**SUMMER– 15 EXAMINATION**

Subject Code: **17440** **Model Answer**

**Important Instructions to examiners:**

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

**Q.1 (A) Attempt any SIX of the following 12 marks**

a) Write down different frequencies for following (frequency range):

1. Voice Frequency
2. High Frequency
3. IR Frequency
4. Visible Spectrum (light)

Ans: **(Four Correct frequencies – ½ mark each)**

| Sr. No | Frequency | Range |
|---|---|---|
| 1 | Voice Frequency | 300 Hz to 3kHz |
| 2 | High Frequency | 3 MHz to 30 MHz |
| 3 | IR Frequency | 30 THz to 430 THz |
| 4 | Visible Spectrum (light) | 375 THz to 750 THz |

b) Define modulation index of FM

Ans: **(Correct definition – 2 marks)**

**Modulation Index of FM:** It is defined as the ratio of Frequency Deviation (δ) to the modulating signal frequency ($f_m$).

**(OR)**

Modulation Index of FM is defined as $m_f = \frac{\delta}{f_m} = \frac{frequency\ deviation}{modulating\ frequency}$

c) Define Pulse Modulation. State its types.

Ans: **(Correct definition – 1 mark, Both Types any two sub classification – 1 mark)**

**Pulse Modulation:** It is defined as the modulation technique in which the various parameters of carrier signal which is the train of periodic rectangular pulses changes in accordance with the instantaneous value of modulating signal.

**Types of Pulse Modulation:**

- Analog Pulse modulation **( ½ M )**
  - **PAM**
  - **PWM**
  - **PPM**
- Digital Pulse Modulation **( ½ M )**
  - **PCM**
  - **DM**
  - **ADM**

d) What are the different types of FM Detectors?

Ans: **(Any four correct types – 2 marks)**

The different types of FM Detectors are:

1. Simple Slope Detector
2. Balanced Slope Detector
3. Ratio Detector
4. Phase Discriminator
5. FM Detector using Phase Locked Loop (PLL)

e) What is the purpose of keeping RF section before mixer stage?

Ans: **(Any two relevant correct points – 2 marks)**

**A radio receiver always has a RF section before the mixer stage because**:

1. It selects the wanted frequency and rejects the unwanted frequencies.
2. Amplifier improves quality of receiver output and removes noise from received signal.
3. Better coupling of receiver to the antenna.
4. Prevention in the reradiation of the local oscillator through the antenna of the receiver.

f) Define Stub. State its two advantages.

Ans: **(Definition – 1 mark, any two advantages – 1 mark)**

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

**Advantages of Stub:**

1. The load and source impedance is perfectly matched.
2. Maximum power transfer to the load.
3. It acts as a series resonant circuit to eliminate the interfering RF signals.

g) What are the different types of wave propagation?

Ans: **(Any four correct types – 2 marks)**

The different types of wave propagation are:

1. Ground Wave Propagation
2. Space Wave Propagation
3. Sky Wave Propagation / Ionospheric Propagation
4. Tropospheric Scatter Propagation
5. Duct Propagation

h) Define antenna resistance and antenna gain.

Ans: **(each correct definition – 1 mark)**

**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.

**Antenna Gain –**

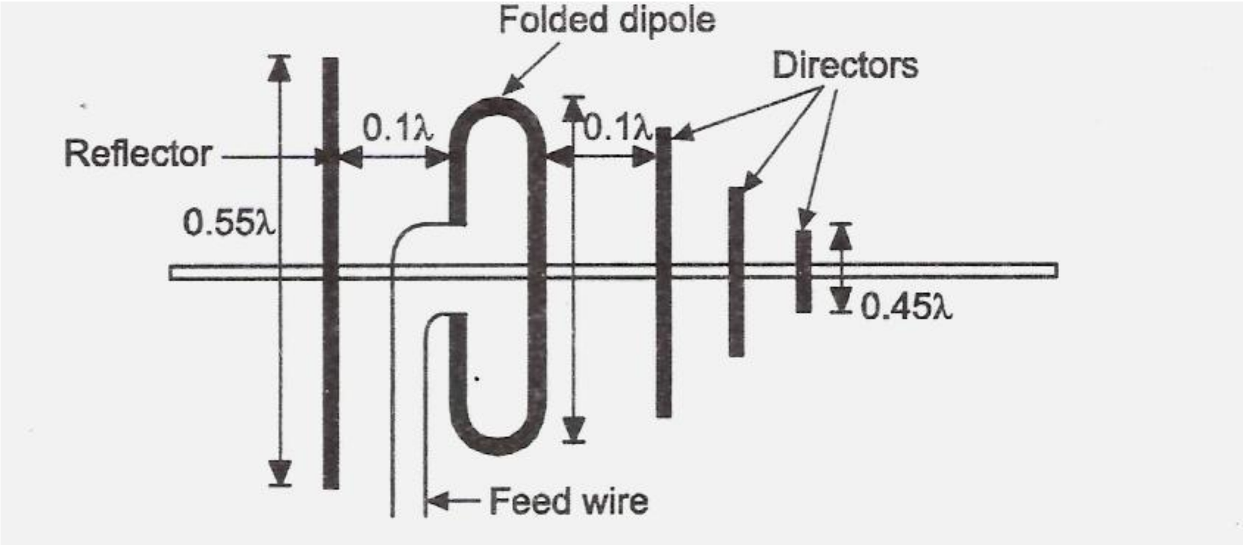
The directional antennae radiate more power in certain direction. The Omni-directional antenna radiates information equally in all directions.

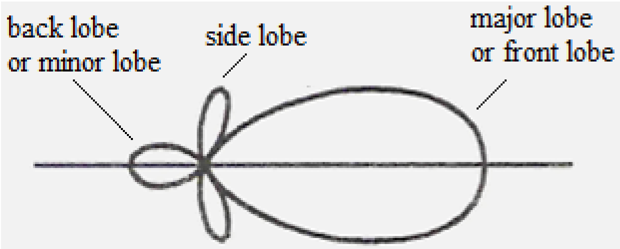
A directional antenna is said to have 'gain' in a particular direction.

**Q 1 (B) Attempt any TWO of the following** **8 marks**

a) Draw Yagi-Uda antenna with its radiation pattern.

Ans: **(Construction – 2 marks, Radiation Pattern – 2 marks)**



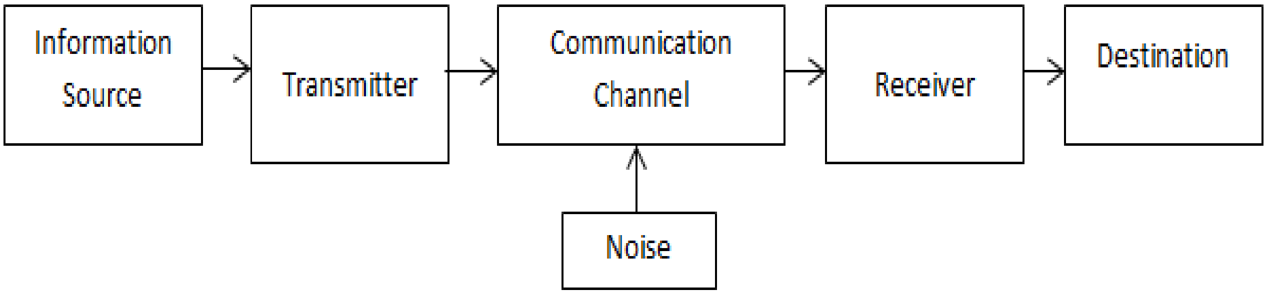

b) Compare ground wave and sky wave propagation for four points.

Ans: **(Any Four relevant correct points – 1 mark each)**

| 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 |
| 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 |

c) Draw the block diagram of basic electronic communication system. Describe its working principle.

Ans: **(block diagram – 2 marks, working principle – 2 marks)**




The information source generates the information which may be analog or digital which is sent to transmitter section where the information is amplified, filtered to remove noise, processed to become compatible with the channel. For e.g. If channel is optical fiber then information is converted into light energy.

The information from transmitter is sent to receiver through the communication medium/channel. The channel may be wired (co-axial cable/optical fiber cable) or wireless (microwave link).

The receiver again filters the information to remove noise, amplify, demodulates and convert the information in the type which is compatible with the destination (for e.g. if destination is computer the information is converted into digital binary form).

**Q 2 Attempt any FOUR of the following** **16 marks**

a) Explain with circuit diagram PWM using IC 555.

Ans: **(Circuit Diagram – 2 marks, operation – 2 marks)**

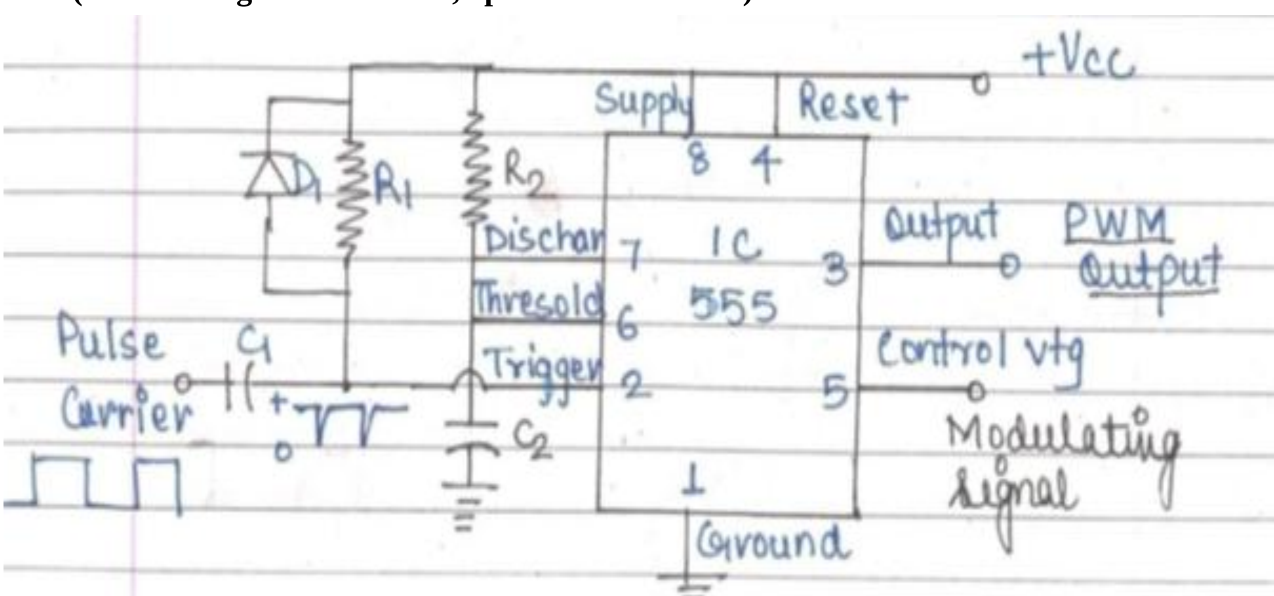



Fig. Circuit of PWM generation using IC 555

**Operation:**

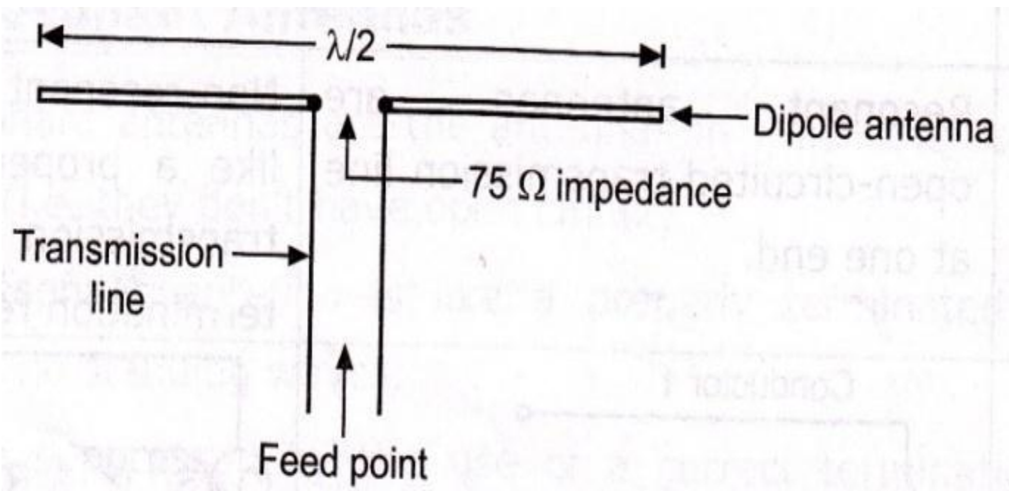
1. The timer IC555 is operated in Monostable mode.
2. The negative going carrier pulses are to the differentiator formed by R1 & C1. The differentiator produces sharp negative pulses which are applied to trigger input pin (2) of IC 555.
3. These triggering decides the starting instants (leading edge) of the PWM pulses. The PWM pulses go high at the instants of arrival of these triggering pulses.
4. The termination of the pulses is dependent upon,

- R2, C2 discharge time
- The modulating signal applied to control input pin (5)

5. The modulating signal applied to pin no (5) will vary the control voltage to IC 555 in accordance to the modulating voltage.
6. As this voltage increases, the capacitor C2 is allowed to charge through R2 up to a higher voltage & hence for a longer time (as R2 C2 time constant is fixed). The width of the corresponding output pulse will increase due to this action. As soon as VC2 is equal to the control voltage, the PWM pulse goes to zero.
7. Thus PWM signal is generated at the output pin (3) of IC555 as Monostable multivibrator.

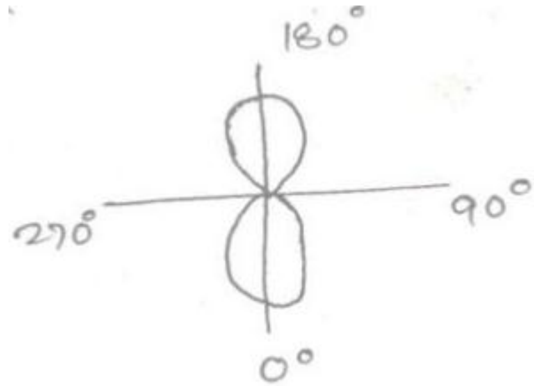
b) Explain half wave dipole (resonant antenna) with its radiation pattern.

Ans: **(Construction – 2 mark, explanation – 1 mark, radiation pattern – 1 mark)**



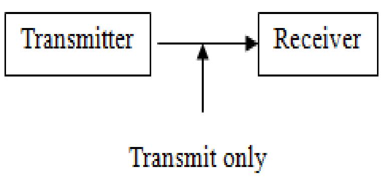
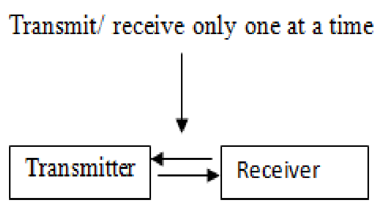
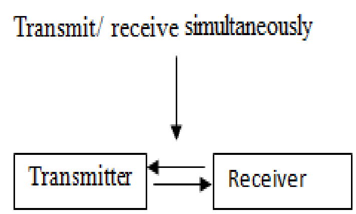

**Explanation:**

1. It is a resonant antenna
2. It is exact half wavelength (λ /2) long & open circuited at one end.
3. The dipole antennas have lengths λ /2 , λ , 3 λ /2 etc. which are all multiple of λ /2. Hence they are resonant.
4. In half wave dipole antennas the forward waves & reflected waves exist. Hence radiation pattern is bidirectional.
5. The radiation pattern of half wave dipole antenna is -



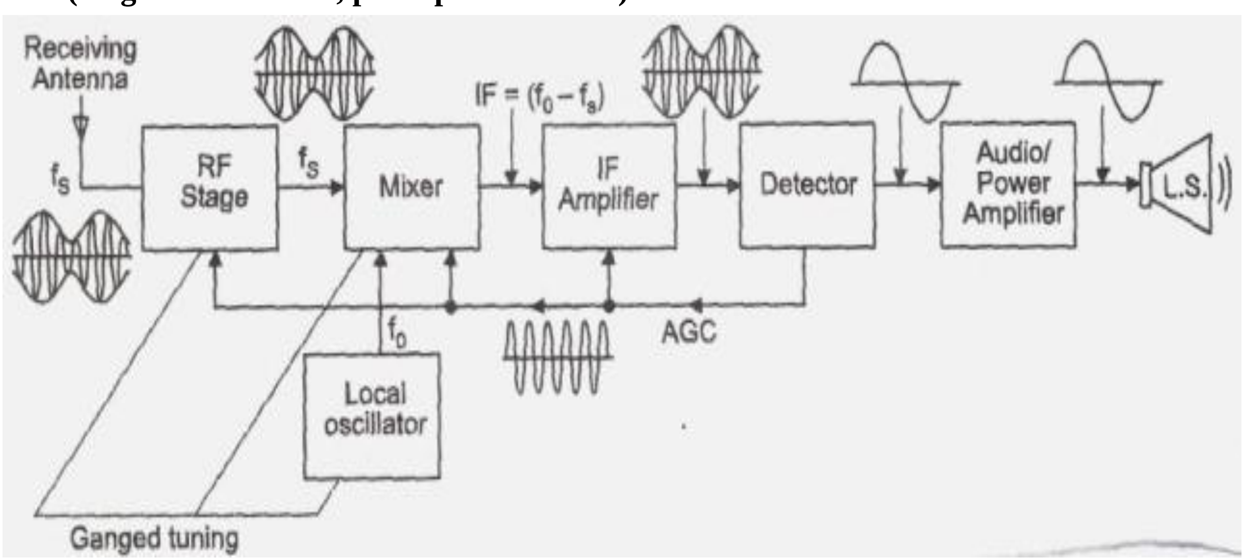

c) Differentiate between simplex and duplex mode of communication.

Ans: **(Two points – 2 marks, Diagram – 2 marks)**

| Sr. No | Simplex Communication | Duplex Communication | |
|---|---|---|---|
| | | Half Duplex | Full Duplex |
| 1 | It's a one way communication (unidirectional) | It's a two way Communication (bidirectional) but simultaneous data transfer is not possible. | It's a two way Communication (bidirectional) with simultaneous data transfer. |
| 2 | Eg: Television, Radio | Eg: Walkie – Talkie | Eg: Mobile |
| 3 |   |   |   |

d) Draw block diagram of AM super heterodyne receiver and explain its working principle.

Ans: **(diagram – 2 marks, principle – 2 marks)**



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.

e) Write a mathematical expression for amplitude modulated wave.

Ans: **(Correct equation – 4 marks)**

$$e_{AM} = E_c \cos \omega_c t + \frac{m_{E_c}}{2} \cos(\omega_c + \omega_m)t + \frac{m_{E_c}}{2} \cos(\omega_c - \omega_m)t$$

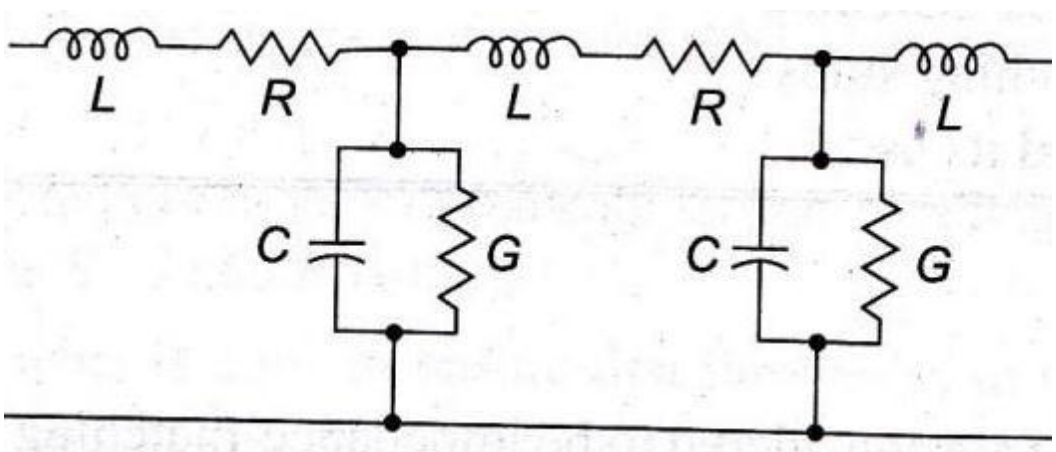
where, $e_{AM}$ – Instantaneous value of Amplitude Modulated Wave.

$E_c$ – Peak voltage of Carrier signal.

m – Modulation Index of AM wave.

f) Draw and explain equivalent circuit of a transmission line.

Ans: **(Circuit – 2 marks, explanation – 2 marks)**




Transmission line is a medium of transmitting the signal over longer distances and so each conductor has a certain length and diameter.

Since each conductor has a certain length and diameter it must have inductance and resistance. R is the resistance in ohms per unit length while L is inductance per unit length in Henry.

Since wires are separated by a medium called dielectric which is not a perfect insulator, some current will flow through it from one conductor to other. This will generate conductance G measured in Siemens.

Also a small capacitance will be generated between the two conductors since in a cable conductors will be separated by insulators which act as dielectric between the conductors.

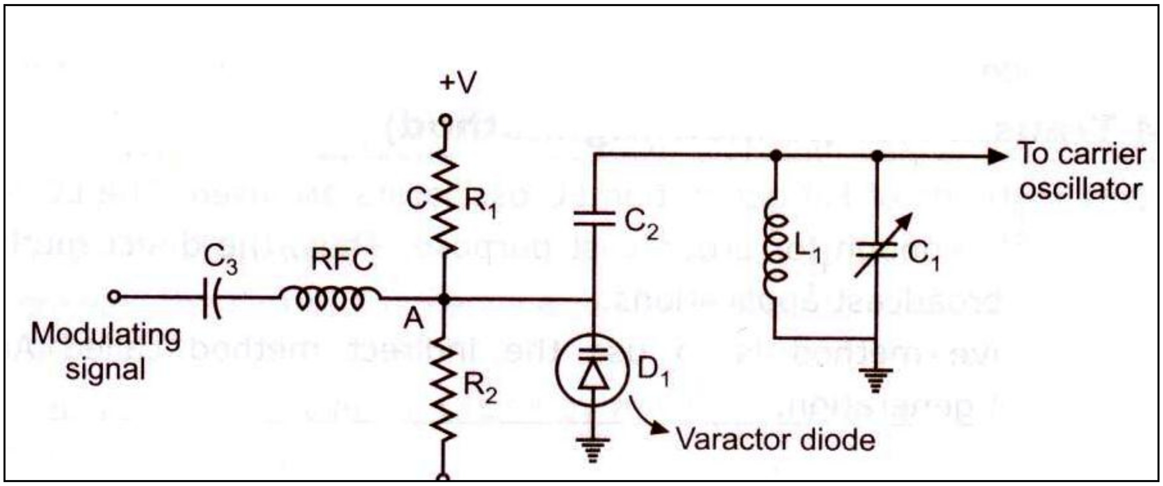
**Q. 3 Attempt any FOUR from the following. 16 marks**

a) Explain the working of varactor diode reactance modulator for FM generation.

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

**Note: Any relevant correct diagram with explanation should be considered**

- Varactor diodes may be used to produce frequency modulation; they are employed with reactance modulator, to provide automatic correction for FM transmitter.




**Working:**

- The $L_1$ and $C_1$ represent the tuned circuit of the carrier oscillator.
- The value of $C_2$ is made very large at the operating frequency so that its reactance is very low.
- As a result, when $C_2$ is connected in series with the lower capacitance of $D_1$, the effect of $D_1$ were connected directly across the tuned circuit.
- The total effective circuit capacitance then is the capacitance of D1 in parallel with C1. This fixes the carrier frequency.
- The capacitance of $D_1$ is controlled by two factors: a fixed d.c. bias and the modulating signal.
- The bias on $D_1$ is set by the voltage divider which is made by $R_1$ and $R_2$.
- The modulating signal is applied through $C_3$ and RFC.
- The $C_3$ is a blocking capacitor that keeps the dc bias out of the modulating signal circuits.
- As the modulating signal varies, it ads to and subtracts from the fixed bias voltage.
- Thus, the effective voltage applied to D1 causes its capacitance to vary.
- A positive going signal at point 'A' adds to the reverse bias, decreasing the capacitance and increasing the carrier frequency.
- A negative going signal at 'A' subtracts from the bias, increasing the capacitance and decreasing the carrier frequency.
- This is nothing but FM.

b) A practical antenna has directive gain of 5dB radiate 1200 watt power. How much power an isotropic antenna should radiate in order to have the same power density at the same distance?

**Ans : (formula- 2marks, answer- 2marks)**

Given: directive gain G = 5dB, power radiated = 1200W
To find: power radiated by isotropic antenna

$$G = \frac{power\ radiated\ by\ practical\ antenna}{power\ radiated\ by\ isotropic\ antenna\ with\ same\ power}$$

$G_{dB}$ = 5dB

G = Antilog $G_{dB}$

G = 3.162

$$G = \frac{Prad}{Piso}$$

$$P_{iso} = \frac{Prad}{G} = \frac{1200}{3.162}$$

$P_{iso}$ = 379.4W

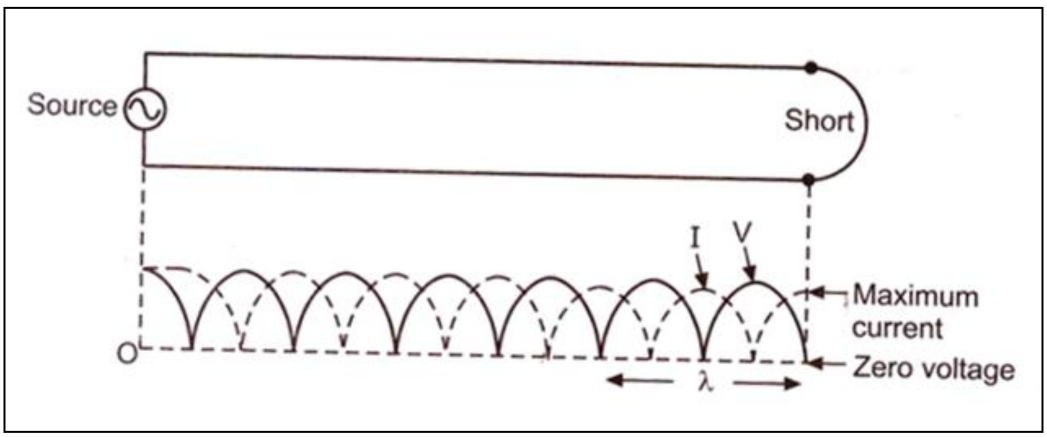
c) Explain standing waves with load terminal open circuit & short circuit.

**Ans: (each circuit - 2 marks)**

Standing waves: The forward and reflected waves on the incorrectly terminated transmission line produce an interference pattern known as Standing waves.

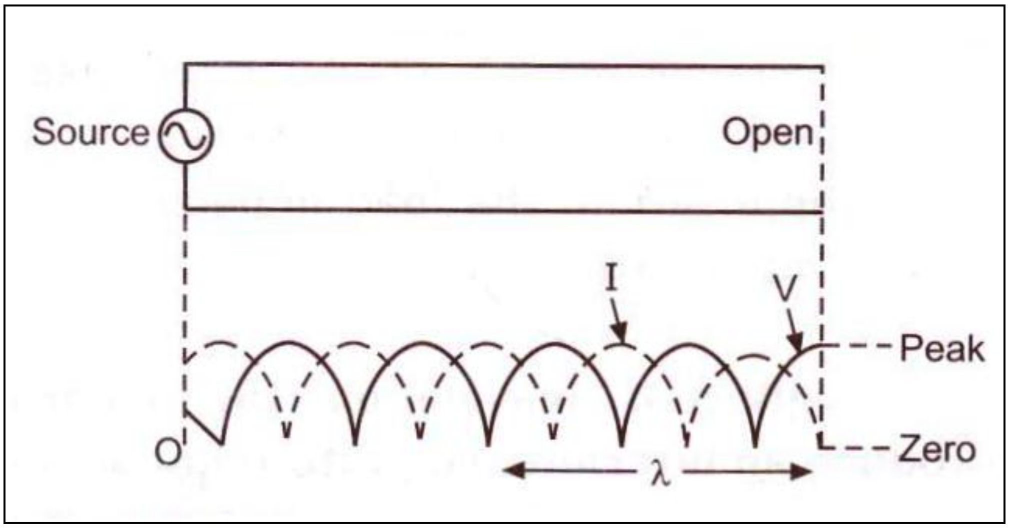
The concept of Standing wave can be best understood by considering the two cases of impedance mismatch at load or the antenna end of the transmission line.

i) Short circuit:



- The waveform below the transmission line shows the voltage and current at each point on the line.
- We can measure these voltages and current at each point with the help of multimeter.
- As shown the voltage is zero while the current is maximum because short circuit means zero impedance.
- All the power is reflected back towards the source.
- The voltage and current variations distribute themselves according to the wavelength of the signal.
- The pattern repeats for every one-half wavelength.
- The voltage and current levels at the source will be dependent on the signal wavelength and actual line.

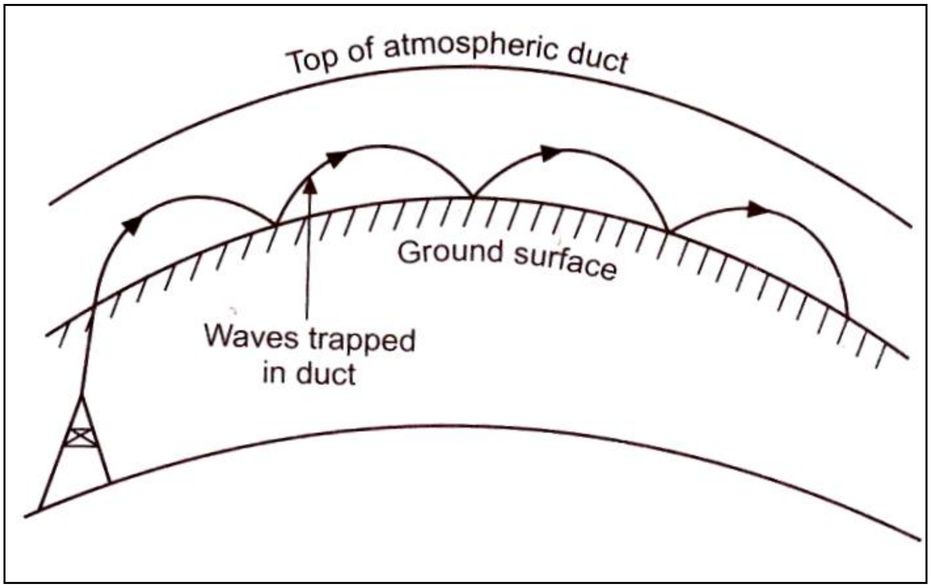
ii) Open Circuit:




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

d) Explain Duct propagation.

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




- Duct propagation is a special type and used for very high microwave frequencies.
- New phenomenon which occurs in super-refraction, also known as ducting.
- As the height above earth increases, the air density decreases and refractive index increases.
- Under certain special atmospheric conditions, a layer of warm air may be trapped above cooler air, often over the surface of water.
- So that refractive index will decrease far more rapidly with height than is usual.
- This happens near ground within 30 m of it.
- Due to this rapid reduction of refractive index, the microwaves completely bend back towards earth surface as shown in fig.
- Microwaves are thus continuously refracted in duct and reflected back by the ground, so that they are propagated around the curvature of the earth for distances which many of times exceed 1000km.
- The main requirement of formation of atmospheric ducts is the so-called temperature inversion.
- Temperature inversion is the increase of air temperature with height, instead of the usual decrease in temperature of $6.5^0$C/km in the standard atmosphere.
- The Duct propagation is used for very high frequencies in GHz range.

e) Define Image Frequency. The RF, local oscillator frequency, IF frequency for AM Receiver is 800KHz, 1255KHz & 455KHz respectively. Determine image frequency.

Ans: **(Definition- 2marks, formula- 1mark, answer- 1mark)**

Image frequency is defined as the signal frequency plus twice the intermediate frequency. It is denoted as Fsi.

Fsi = Fs + 2Fi

Where Fs – Signal frequency

Fi – intermediate frequency

Given: Fs = 800KHz (RF signal frequency)

Fo = 1255KHz (local oscillator frequency)

Fsi = 455KHz (IF frequency)

Fsi = Fs + 2Fi &

Fi = Fo – Fsi

Fi = 1255 – 455

Fi = 800 KHz

Fsi = $800 \times 10^3 + 2 \times 800 \times 10^3$

= 2400 KHz

f) Explain power relation in AM wave.

**Ans:**

**i) The Total power in AM (Pt) :**

Pt = (Carrier power) + (Power in USB) + (Power in LSB)

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

$\therefore \quad Pt = \frac{Er^2 carr}{R} + \frac{Er^2 USB}{R} + \frac{Er^2 LSB}{R}$ **(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.

**ii) Carrier power (Pc):**

$$Pc = \frac{Er^2 carr}{R}$$

$$= \frac{(E\sqrt{2})^2}{R}$$

$$\mathbf{Pc = \frac{E^2c}{2R}}$$ **(1 mark)**

Where, Ec = Peak carrier amplitude

**iii) Power in sidebands:**

The power in USB and LSB is same as,

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

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

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

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

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

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

$$\therefore \quad \mathbf{P_{USB} = P_{LSB} = \frac{m^2}{4} Pc}$$ **(1 mark)**

**iv) Total power in AM :**

The total power in AM is,

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

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

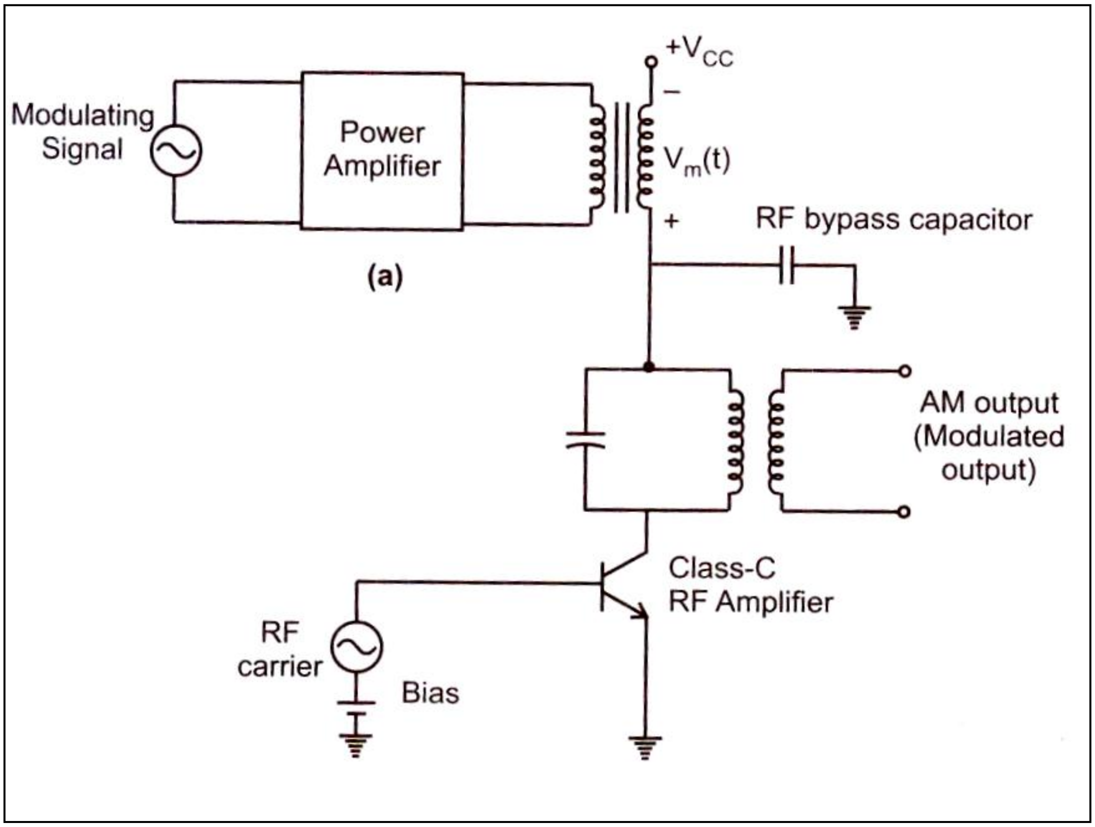
$$\therefore \quad Pt = (1 + \frac{m^2}{2}) Pc$$ **(1 mark)**

**Q. 4 Attempt any FOUR from the following. 16 marks**

a) Draw and explain circuit of AM modulator using BJT.

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

**Note: Any relevant correct circuit with explanation should be considered**




- AM modulator circuit is use to get the amplitude modulated signal as output.
- The transistor is normally operated in the class c mode in which it is biased well beyond cut-off.
- The carrier input to the base must be sufficient to drive the transistor into conduction over the part of RF cycle, during which collector current flows in the form of pulses.
- The tuned circuit in the collector is tuned to resonate at the fundamental component, thus, the RF voltage at the collector is sinusoidal.
- When modulating signal is applied to the steady collector voltage, changes to a slowly varying voltage given by V'cc = Vcc + Vm(t).
- The modulating voltage Vm(t) is applied in series with Vcc through the low frequency transformer.
- The RF bypass capacitor provides a low impedance path for the RF to ground so that negligible RF voltage is developed across the LF transformer secondary.
- The modulated output is obtained through mutual inductive coupling.
- The coupling prevents the steady voltage from being transferred to the output, so that Rf varies about mean value of zero.

b) Compare the bandwidth that would be required to transmit baseband signal with a frequency range from 300Hz to 3 KHz using

i) Narrow band FM with maximum deviation of 5 KHz

ii) Wideband FM with maximum deviation of 75 KHz.

Ans: **(Formula each – 1mark, Answer each – 1 mark)**

i) For Narrow band FM

- Max modulating frequency is for baseband signal range (Fm) = 300Hz to 3KHz
- Frequency deviation (δ) given is 5KHz

$BW = 2(\delta + Fm)$

$= 2\ (5 + 3)$

**= 16 KHz**

ii) For Wideband FM

- Max Wideband frequency (Fm) = 5KHz
- Frequency deviation (δ) given is = 75KHz

$\therefore\ BW = 2(\delta + Fm)$

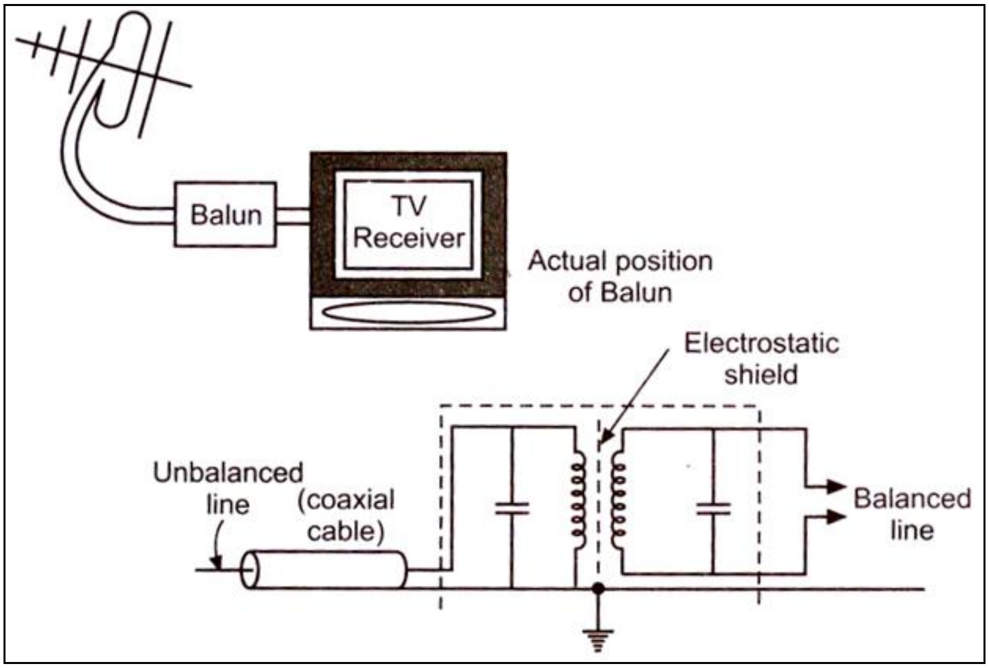
$= 2\ (75 + 10)$

$= 2 \times 90$

**= 180 KHz**

c) Explain working of Balun with diagram.

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



1. A Balun or a balance to unbalance transformer, is a circuit element used to connect a balanced line to unbalanced line. i.e. it is used to connect an unbalanced (coaxial) line to a balance antenna such as a dipole.
2. As shown in fig. here the windings associated with the balanced system is symmetrically arranged with respect to a grounded electrostatic shield so that stray capacitances inevitably present will not introduce unbalance.
3. At high frequencies, several transmission line baluns used for differing purposes and narrow band or broadband application.

   e.g. if impedance of parallel wire is 300 Ω and co-axial is 75 Ω then,

   $Zo = \sqrt{Z1Z2} = \sqrt{300\ X\ 75} = 150\ \Omega$
4. The most common balun a narrow band one shown in fig. it is known as choke, sleeve or bazooka balun.

d) Explain i) critical frequency ii) skip distance

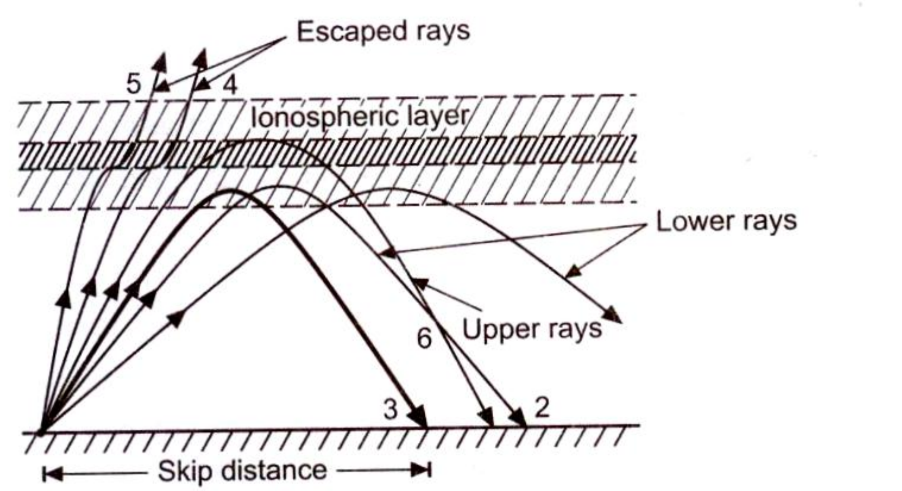
Ans: **(Each explanation - 2 marks)**

**i) Critical frequency:** The critical frequency of a layer is defined as the maximum frequency that is returned back to the earth by that layer, when the wave is incident at an angle $90^0$ (normal) to it.

The critical frequency for $F_2$ layer is between 5 to 12 MHz

ii) **Skip distance:** The skip distance is defined as the shortest distance from a transmitter, measured along the surface of earth at which a sky wave of fixed frequency returns back to the earth.

The frequency should be greater than critical frequency $f_c$ .



Effects of Ionosphere on Rays of Varying Distance

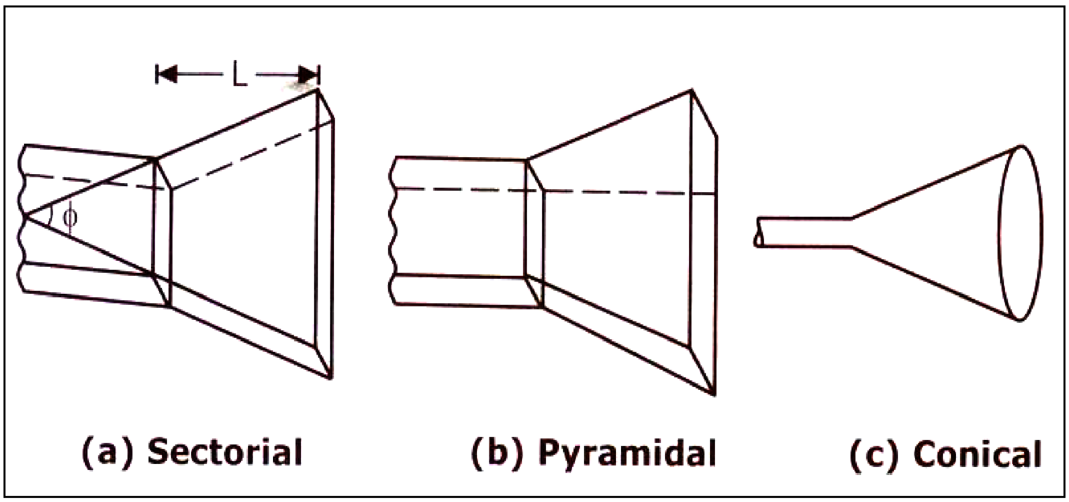
e) What are different microwave antennas? Explain horn antenna.

Ans: **(List 2 Antennas– 1 mark, any one diagram of horn antenna – 1mark, explanation- 2 marks)**

Types of microwave antennas: i) Dish antenna ii) Horn antenna

**Horn antenna:**

1. It is basically a waveguide terminated by horn.
2. Waveguide is a hollow metallic pipe used to carry electromagnetic waves at microwave frequencies.
3. All the energy travelling forward in the waveguide is radiated very effectively with the addition of the horn.
4. There are three configuration s of most commonly used Horn antennas, i) Sectorial ii) Pyramidal iii) Conical




As shown in fig.

i) The Sectorial horn flares out only in one direction.

ii) Pyramidal horn flares out in both directions and has the shape of truncated pyramid.

iii) The Conical horn is the termination of a circular waveguide.

- The ratio of $L/\lambda$ decides the beam width and the gain of the antenna.
- There are two types of Horn antenna

  a) Cass- horn antenna

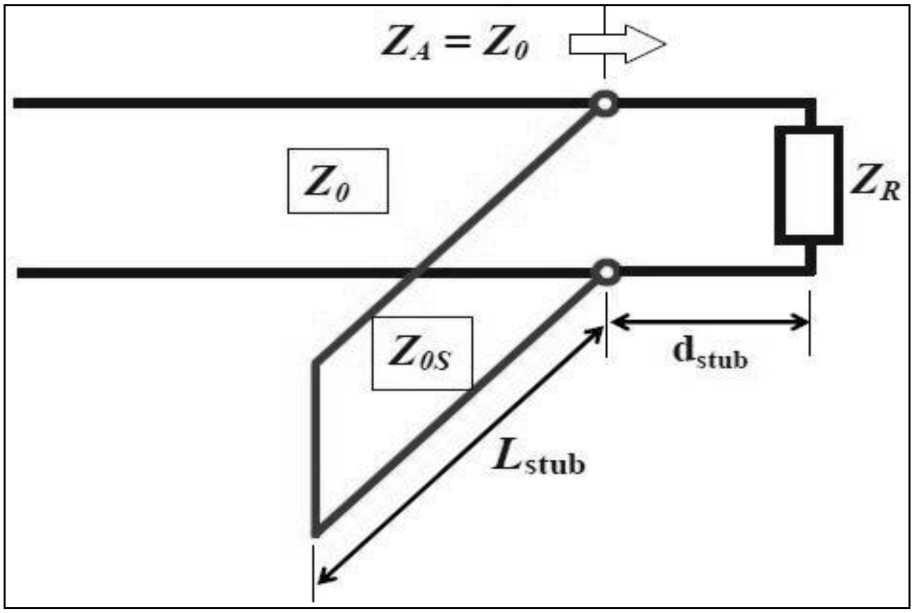
  b) Hog Horn antenna

f) Explain single & double stub matching.

**Ans. (Each type - 2 marks)**

**Single stub:**

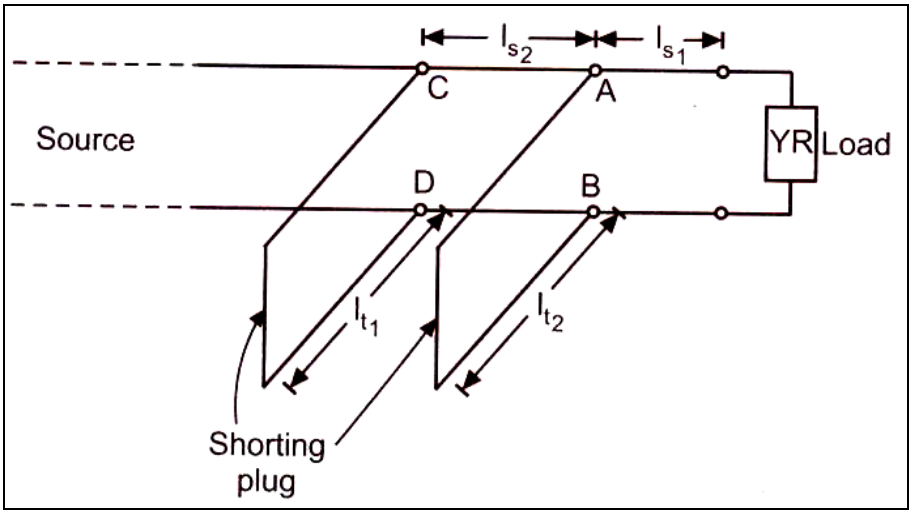
Stub is the piece of short circuited TL which is used to tune out the reactance of the load when connected across the TL as close as possible.




1. The most important feature of single stub matching is that the stub should be located as near to the load as possible.
2. The characteristic admittance of the stub so connected in shunt should be same as that of the main line.
3. The main element of this transmission line is a short circuited section of line whose open end is connected to the main line at a particular distance from the load end.
4. Where the input conductance at that point is equal to the characteristic conductance of the line, and the stub length is adjusted to provide a susceptance equal in value but opposite in sign, to the input susceptance of the main line at that point.
5. So the total susceptance of the main line at that point is zero.
6. The combination of stub and the line will thus present a conductance which is equal to the characteristic impedance of the line, i.e. the main length of the HF transmission line will be matched.

**Double stub:**

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

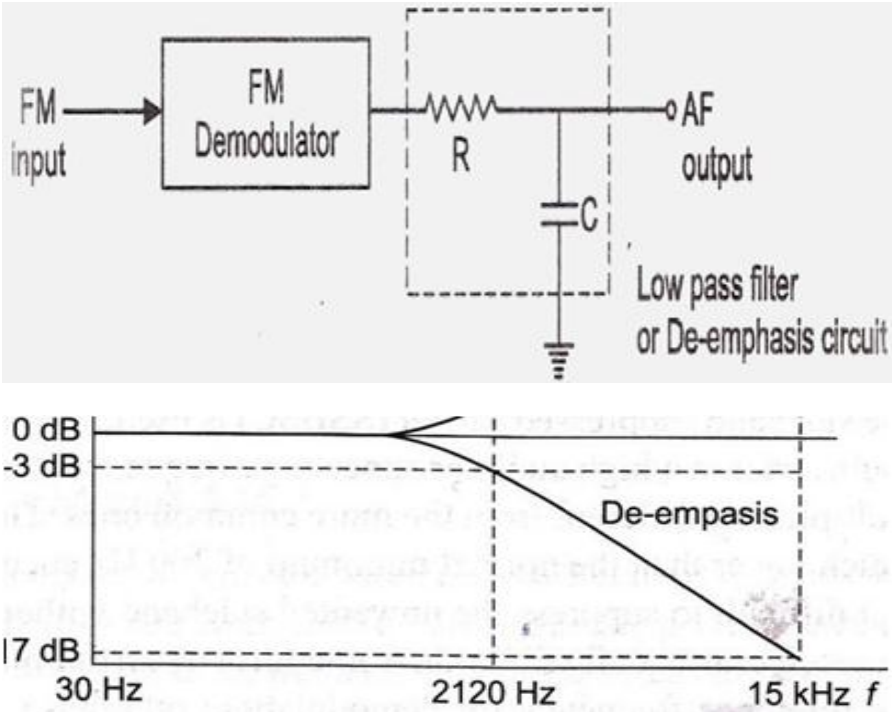



- Here, two short circuited stubs at two fixed point usually λ/4 apart are utilized.
- Their positions are fixed but lengths are independently adjustable.
- The double stub matching provides wide range of impedance matching.

**5. Attempt any FOUR from the following** **16 marks**

a) Explain the working of De-emphasis circuit.

**Ans:- (Diagram – 2marks, explanation- 2 marks)**



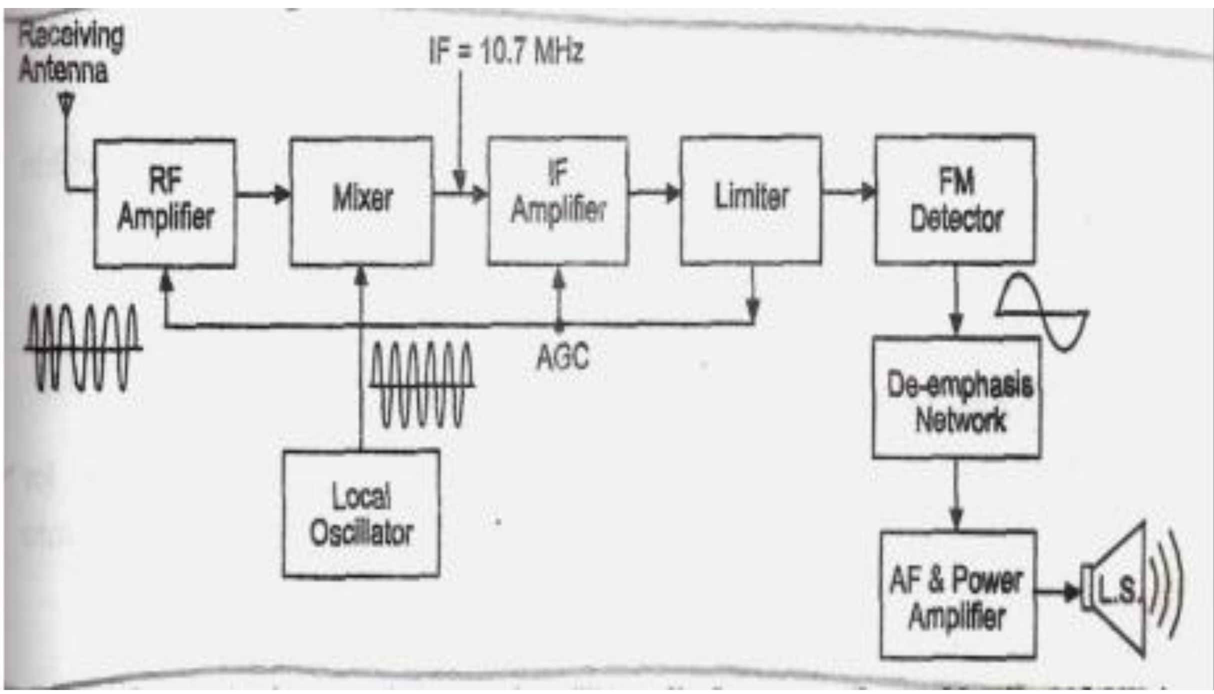
In FM, noise has greater effect on higher modulating frequencies than the lower one. Therefore the higher modulating frequencies have to be boosted artificially at the transmitter before modulation and corresponding cut off at the receiver after demodulation.

This boosting of higher modulation frequencies at the transmitter in order to improve noise immunity is called as pre-emphasis. The compensation at the receiver ie. Attenuation of this higher modulation frequency after detector at receiver is called as De-emphasis, which is basically a low pass filter.

Pre-emphasis is used at transmitter and de-emphasis at receiver to o\improve the noise immunity.

b) Draw block diagram of FM receiver.

**Ans:-(Correct diagram – 4 marks)**

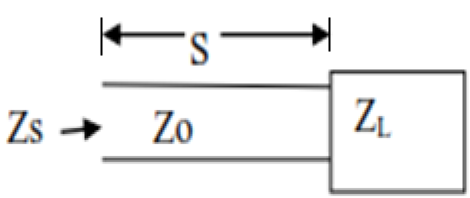



c) Explain quarter wavelength transformer.

**Ans :-( Diagram – 1 marks, explanation- 3 marks)**

In all applications of transmission line, it is required that the load be matched to line, which requires tuning out the unwanted load reactance and the transformation of resulting impedance to the required value especially at high frequencies.

The impedance of the quarter line depends on load impedance and characteristics impedance as shown-




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

When the length S is exactly quarter wavelength line then the line is lossless. If the $Z_o$ is varied, the impedance seen at the input to the λ/4 transformer will also vary accordingly, so that load may be matched to characteristic impedance of the main line. This is similar to varying truns ration of a transformer to obtain the required value of inpur impedance to match the load impedance. Quarter wave transformer works as filter to prevent unwanted frequencies from reaching the load such as antenna.

The name transformer is given to quarter wavelength transmission line since it behaves as a transformer depending upon the value of $Z_L$.

If ZL = Zo then it acts as 1 : 1 transformer.
If ZL > Zo then it acts as a Step down transformer
If ZL < Zo then it acts as a Step up transformer

d) The operating frequency for pyramidal horn antenna is 10 GHz. The horn antenna is 10 cm high and 12 cm wide. Calculate
1) Beam width of antenna
2) Power gain of antenna if K=5.

**Ans: - (Beam width – 2 marks, Power gain – 2 marks)**
**Given:** w = 12 cm = 0.12m, H = 10 cm = 0.10m
Operating frequency = 10GHz
**To find:** Beam width of antenna =?
Power Gain if K = 5?
**Solution:**
We have,

Beam width = $B_W = \frac{80}{\frac{W}{\lambda}}$ for width w

Beam width = $B_H = \frac{80}{\frac{H}{\lambda}}$ for width H

Power gain $G = \frac{4\pi K A}{\lambda^2}$ where K = 5

$\lambda = \frac{c}{f} = \frac{3 X 10^8}{10 X 10^9} = 0.03$

A =Aperture in meters = w x H
= 0.12 x 0.10 = 0.012$m^2$

$B_W = \frac{80}{\frac{0.12}{0.03}} = 20$

Therefore, $B_W$ in dB = 10 log 20
= 13 dB

**Therefore $B_W$ = 13 dB (1 mark)**

$B_H = \frac{80}{\frac{0.10}{0.03}} = 24$

Therefore, $B_W$ in dB = 10 log 24

= 13.8 dB

**Therefore $B_W$ = 13.8 dB (1 mark)**

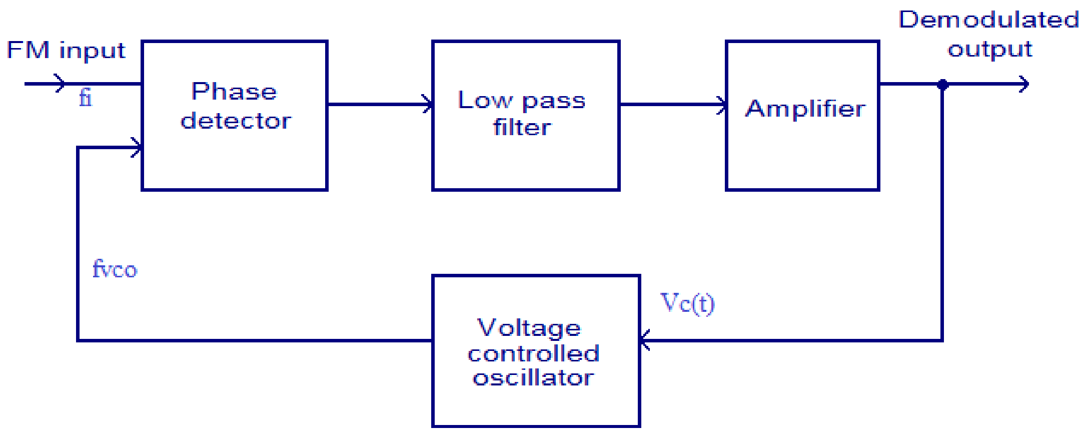
Power gain G = $\frac{4\,\pi\,K\,A}{\lambda^2} = \frac{4\,\pi\,X\,5\,X\,0.012}{0.03^2} = 837.75$

Gain in dB = 10 log 837.7 = 29.23 dB

**Therefore, Gain in dB = 29.23 dB (2 marks)**

e) Explain the working of FM demodulator using phase lock loop with the help of circuit diagram.

**Ans:- (Diagram – 2marks, explanation- 2 marks)**




PLL FM demodulator circuit

**Explanation:-**

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

f) State the different losses in transmission line.

**Ans: -(Any four losses – 4 marks)**

Losses in transmission line:-

1) Conductor loss
2) Dielectric heating loss
3) Radiation loss
4) Coupling loss
5) Corona

**6. Attempt any FOUR from the following 16 marks**

a) Draw the block diagram of PPM. Draw waveforms to explain the working of PPM.

**Ans:- (Diagram – 2marks, explanation- 1marks, waveforms- 1 marks)**

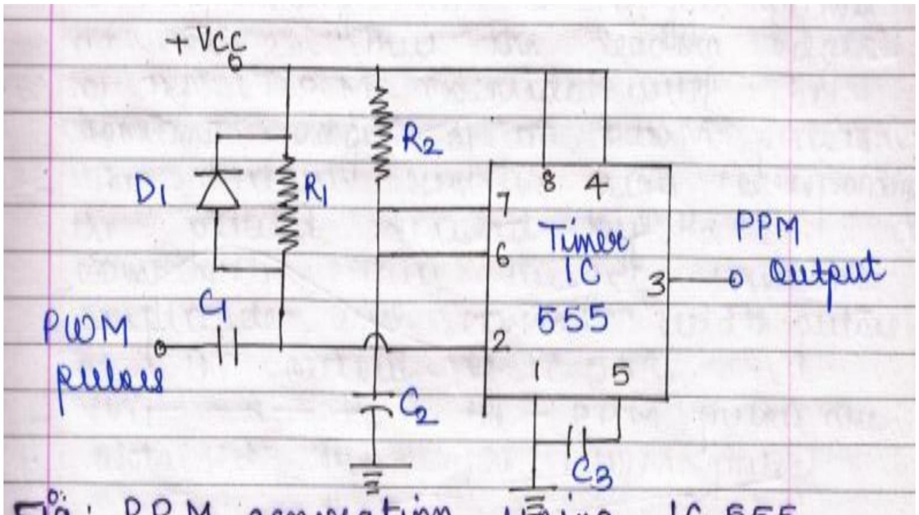



Fig: PPM generation using IC 555

**Explanation-**

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

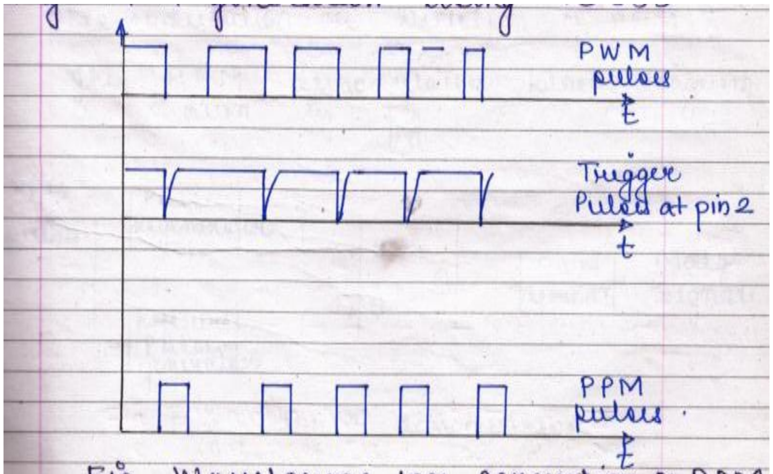



Fig Waveforms for generation of PPM

b) Explain the sensitivity and selectivity for AM radio receiver.

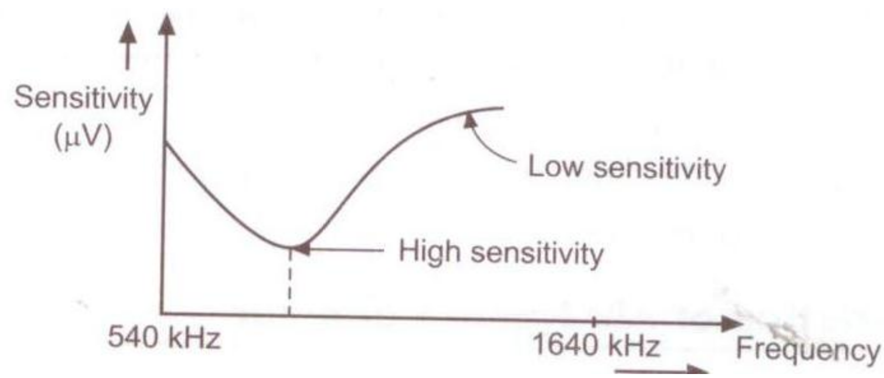
Ans:-

**Sensitivity:**

The ability to amplify weak signals is called sensitivity. The sensitivity is expressed in millivolt. It is often defined in terms of the input voltage that must be applied at the input of the receiver to obtain a standard output power.

The sensitivity curve indicates that the receiver input required to obtain the same standard output changes with carrier frequency. **(1 mark)**

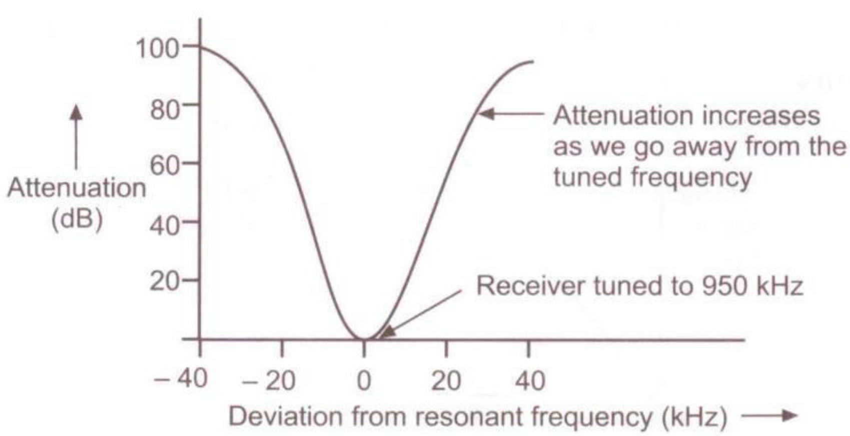
**Graph:** **(1 mark)**




**Selectivity:**

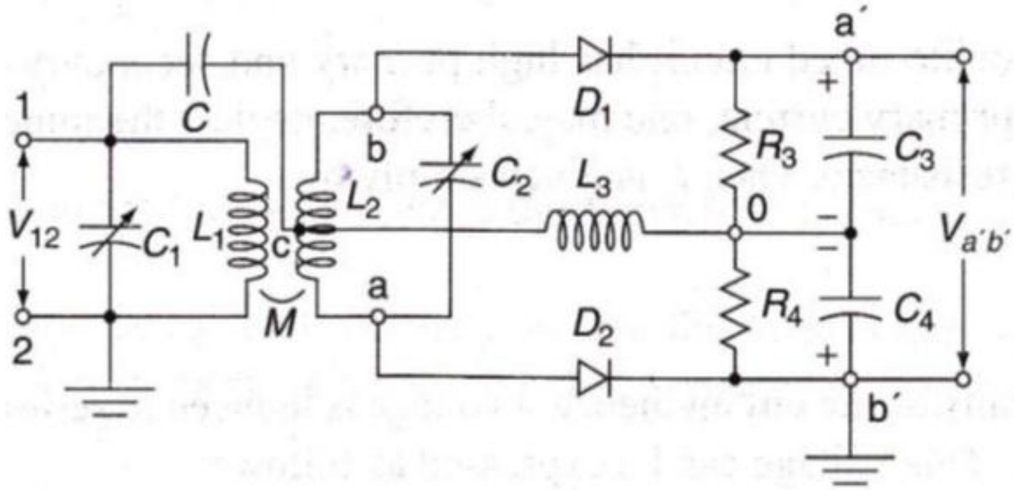
The ability of radio receiver to reject the unwanted signals is called selectivity. It shows that the receiver offers a minimum rejection at 950 kHz but the rejection increases as the input signal frequency deviates on both sides of 950 kHz. The selectivity decides the adjacent channel rejection of a receiver. **(1 mark)**

**Graph-** **(1 mark)**



c) Explain the working of phase discriminator FM.

**Ans:- (Diagram – 2marks, explanation- 2 marks)**

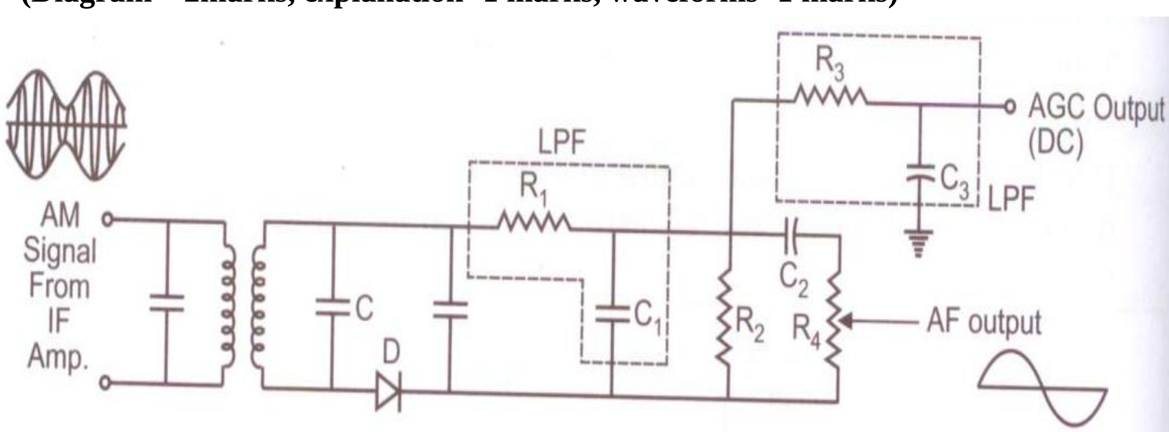



**Explanation-**

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

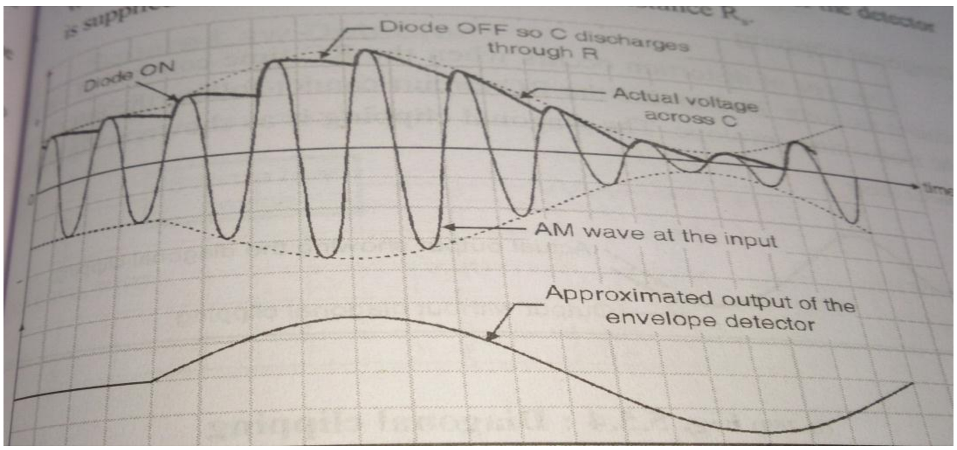
d) Explain demodulation of AM signal using practical diode detector.

**Ans:- (Diagram – 2marks, explanation- 1 marks, waveforms -1 marks)**



**Explanation-** The circuit operates in the following manner-

- The diode has been reversed so that now the negative envelope is demodulated. Due to this negative envelope AGC voltage will be developed.R1 and R2 ensures that there is a series DC path to ground for diode.
- R1 and C1 is the low pass used to remove RF ripple that is present in the detector o/p.C2 is coupling capacitor that prevents the diode DC o/p from reaching the volume control R4.
- R3 and C3 is a low pass filter which removes AF components and helps to produce AGC voltage.
- The DC AGC voltage is proportional to the amplitude of AM signal.




e) What is frequency changing and tracking?

**Ans:-**

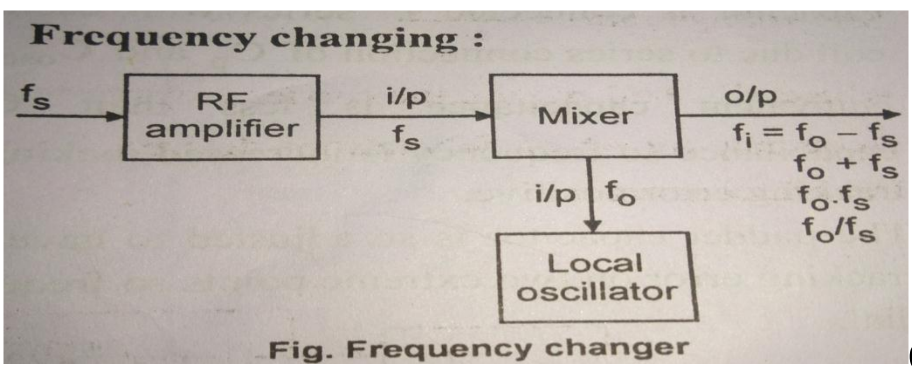


Fig. Frequency changer **(1 marks)**

Mixer is the frequency changer which is a nonlinear circuit, having two sets of i/p terminals and one set of o/p terminals. The signal from antenna or RF stage Fs is fed to one of the i/p and the other i/p is from the local oscillator Fo. The mixer produces several frequencies at the o/p, among which Fo – Fs is called as the intermediate frequency Fi. **(1 marks)**

**Frequency Tracking**:-The super heterodyne receiver has to a no of tunable circuits which must be tuned correctly if any given station is to be received. So any error should not occur, called as tracking errors Thus frequency tracking is the process in which the local oscillator frequency follows or tracks the signal frequency to have a correct frequency difference for IF stage.

There are two types of tracking-
a) two point tracking
b) three point tracking **(2 marks)**

f) For 2 meter diameter parabolic reflector with 10 watt of power radiated by the feed mechanism operating at 6 GHz with transmit antenna efficiency of 55%. Determine
1) beam width of antenna
2) transmit power gain
Ans: **(Beam width – 2 marks, Transmit power gain – 2 marks)**

Given: f = 6 GHz

% Efficiency $\eta$ = 0.55

$\lambda = \frac{c}{f} = \frac{3 X 10^8}{6 X 10^9} = 0.05$

K = 70, D = 2m
To find: Beam width =?
Power Gain =?
Solution:
Transmit Power gain

$G = \eta \text{ x } \left(\frac{\pi D}{\lambda}\right)^2$

$= 0.55 \text{ x } \left(\frac{\pi X 2}{0.05}\right)^2$

G = 15791.36

G in dB = 10 log G

= 41.98 dB

Therefore, G = 41.98 dB

Beam width = Half power beam width

$= \alpha = \frac{K X \lambda}{D} = \frac{70 X 0.05}{2} = 1.75^0$