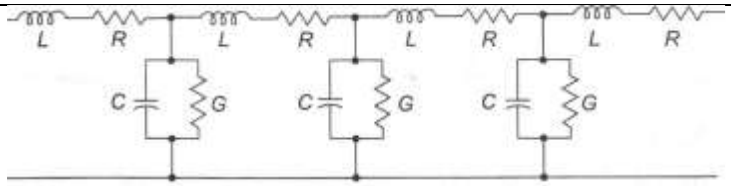
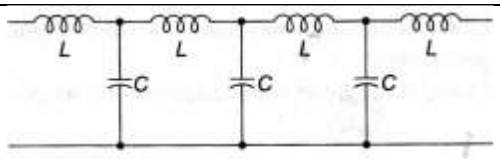
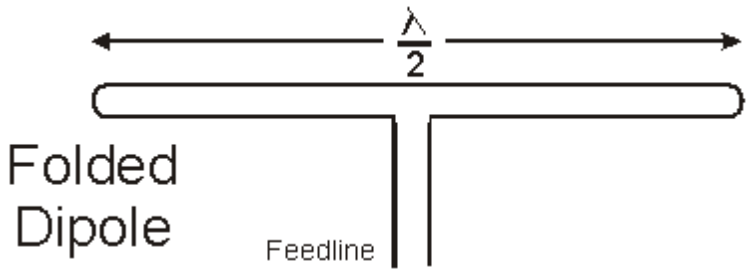
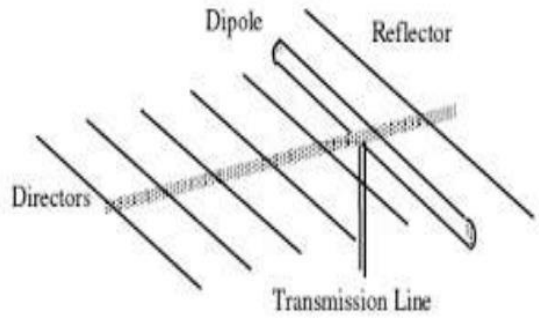
MODEL ANSWER
SUMMER– 18 EXAMINATION

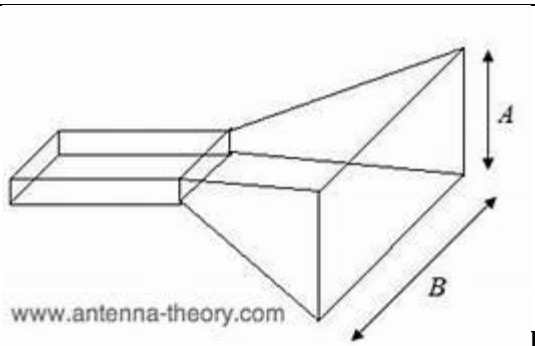
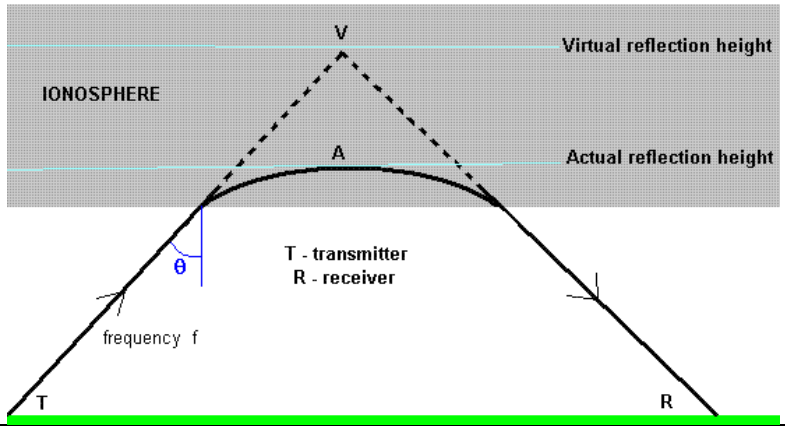
Subject Title:- Radio Reception **Subject Code:-** 17437

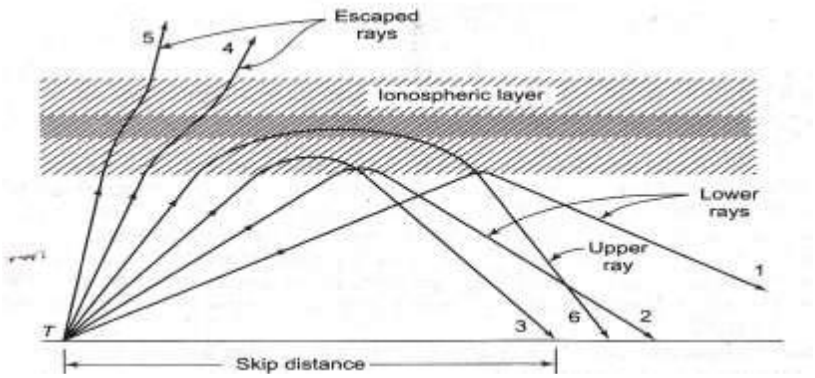
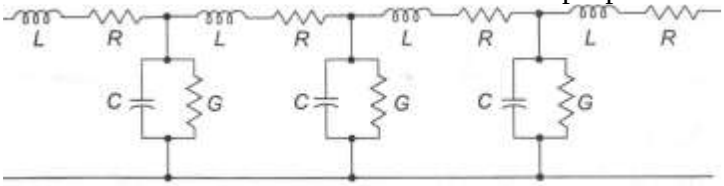
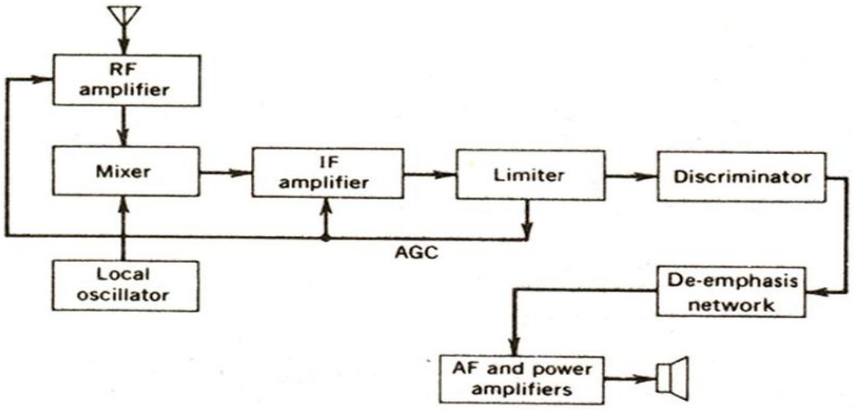
Important Instructions to examiners:

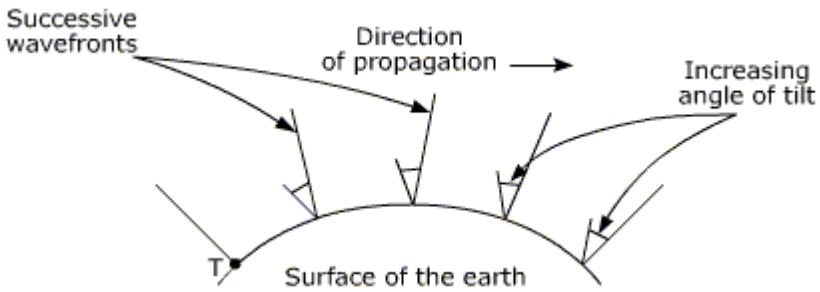
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 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.

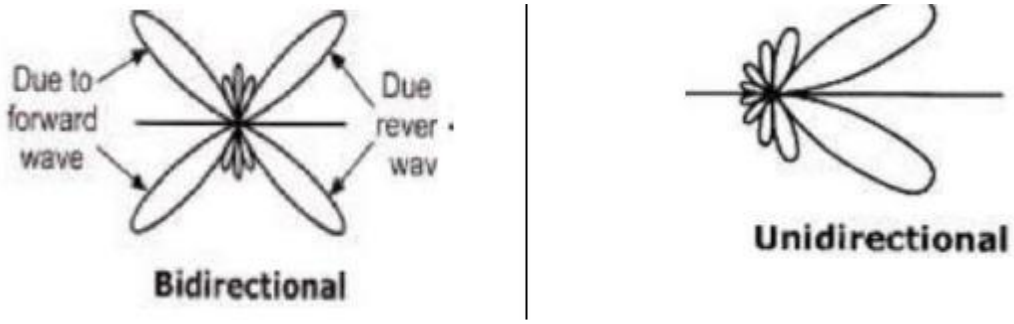
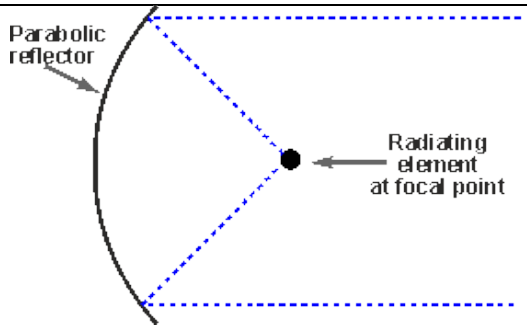
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	**Attempt any SIX :**	**12 Marks**
	a)	**Define attenuation of electromagnetic wave.**	**2 Marks**
	Ans:	As the electromagnetic wave propagates through the free space it spread out resulting in reduction of power density this is called as attenuation. **or** It is defined as the reduction in power density with increase in distance. The reduction in power density is equivalent to power loss hence it is called as attenuation. • ***Any other relevant def marks to be awarded.***	**Def-2m**
	b)	**Draw equivalent circuit of transmission line.**	**2 Marks**
	Ans:	 **Or**	**Any one dig-2m**

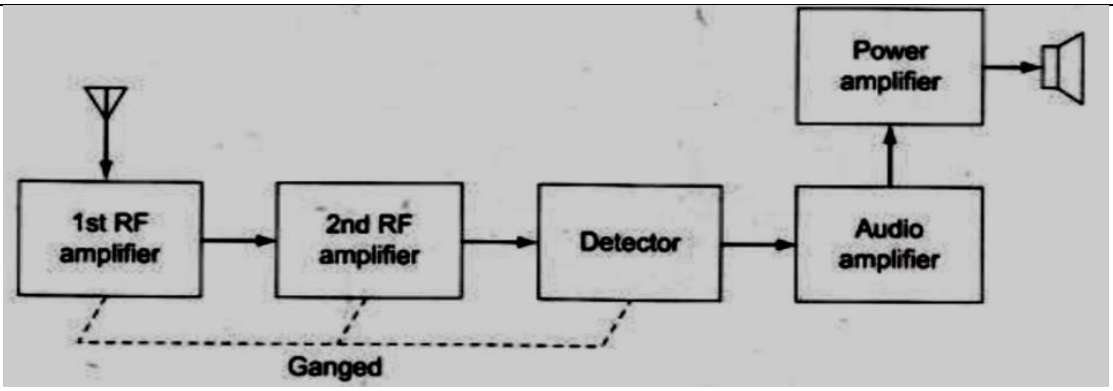
		 ***As low or high frequency is not mentioned, for any dig marks can be awarded.***	
	c)	**Name various wave propagation. Which type is used for low frequency wave ?**	**2 Marks**
	Ans:	1. Ground / surface waves 2. Space waves **3.** Sky waves Ground / surface waves is used for low frequency wave.	**Various waves-1m** **Type -1m**
	d)	**Draw neat diagram of Hertzian dipole.**	**2 Marks**
	Ans:	 ***Any other dig of hertzian dig marks can be awarded.***	**Dig-2m**
	e)	**Name UHF and microwave antenna and draw neat diagram of any one.**	**2 Marks**
	Ans:	UHF antenna-Yagi uda Microwave antenna –Horn antenna,Dish antenna  **Yagi uda** **Or**	**Naming - 1/2 m each** **Dig-1m**

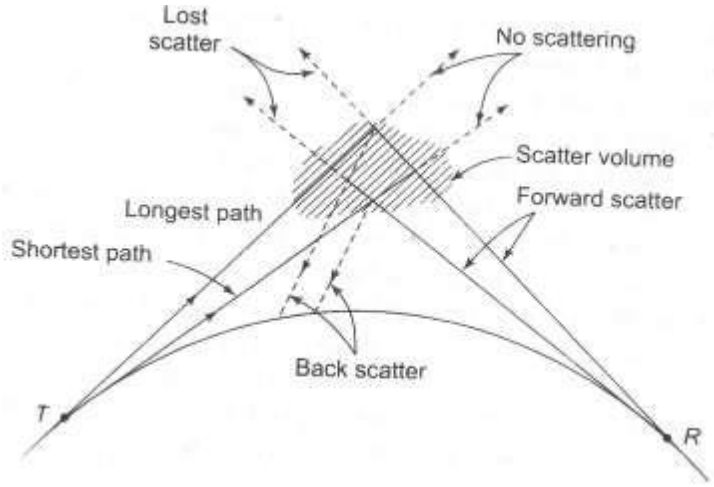
		 **horn antenna**	
f)		**State function of mixer circuit in superheterodyne receiver.**	**2 Marks**
Ans:		Mixer in superhetrodyne receiver takes the incoming frequency and local oscillator frequency mix it generating intermediate frequency.	**Function-2m**
g)		**State necessity of alignment in radio receiver.**	**2 Marks**
Ans:		**Necessity of alignment:-** The marginal adjustment of the local oscillator and RF tuned frequency to get maximum output of a radio receiver is known as Alignment of radio receiver.	**Necessity-2m**
h)		**State function of amplitude limiter block in FM receiver.**	**2 Marks**
Ans:		Function of amplitude limiter block in FM receiver-to remove the noise components	**Function-2m**
B)		**Attempt any TWO :**	**8 Marks**
a)		**Describe following terms :** **(i) Virtual height** **(ii) Skip distance**	**4 Marks**
Ans:		**(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. 	**(i) Virtual height Def-1m Dig-1m**

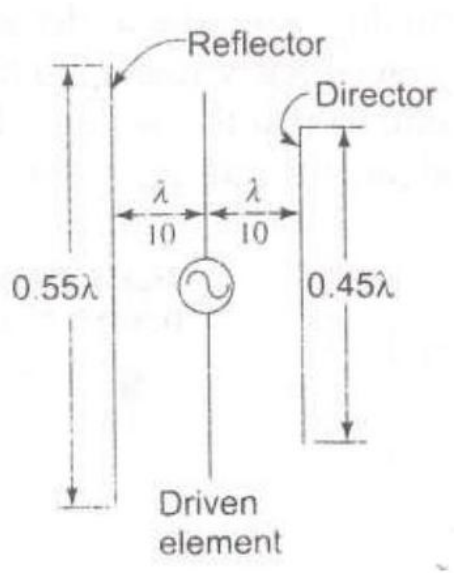
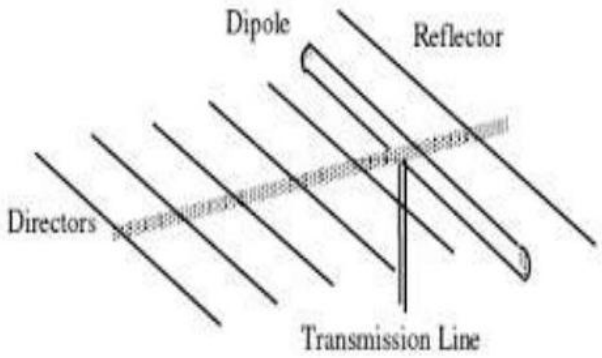
		(ii) Skip Distance: Skip distance is defined as the minimum distance from a transmitter antenna that a sky wave at a given frequency will be returned to earth.  	**(ii) Skip distance Def-1m Dig-1m**
	b)	**Explain reactance properties of transmission line.**	**4 Marks**
	Ans:	• The feature of transmission line of having resistance, capacitance, conductance and inductance contributes to the reactance properties of transmission line.  •	**Two points-2m each**
	c)	**Draw block diagram of FM radio receiver. State function of FM demodulator.**	**4 Marks**
	Ans:	 function of FM demodulator –it demodulates the signal and gives the original information signal	**Dig-2m Function-2m.**
Q 2		**Attempt any FOUR :**	**16 Marks**
	a)	**Describe ground wave propagation with neat sketches.**	**4 Marks**

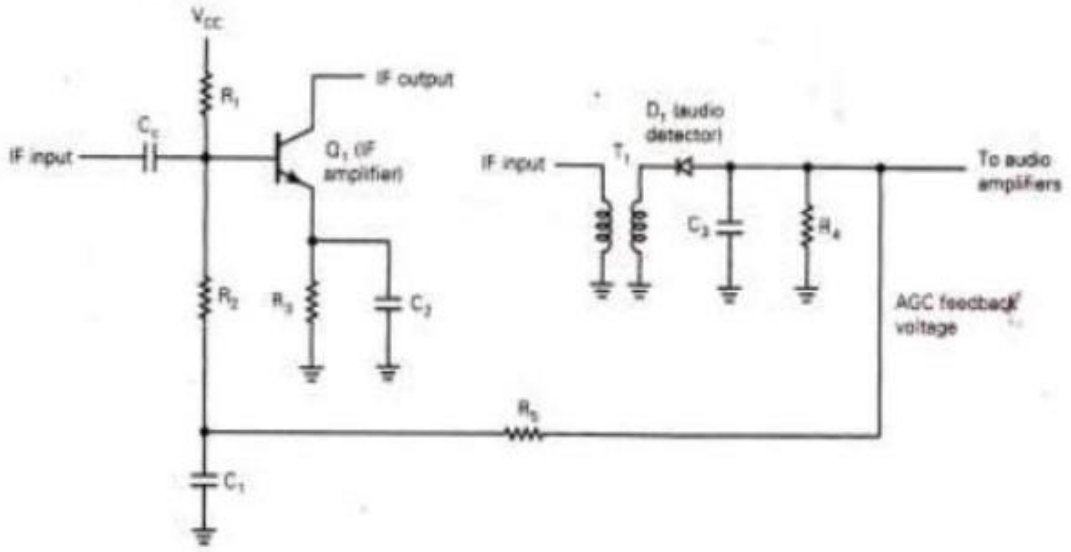
	Ans:	 **Explanation:** • Ground waves propagates along the surface of the line, • Ground waves are attenuated as it loses some energy by absorption by earth • It is is accompanied by changes induce in earth • Frequency range is from few KHz to few Mhz • It is used in AM radio	Description-2m Dig-2m
	b)	**Define characteristics impedance of transmission line. State its importance.**	**4 Marks**
	Ans:	• Characteristics impedance of transmission line is defined as the impedance seen looking into a infinitely long line or the impedance seen looking into a finite length of line that is terminated in a purely resistive load . Importance- • For maximum power transfer from source to load transmission line to be terminated by resistive load which must be equal to Characteristics impedance of transmission line	**Def-2m Importance -2m**
	c)	**Differentiate between resonant and non-resonant antenna for two points.**	**4 Marks**
	Ans:	<table><tr><th>Resonant antenna</th><th>Non resonant antenna</th></tr><tr><td>Its length is exactly equal to multiples of half wavelength (λ / 2)</td><td>Its length is not exactly equal to multiples of half wavelength (λ / 2)</td></tr><tr><td>The radiation pattern is of figure of eight</td><td>The radiation pattern is of figure of eightbut it is unidirectional antenna.</td></tr><tr><td>The standing wave is present because it is open at both ends.</td><td>The standing wave is not present because it is terminated in correct impedance at both ends.</td></tr><tr><td>The reflection of signal occurs.</td><td>The reflection of signal does not occurs.</td></tr><tr><td>**Radiation pattern:**</td><td>**Radiation pattern:**</td></tr></table>	**Any 2 points 1point-2m each**

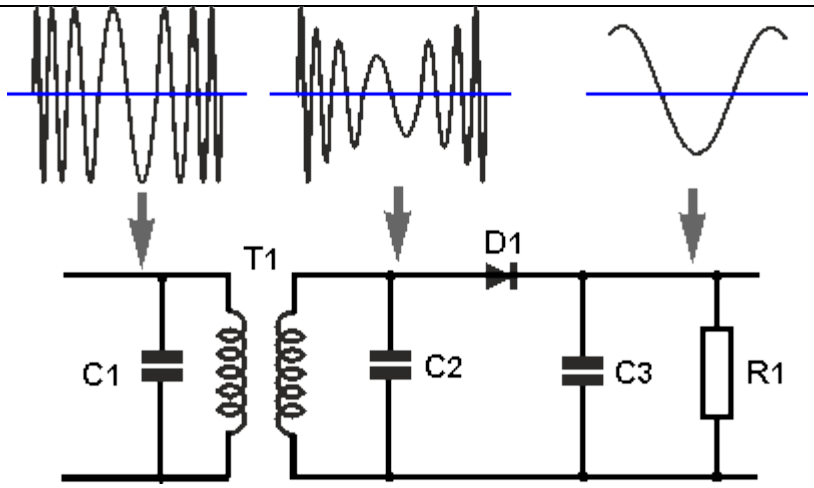
			
	d)	**Describe working principle of focal feed parabolic reflector.**	**4 Marks**
	Ans:	 **Focal feed parabolic reflector:** • The parabolic reflector or dish antenna consists of a radiating element which may be a simple dipole or a waveguide horn antenna. • This is placed at the focal point of the parabolic reflecting surface. • The energy from the radiating element is arranged so that it illuminates the reflecting surface. • Once the energy is reflected it leaves the antenna system in a narrow beam. As a result considerable levels of gain can be achieved.	**Dig -2m** **Exp-2m**
	e)	**Draw block diagram of tuned radio receiver and explain each block.**	**4 Marks**

	Ans:	 **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.	**Dig-2m** **Exp-2m**
	f)	**State procedure for alignment of RF in radio receiver.**	**4 Marks**
	Ans:	**RF alignment of Radio Receiver:- 2M** • The marginal adjustment of the local oscillator and RF tuned frequency to get maximum output of a radio receiver is known as Alignment of radio receiver. • The RF alignment of the radio receiver is also called as RF tracking of the receiver. • To obtain the maximum output signal at the center frequency of AM radio receiver.	**Exp-4m**
Q. 3		**Attempt any FOUR :**	**16 Marks**
	a)	**Explain tropospheric scatter propagation.**	**4 Marks**
	Ans:	**Tropospheric scatter propagation:** • It is also known as troposcatter,or forward scatter propagation, tropospheric scatter propagation is a means of beyond the horizon propagation for UHF signals. It uses certain of the troposphere, the nearest portion of the atmosphere. • The reasons for the scattering are not fully understood. But there are two theories. One suggests reflections from "blobs" in the atmosphere, similar to the scattering of searchlight beam by dust particles.	**Exp-4m**

		• The best frequencies, which are also the most often used are centered 900,2000and 5000MHz . • This method of propagation is often used to provide long-distance telephone and other communication links, as an alternative to microwave links or coaxial cables over rough or inaccessible terrain. • Tropospheric scatter propagation is subject to two forms of fading. The first is fast, occurring several times per minute at its worst, with maximum signal strength variations in excess of 20dB. • The second form of fading is very much slower and is caused by variations in atmospheric conditions along the path. • It has been found in practice that the best results are obtained from tropo scatter propagation if antennas are elevated and then directed down toward the horizon.  	
	b)	**What are standing waves? Define SWR and VSWR.**	**4 Marks**
	Ans:	**Standing waves –**In mismatched transmission line two electromagnetic waves travel in opposite directionon the line at the same timewhicset up an interference pattern known as standing wave. **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. **VSWR** is defined as the ratio of the maximum voltage to the minimum voltage in the standing wave.	**standing waves-1m** **SWR -1.5m** **VSWR-1.5m**
	c)	**Describe with neat diagram beamwidth and bandwidth of antenna.**	**4 Marks**
	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. **Or** The beamwidth of an antenna is described as angular separation between the two half-power points (3db) on the major lobe of antenna radiation pattern	**2m-each**

		Bandwidth of antenna- It is the range of frequency over which the antenna gives satisfactory operation . It is often taken as difference between half power frequency	
	d)	**What is antenna array ? Draw Yagi—Uda antenna.**	**4 Marks**
	Ans:	**antenna array-**It is an antenna system made up of large group of similar antenna on a common plane **Yagi—Uda antenna.** or   	**Def-1M** **Dig-3m**
	e)	**With neat circuit of simple AGC, explain the working of AGC.**	**4 Marks**

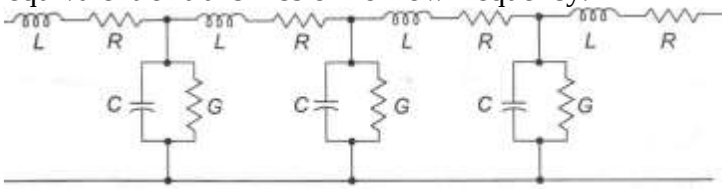
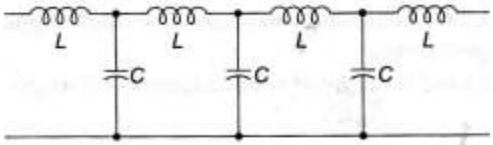
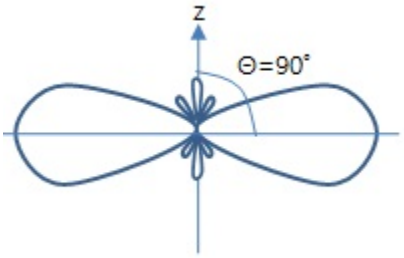
	Ans:	 **Simple AGC** The circuit shown below is a negative peak detector and produces a negative voltage at its output. The greater the amplitude of the input carrier, the more negative the output voltage. • The negative voltage from the AGC detector is fed back to the IF stage, where it controls the 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.	**Dig-2m** **Exp-2m**
	f)	**Draw neat circuit diagram of slope detector and explain it.**	**4 Marks**
	Ans:	• Slope detector is FM detector circuit • . The input signal is a frequency modulated signal. • 'It is applied to the tuned transformer (T1, C1, C2 combination) which is offset from the centre carrier frequency. • This converts the incoming signal from just FM to one that has amplitude modulation superimposed upon the signal.	Dig-2m Exp-2m

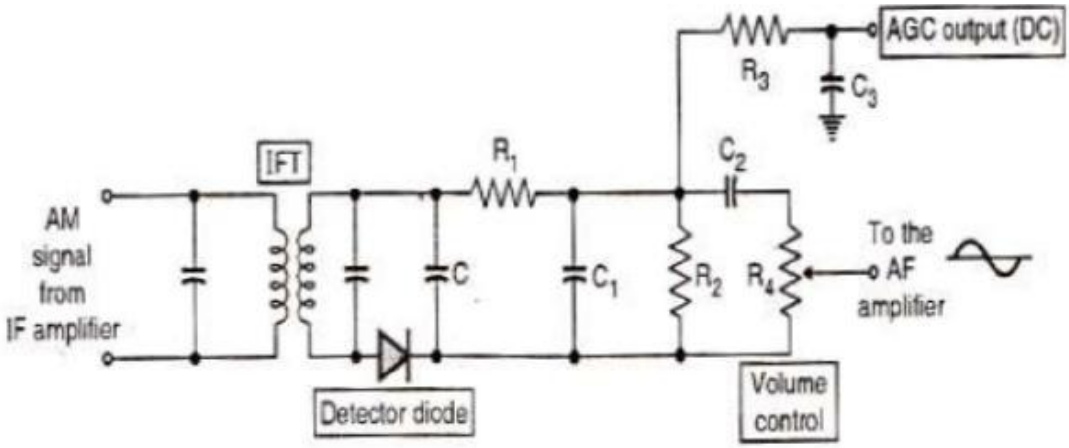
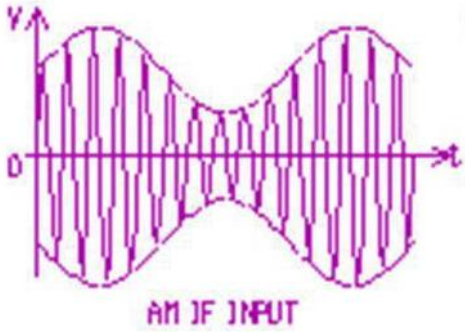
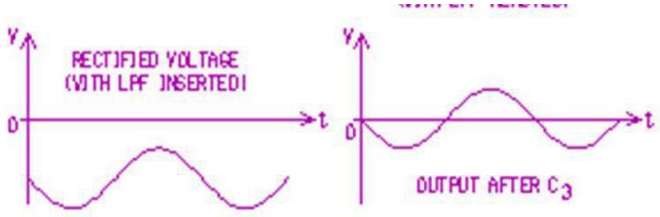


FM slope detector circuit showing waveforms

- This amplitude signal is applied to a simple diode detector circuit, D1.
- Here the diode provides the rectification.
- C3 removes any unwanted high frequency components, and R1 provides a load.

Q. 4		**Attempt any FOUR :**	**16 Marks**
	a)	**Describe sky wave propagation. Give range of frequency propagate through sky wave.**	**4 Marks**
	Ans:	The transmitted signal travels into the upper atmosphere where it is bent or reflected back to earth. **Characteristics of sky wave propagation:** • The four main ionospheric layers are F2, F1, E and D in the descending order. • The D layer is the lowest and it exists at a height of about 70Km from the earth surface. • The E layer existing at an approximate of 100Km, and disappears in the night. • The F1 layer is at about 180Km height and has an approximate thickness of 20Km in the day time. • The F2 layer is the most reflecting layer for the HF radio signals incident on it. **range of frequency propagate through sky wave.-3MHz to 30MHz**	**Des-2m range-2m**
	b)	**Describe basic principle of transmission line.**	**4 Marks**
	Ans:	• For many of the transmission lines, such as coaxial cable and twisted pair lines, there are two separate conductors separated by an insulating dielectric. • These lines are described by using voltages and currents in an equivalent circuit. • The electrical equivalent of transmission for low frequency:	**Any 2point-2m**

		• The electrical equivalent of transmission for low frequency:  • The electrical equivalent of transmission for high frequency:  	
	c)	**Describe construction of broad side array. Draw radiation pattern of it.**	**4 Marks**
	Ans:	An arrangement in which the principal direction of radiation is perpendicular to the array axis and also to the plane containing the array element" is termed as the **broad**  **broad side array** • The above figure shows the radiation pattern of the broad side array. • The beam is a bit wider and minor lobes are much reduced in this.	**02 marks diagram +02 marks explnation**
	d)	**Describe choice of IF used in radio receiver.**	**4 Marks**
	Ans:	The frequency spectrum has been distributed for various purposes. • Otherwise, the people may use the frequencies of their choice & there will be wide range of interference. So, in order to ensure proper reception of signals, the standards have been fixed for the transmission of frequencies & also for the intermediate frequency. If the intermediate frequency is varied the overall frequency value will also vary. • The intermediate frequency value should be so designed that it should not lie within the range of mixer stage. Otherwise, there is the production of noise signal due to the interference of mixer frequency & intermediate frequency. • The intermediate frequency should not be too high. Otherwise, it will reduce the selectivity of the receiver because of increase in bandwidth. • Considering all these factors intermediate frequency is kept constant	**Any 2point-2m each**

e)	**Draw neat circuit diagram of practical diode detector. Draw its waveforms.**	**4 Marks**
Ans:	 Fig. Practical diode detector circuit **Input wave form:**  **Output wave form:** 	
f)	**Draw neat circuit diagram of amplitude limiter and explain its working.**	**4 Marks**
Ans:		**Dig-2m Exp-2m**

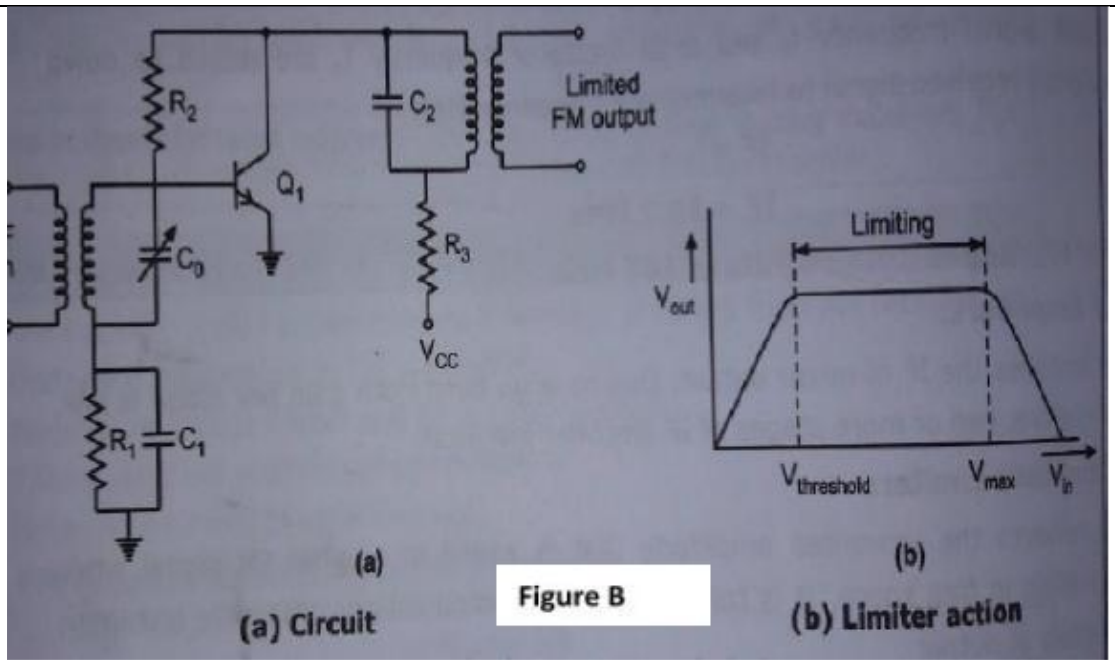


Figure B

Operation:- ● 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.

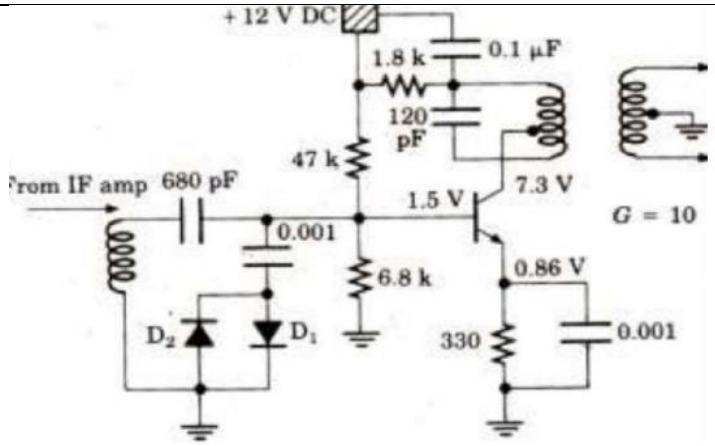
● The output tank circuit is tuned to the IF center frequency.

● 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.

or



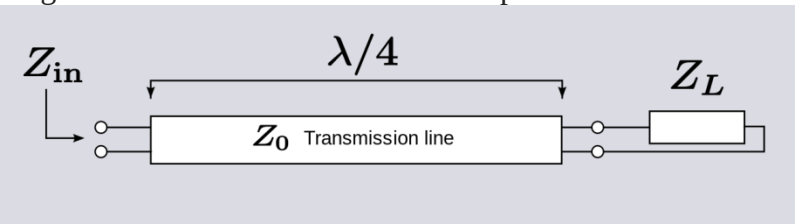
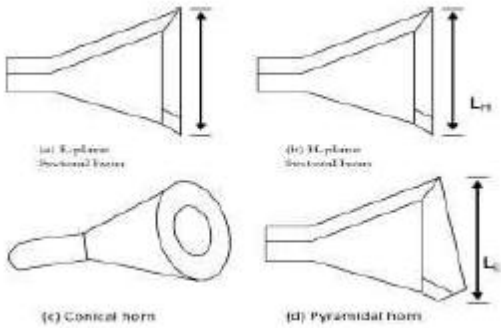
Operation:- (Figure A)

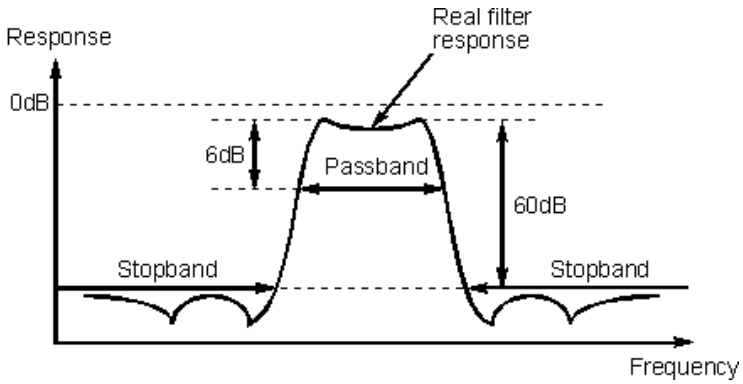
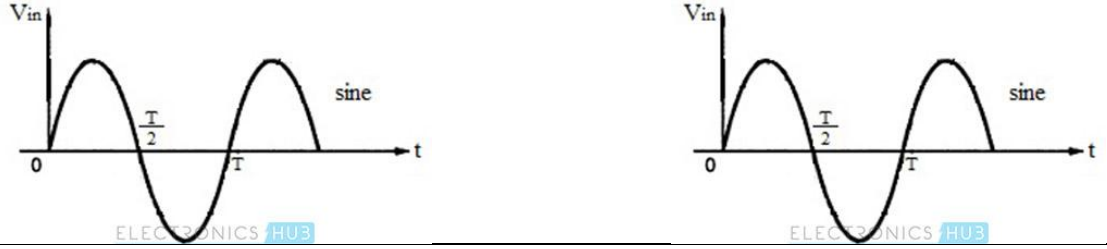
- In frequency modulation, the signal amplitude is held constant while the carrier frequency is varied.
- Any noise that contaminates the signal will manifest itself as a change in amplitude.
- The first limiter is a pair of back-to-back diodes D_1 and D_2.
- Diode D_1 will conduct when the input signal 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.

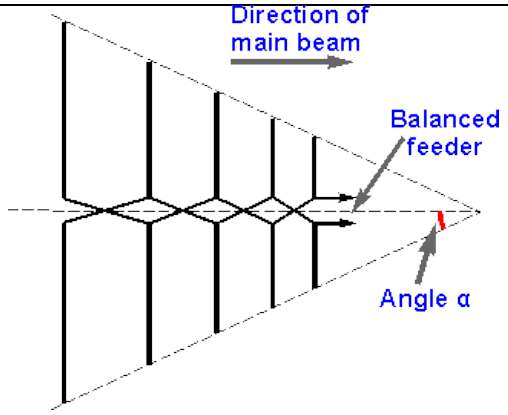
- The collector and emitter currents increase, raising the emitter voltage at the same time that the collector is going lower.
- The total collector change is 9.4 V, limiting the output signal to 9.4 V p-p, instead of the alternately driven into saturation and cutoff, it limits the signal amplitude.

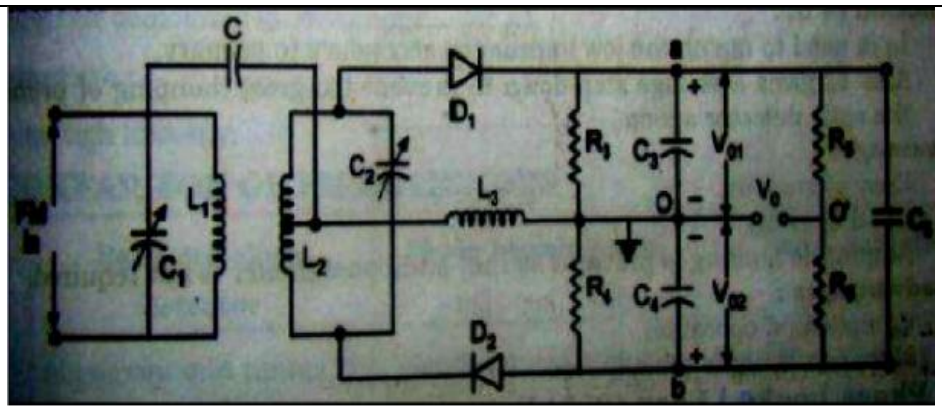
Q.5		**Attempt any SIX :**	**16 Marks**
	a)	**Define critical frequency and maximum usable frequency. State their relationship.**	**4 Marks**
	Ans:	**Critical frequency:** It is the highest frequency that can be propagated directly upward and still be returned to earth by the ionosphere. **OR** The highest frequency that will be returned to earth in the vertical direction is the critical frequency. Maximum usable frequency: It is the highest frequency which is used for sky wave propagation.I t is called	

		optimum working frequency . MUF = critical frequency fc /*cos*θ MUF=critical frequency fc* Sec θ **or** 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	
	b)	**Describe quarter wave line.**	**4 Marks**
	Ans:	• When length of **transmission line** is exactly one-**quarter** of a **wavelength** (λ) long and terminated in some known impedance is called transmission line. •  ***Relevant diagram and description marks to be allocated***	**Any two point-2m each**
	c)	**Draw neat diagram and state working of Horn antenna.**	**4 Marks**
	Ans:	 **Fig. Horn antenna** **Working:** • 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.	**Dig-2m Working-2m**

		• In horn feed impedance matching is very properly. • All energy travelling forward is radiated. • Directivity is improved. • Diffraction is reduced	
	d)	**Describe image signal. How it is rejected ?**	**4 Marks**
	Ans:	**Image signal**- is an unwanted signal which enters the RF amplifier stage gets mixed with local oscillator frequency in mixer generating IF reaches IF amplifier and demodulator also. **Method of rejecting the images signal:** • The image frequency must be rejected by the receiver. The images rejection depends on the front end selectivity of the receiver i.e the selectivity of the RF circuit. • The image rejection must be achieved before the IF stage because one it reaches the IF stage it cannot be removed. • The rejection of an image signal is dependent on the ratio of the wanted to unwanted signal frequencies & on the Q of resonant circuit before mixer amplifier	
	e)	**Describe with neat diagram selectivity and fidelity.**	**4 Marks**
	Ans:	Selectivity: Ability to reject unwanted frequency signals is called selectivity  Fidelity: It is the ability of receiver to reproduce all the modulating frequencies equally. **Or** it is ability of receiver to reproduce the oup put exact that of input. Input Output  	**Selectivity-2m** **Fidelity-2m**
	f)	**Describe AFC. How it is useful in receiver circuit ?**	**4 Marks**

	Ans:	**AFC** : • AFC is used to automatically adjust the frequency in the recevier. • Automatic Frequency Control (AFC), also called Automatic Fine Tuning (AFT), • AFC is a method or circuit to automatically keep a resonant circuit tuned to the frequency of an incoming radio signal . • AFC is used im FM receiver **Useful in receiver circuit** :It is primarily used in radio receivers to keep the receiver tuned to the frequency of the desired station.	**Describe-2m** **Useful-2m**
Q.6		**Attempt any FOUR :**	**16 Marks**
	a)	**Describe primary and secondary constants of transmission line.**	**4 Marks**
	Ans:	**Primary constants of transmission line.-** • Series Resistance • Shunt Capacitance • Series Conductance • Shunt Inductance Resistance and inductance will occur along the line and capacitance and conductance will occur between conductor Primary constants are uniformly distributed along the line length so called as distributed parameters **Secondary constants of transmission line.** • Characteristic Impedance • Propagation constant These parameters are derived from primary constants.	**2m-each**
	b)	**Define following terms w.r.t. antenna :** **(i) Antenna gain** **(ii) Directivity** **(iii) Power gain** **(iv) Antenna resistance**	
	Ans:	**(i) 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. **(ii) Directivity:** System **Directivity :-** It is the maximum directive gain which is obtained in only one direction in which the radiation is maximum. Thus Directivity = Max. directive gain **Or** It is ability of antenna to send or receive signal over a narrow horizontal directional	**1m -each**

		range **(iii) Power gain:** That is Power gain = $\frac{power fed\ to\ the\ isotropic\ antenna}{power\ fed\ to\ the\ directional\ antenna}$ **Power gain:** It is the ratio of power fed to an isotropic antenna to the power fed to a directional antenna, to develop the same field strength at the same distance, in the direction of maximum radiation **(iv) Antenna resistance:** **Antenna resistance:** 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. $Rr = \frac{Pt}{I^2}$ (ii) Where Pt is radiated power by antenna I is the current at feed point (ii) Resistance due to actual losses in the antenna	
	c)	**Draw and explain working principle of dipole array.**	**4 Marks**
	Ans:	 **principle of dipole array.** • Many types of array antennas are constructed using multiple dipoles, usually half-wave dipoles. • The purpose of using multiple dipoles is to increase the directional gain of the antenna over the gain of a single dipole; the radiation of the separate dipoles interferes to enhance power radiated in desired directions.	**Dig-2m** **Exp-2m**
	d)	**Describe frequency tracking.**	**4 Marks**
	Ans:	**The frequency tracking in radio 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.	**Exp-4m**

		• The radio 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 • $f0 – fs = I.F.$ • Stations will appear away from their current position on frequency dial of the receiver.	
	e)	**Draw neat diagram of ratio detector. How it is different from Foster Seelay detector ?**	**4 Marks**
	Ans:	 • In Foster Seelay Diode D2 is in same direction as of diode D1 • Ratio detector is not affected by amplitude changes in FM	**Dig-3m** **Difference-1m**
	f)	**Describe dynamic range of radio receiver.**	**4 Marks**
	Ans:	**Dynamic range:-** • Dynamic range is the input power range over which the receiver is useful. • It is the difference between the minimum input level necessary to discern a signal and input level that will over drive the receiver and produce distortion. • Low value of dynamic range will cause distortion for weaker signal • Dynamic range of 100dB is the highest possible value. • It is the range of signal levels over which it can operate. The low end of range is governed by its sensitivity and high by overload or strong single handling performance.	**Any 4 points** **Each-1m**