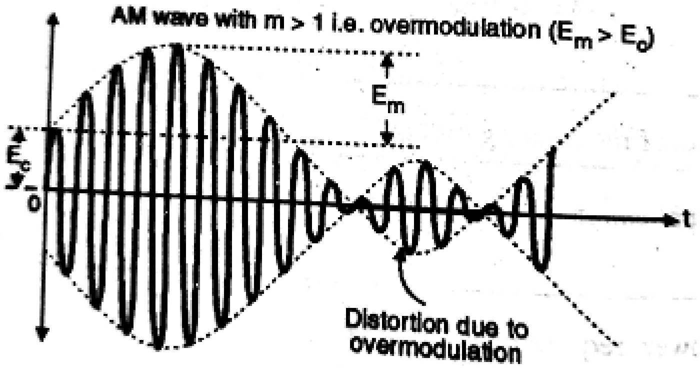


(iii)m>1

- If m>1 or if the percentage of modulation is greater than 100% then this type of modulation is known as **overmodulation** .
- The amplitude of modulating signal greater than carrier amplitude.For m>1 the

envelope can sometimes reverse the phase.

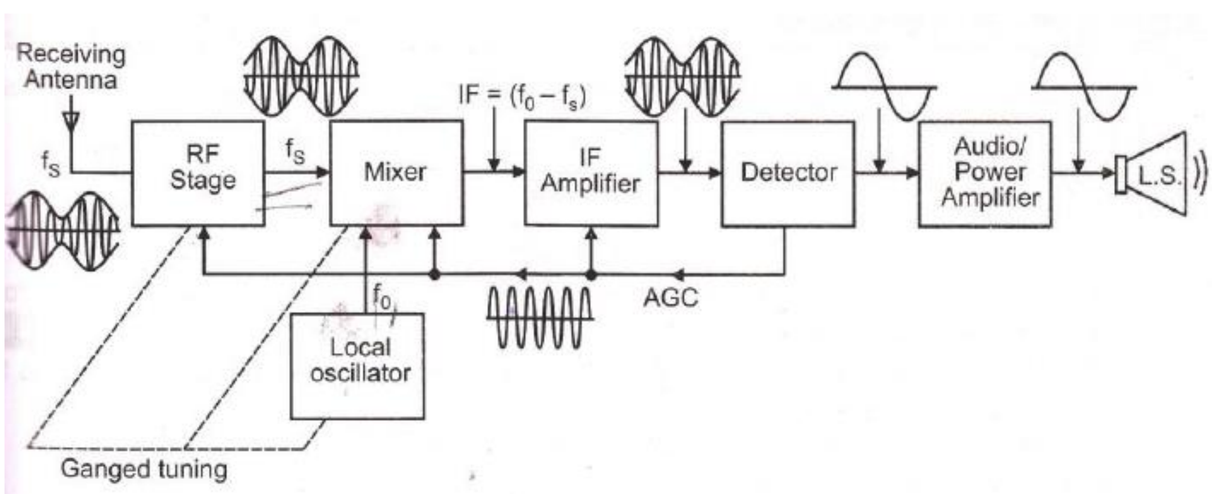
- overmodulation introduces envelope distortion.Hence it should be avoided.



b) **Explain the working of AM super heterodyne receiver with the help of neat block diagram and waveform** **6M**

Ans:

2 M-Diagram,1 M-waveform, 3M-Explaination



AM super heterodyne receiver works on the principle of super heterodyning.
In the super heterodyne receiver, the incoming signal voltage is combined with a signal generated in the receiver. The local oscillator voltage is normally converted into a signal of a low fixed frequency with the help of mixer.
The signal at this intermediate frequency contains the same modulation as the original carrier and it is now amplified and detected to reproduce the original modulating signal

Functions of each block-

Receiving antenna- AM receiver operates in the frequency range of 540 KHz to 1640

		KHz. **RF stage-** Selects wanted signal and rejects all other signals and thus reduces the effect of noise. **Mixer-** Receives signal from RF stage Fs and the local oscillator Fo, and are mixed to produce intermediate frequency signal IF which is given as: IF=Fo-Fs **Ganged Tuning-** To maintain a constant difference between the local oscillator and RF signal frequency, gang capacitors are used. **IF stage-** The IF signal is amplified by the IF amplifier with enough gain. **Detector-**Amplified signal is detected by the detector to get original modulating signal. The detector also provides control signals to control the gain of IF and RF stage called as AGC. **AGC-** Automatic gain control controls the gain of RF and IF amplifiers to maintain a constant output level at the speaker even though the signal strength at the antenna varies.	
	c)	**Explain following terms in short related to antenna** **(i) Antenna resistance** **(ii) Directivity** **(iii)Antenna gain** **(iv)Power density** **(v) Radiation pattern** **(vi)Polarization**	**6M**
	Ans:	**(i)Antenna resistance:-** The resistance of an antenna has two components: 1. Its radiation resistance due to conversion of power into electromagnetic waves 2. The resistance due to actual losses in the antenna. or The antenna resistance has two components: **1.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. $$Rr = \frac{Pt}{I^2}$$	1 M for each correct definition

Where

Pt is radiated power by antenna

I is the current at feed point

2.**Resistance due to actual losses in the antenna**

(ii).Directivity:-

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

Therefore **Directivity = Maximum Directive gain.**

OR

The directive gain is defined as the ratio of the power density in a particular direction of one antenna to the power density that would be radiated by an omnidirectional antenna (isotropic antenna).

The maximum directive gain is called directivity.

(iii)Antenna gain:-

Antenna Gain –

The directional antenna radiate more power in certain direction. The Omni-directional antenna radiates information equally in all directions.

Or

Antenna gain

It is the ratio of focused transmitted power (Pt) to the input power of the antenna (Pi)

Or

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.

(iv)Power density:-

The EM waves cause the energy to flow from one point to the other in the direction of propagation.

The power density is defined as the rate at which energy passes through a given surface area in free space.

Therefore,

Power density = Energy per unit time per unit area.

(v) Radiation pattern:-

The transmitting antenna transmit more energy in some directions than the other directions.

A graph or diagram which tells us about the manner in which an antenna radiates power in different directions is known as the "Radiation Pattern of antenna".

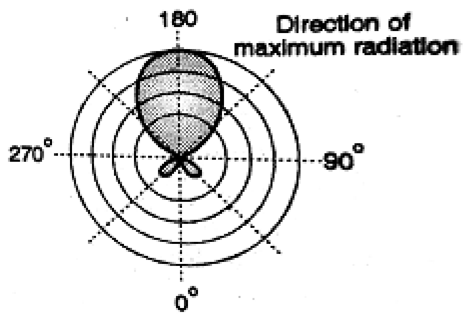


Fig.- Radiation Pattern of an antenna

(vi)Polarization:-

Polarization is defined as the direction of the electric vector in the electromagnenic wave radiated from an antanna.

OR

The polarization of a plane EM wave is simply the orientation of the electric field vector with respect to the surface (i.e. looking at the horizon)