S.Y. Diploma : Sem. IV
[EJ/EX/ET/EN/IS/IC/IE/IU]

Analog Communication

Solution of Prelim Paper

Q.1(a) Attempt any SIX of the following : [12]

Q.1(a) (i) Define Analog signal and digital signal. [2]

Ans.: Analog signal : [1mark]

The analog signal is type of signal which varies smoothly and continuously with time. This means that analog signals are defined for every value of time and they take on continuous value in a given time interval.

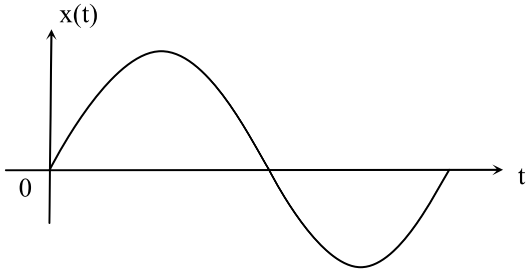


Fig.: An analog signal

Digital signal : [1mark]

An alternative form of signal representation is that of a sequence of numbers, each number representing the signal magnitude at an instant of time. The resulting signal is called a digital signal

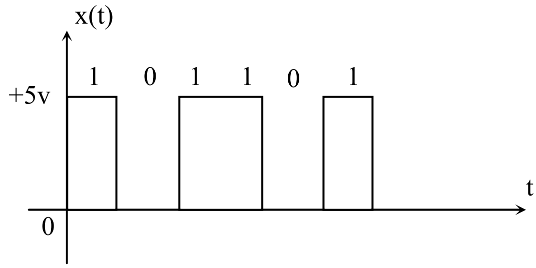
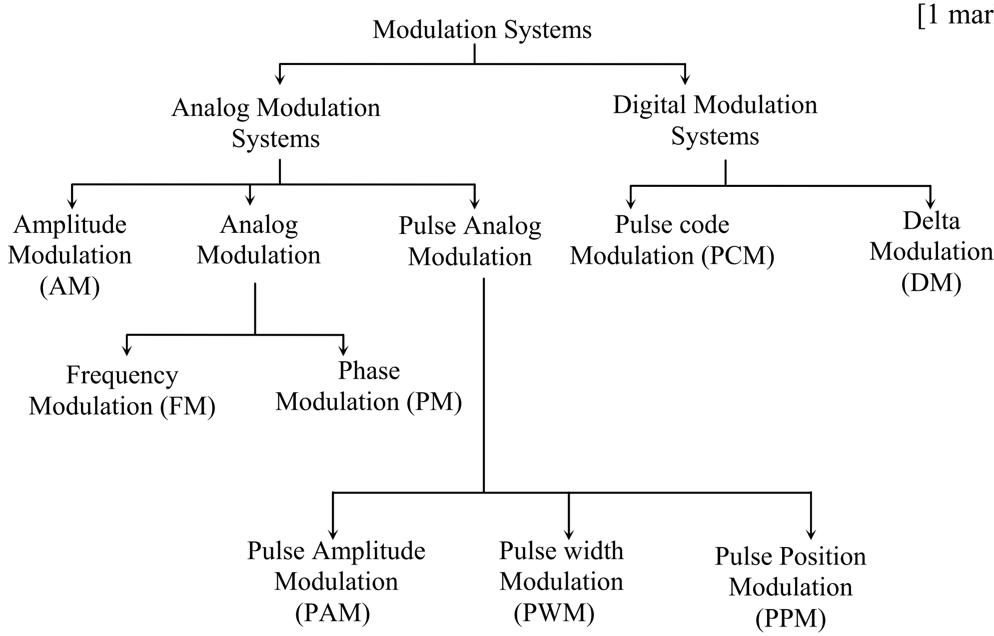


Fig.: Variation of a binary digital signal with time

Q.1(a) (ii) Define modulation and state it's types. [2]

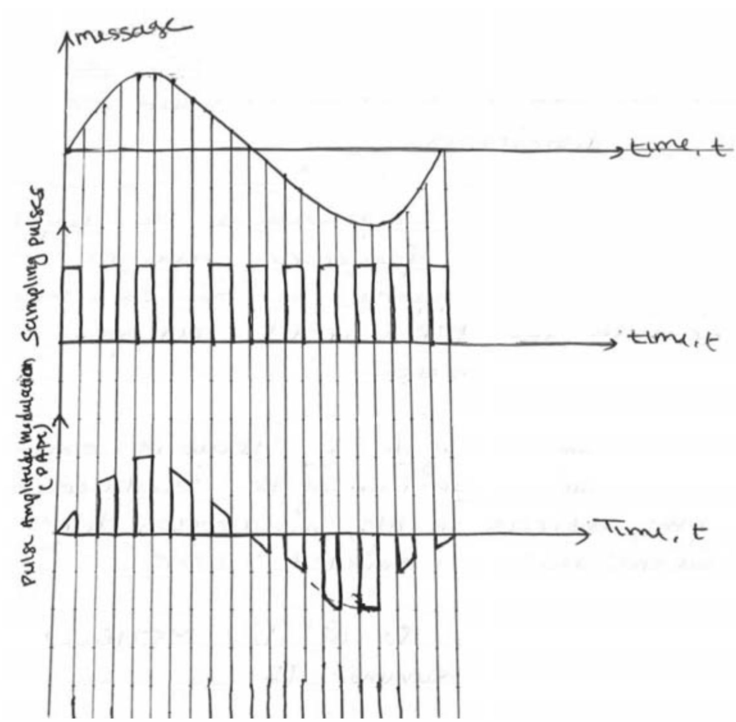
Ans.: In the modulation process, some parameter of the carrier wave (such as amplitude, frequency or phase) is varied in accordance with the modulating signal. [1 mark]

[1 mark]



Q.1(a) (iii) Draw the waveform for PAM waveform **[2]**

Ans.: **PAM :** Pulse amplitude modulation may be defined a that types of modulation in which the amplitudes of regularly spaced rectangular pulses vary according to instantaneous value of the modulating or message signal. [½ mark]



[½ mark]

[½ mark]

[½ mark]

Q.1(a) (iv) What is the purpose of limiter in FM receiver? [2]

Ans.: FM waves which is transmitted by the transmitter has a constant amplitude, but while travelling the noise or unwanted signal is added to it to change its change its amplitude. This unwanted amplitude change should be removed before the signal is given to demodulation. The amplitude limiter will limit the amplitude of the signal, so that no noise should change the value of the signal. [2 marks]

Q.1(a) (v) Why FM is less affected by Noise [2]

Ans.: FM is less affected by noise because [2 marks]

(i) FM receivers may be suited with amplitude limiters to remove the amplitude variations caused by noise. Thus marks FM reception a good deal more immune to noise than AM reception.
(ii) It is possible to reduce noise still further by increasing the frequency deviation. This is a feature which AM does not have because it is not possible to exceed 100 percent modulation without causing severe distortion.
(iii) FM broadcasts operate in the upper VHF and UHF frequency ranges at which thrice happens to be less noise than in the MF and HF ranges occupied by AM broadcasts.
(iv) The amplitude of the FM wave is constant. It is thus independent of the modulation depth, where as in AM, modulation depth governs the transmitted power.

Q.1(a) (vi) Define fading with respect to wave propagation. [2]

Ans.: 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. [2 marks]

Q.1(a) (vii) Define antenna resistance and antenna gain. [2]

Ans.: **Antenna Resistance** [Correct definition - 1 mark]

The resistance of an antenna has two components:
(i) Its radiation resistance due to conversion of power into electromagnetic waves.
(ii) The resistance due to actual losses in the antenna.

Antenna Gain [Correct definition - 1 mark]

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(a) (viii) Define stub. State its two advantages [2]

Ans.:
- Stub is a piece of additional transmission line connected across the primary transmission line as class as possible to the load. [1 mark]
- Two advantages are : [Each ½ mark]
  (i) We can tuned-out the reactive part of Z_L with an inductor or capacitor.
  (ii) It is possible to use a piece of short circuited transmission line to tuned out the reactive part of Z_L.

Q.1(b) Attempt any TWO of the following [8]

Q.1(b) (i) Classify electronic communication systems based on direction and communication [4]

Ans.: Based on whether the system communicates only in one direction or otherwise, the communication systems are classified as under. [1 mark]

(1) Simplex System
(2) Half duplex System
(3) Full duplex System

(1) Simplex System [1 mark]

In these systems the information is communicated in only are direction. For example, the radio or TV broadcasting system can only transmit. They cannot receive.

Another example of simplex communication is the information transmitted by the telemetry system of a satellite to earth.

(2) Half duplex System [1 mark]

These systems are bidirectional i.e. they can transmit as well as receive but not simultaneously. At a time, these systems can either transmit or receive. For example a transreceiver or walkg talky set.

The direction of communication alternates. The radio communications such as those used in military, fire fighting, citizen bands and amateur radio are half duplex system.

(3) Full duplex System [1 mark]

These are truly bidirectional systems as they allow the communication to take place in both the directions simultaneously. These system can transmit as well as receive simultaneously, for example, the telephone system.

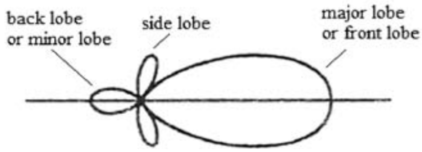
Q.1(b) (ii) Compare ground wave and space wave propagation an basis of frequency range and method of wave propagation. [4]

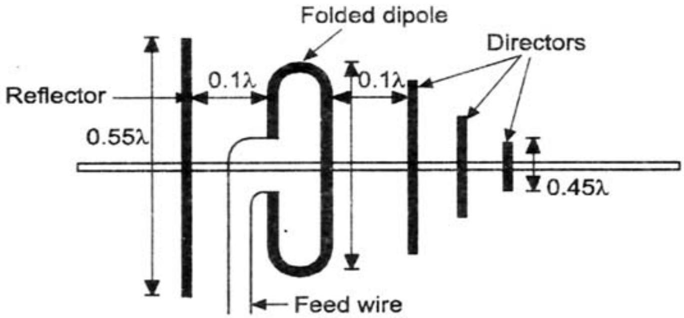
Ans.: [2 mark each]

		Ground Wave	**Space Wave**
(1)	Frequency range	It exists in the frequency range from 30 KHz to 3 MHz.	Used for frequency above 30 MHz.
(2)	Method of wave propagation	Ground waves are surface waves which travels along.	Space wave travels in a straight line.

Q.1(b) (iii) Draw radiation pattern of yagi–uda antenna. Explain its working principle. [4]

Ans.: [Radiation pattern 2 marks and Working principle 2 marks]





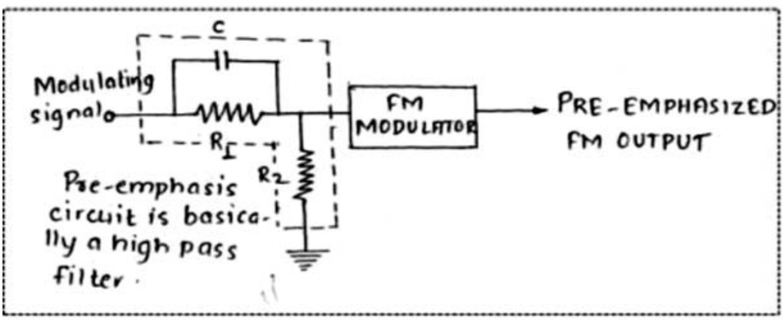
A Yagi-Uda antenna, commonly known as a Yagi antenna, is a directional antenna consisting of multiple parallel elements in a line, usually half-wave dipoles made of metal rods.

A Yagi-Uda antenna, commonly known as a Yagi antenna, is a directional antenna consisting of multiple parallel elements in a line, usually half-wave dipoles made of metal rods. Yagi-Uda antennas consist of a single driven element connected to the transmitter or receiver with a transmission line, and additional parasitic elements: a so-called reflector and one or more directors.

Q.2 Attempt any FOUR of the following. [16]

Q.2(a) Explain pre-emphasis and de-emphasis networks used in FM transmission and reception. [4]

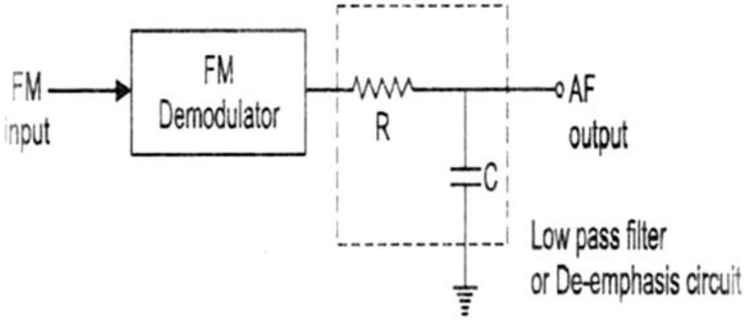
Ans.: pre-emphasis [2 marks]



- The artificial boosting of higher audio modulating frequencies in accordance with prearranged response curve is called pre-emphasis.

- In FM, the noise lias a areata effect on the higher modulating frequencies. This effect can be reduced by increasing the value of modulation index (ml).
- This can be done by increasing the deviation and can be increased by increasing the amplitude of modulating signal at higher frequencies.

De-emphasis [2 marks]



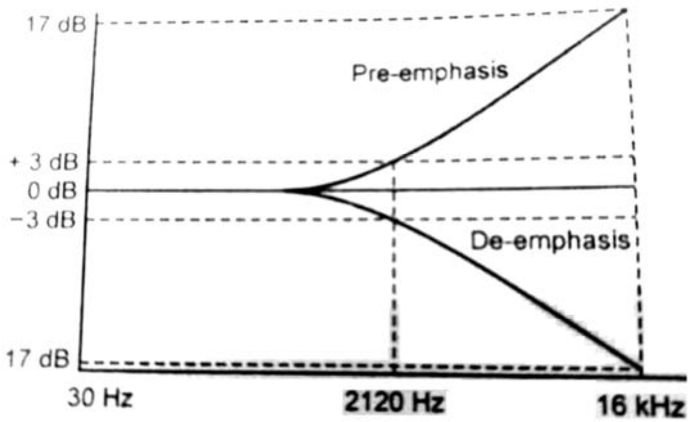


Fig. Emphasis curves

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.

Q.2(b) In an AM receiver, the based Q of the antenna circuit at the input to the mixer at 100. If Intermediate frequency (IF) 15 455KHz. Calculate the image frequency and its rejection at 1MHz. **[4]**

Ans.: Given

$f_s = 1MH_2$

Q = 100

IF = 455 KHz

Image Frquency $f_{si} = f_s + 2If$

$= 1MHz + 2(455KH_2)$

$f_{si} = 1.91MHz$ [1 mark]

Image frequency rejection factor, $\propto$

$$\propto = \sqrt{1+Q^2\rho^2}$$

$$\text{where } \rho = \frac{f_{si}}{f_s} - \frac{f_s}{f_{si}}$$

$$\rho = \frac{1.91M}{1M} - \frac{1M}{1.91M}$$

$\rho = 1.386$ [1½ marks]

$$\therefore \propto = \sqrt{1+(100)^2(1.386)^2}$$

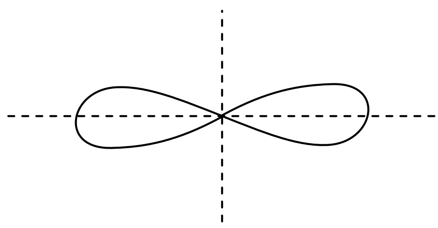
$\propto = 138.64$ [1½ marks]

Q.2(c) What is folded dipole antenna? Draw its pattern list is advantages. **[4]**

Ans.: Folded Dipole [2 marks]

- Like a standard dipole antenna, it is one half wave length long, it consist of two parallel conductors connected at the ends of which one side is open for connection to transmission line.
- The impedance of the antenna is 300 Ω.
- The two parallel conductors is directly proportional to the frequency.
- It can be used for both transmitting as well as receiving.
- It can be used in TV and FM radio reception.

Radiation Pattern [1 mark]



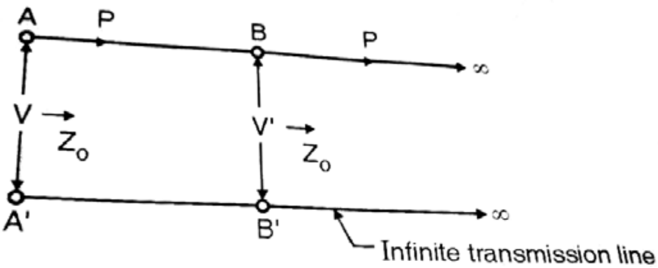
Advantages : [1 mark]

(i) Higher input impedance
(ii) Higher bandwidth
(iii) Cost efficient
(iv) Impedance matching
(v) Construction is easy

Q.2(d) Derive the equation for characteristic impedance of transmission line at low frequency and high frequency. **[4]**

Ans.: Characteristics impedance- Characteristic impedance of a transmission line, ZO is the impedance measured at the input of this line when its length is infinite.

[1 mark]



Explanation [3 marks]

Z0 will be measured at the input of transmission line if the output is terminated in Z0.Under these conditions, z0 is considered purely resistive. From filter theory, the characteristic of an iterative circuit consisting of series and shunt elements is given by,

$$Z_0 = \sqrt{\frac{\bar{Z}}{Y}}$$

Where, Z0 = Characteristic impedance
Z = series impedance per section
= R + jωL (Ω/M)
Y = Shunt admittance per section
= G + jwC (s/m)

Therefore,

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

This equation shows the characteristics impedance of transmission line may be complex.

At Radio Frequency (OR at high frequency):

The resistive components are ignored.

$\omega L >> R$, $\omega C >> G$

Therefore, $Z_0 = \sqrt{\frac{j\omega L}{j\omega C}} = \sqrt{\frac{L}{C}}$

Where L is measured in H/m and f/m.

At low frequency:

$R >> \omega L$, $G >> \omega C$

Therefore, $Z_0 = \sqrt{\frac{R}{G}}$

Q.2(e) For a transmission lines, if R is the reflection coefficient what will be it's value. [4]
(i) If there is no reflected voltage.
(ii) If reflected and incident voltages are same.
(iii) If reflected voltage = 12 V and incident voltage = 24V
(iv) If reflected voltage = 2V and incident voltage = 2V

Ans.: [1 mark for each point]

$$R=\frac{V_r}{V_i}$$

(i) If $V_r = 0$

$R = 0$

(ii) If $V_r = V_i$

Then, R= 1

(iii) If, $V_r = 12V$, $V_i = 24V$

$$R = \frac{12}{24}$$

$\therefore$ R = 0.5

(iv) If, $V_r = 2V$, $V_i = 2V$

$$R = \frac{2}{2}$$

$\therefore$ R = 1

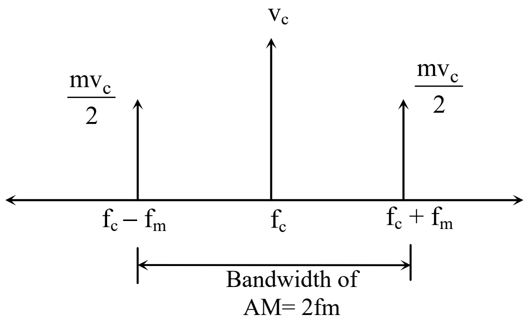
Q.2(f) Draw and explain the frequency spectrum of AM wave. [4]

Ans.: [Diagram 2 marks and Explanation 2 marks]

The dual-side band Full carrier (DSB- FC) AM equation is given as

$$V_{am} = \underbrace{V_c \sin \omega_c t}_{\text{Unmodulated Carrier}} + \frac{mv_c}{2}\underbrace{\cos(\omega_c - \omega_m)t}_{\text{Lower Sideband (LSB)}} - \frac{-mv_c}{2}\underbrace{\cos(\omega_c + \omega_m)t}_{\text{Upper Sideband (USB)}}$$

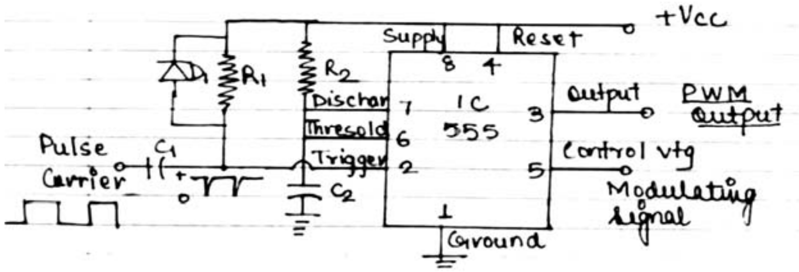
- AM waveform consist of unmodulated carrier ($V_c \ \sin\omega_c t$) lowerside band, Where
  $f = \omega_c - \omega_m$ and upperside band where
  $f = \omega_c + \omega_m$
- Amplitude of each sideband is $\frac{mv_c}{2}$ where m is modulating index.
- If we plot frequency on x-axis and respective amplitude on y–axis, we get frequency spectrum of AM.
- Frequency spectrum describes how power is distributed at various frequencies.



Q.3 Attempt any FOUR of the following. [16]

Q.3(a) Draw and explain the generation of PWM using IC 555. [4]

Ans.: Circuit Diagram [2 marks]



Operation: [2 marks]

(1) The timer IC555 is operated in Monostable mode.

(1) The negative going carrier pulses are to the differentiator formed by Rl & CI. 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.

Q.3(b) With the help of neat diagram explain how PLL can be used for FM demodulation **[4]**

Ans.: [Diagram 2 marks and Explanation 2 marks]

PLL as FM Detector:

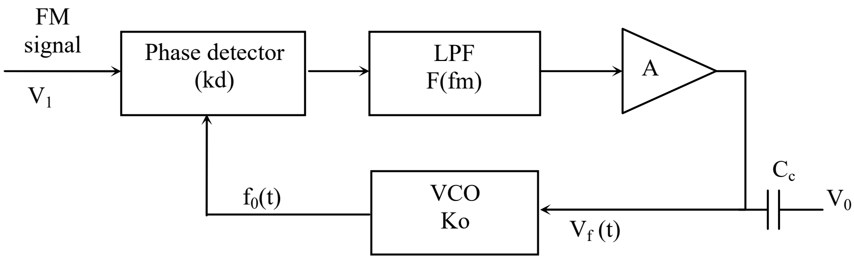


Fig.: PLL as FM detecter

If the PLL is locked on an input frequency (FM signal) we will have that the VCO frequency $f_c + k_o v_f$ will be equal to the instantaneous frequency of the FM signal f_i so that

$$f_i = f_c + k_o V_f$$

and thus the VCO control voltage v_f will be given by

$$v_f = \frac{f_i - f_c}{k_o}$$

If the instantaneous frequency of the FM signal is given by

$$fi(t) = f_{carr} + \Delta f \sin(\omega_{mt})$$

where f_{carr} is the (unmodulated) carrier frequency, Δf is the peak frequency deviation and w_m is the angular frequency of the modulating signal, we will have that

$$V_f(t) = \frac{f_i(t) - f_c}{k_o}$$

$$= \frac{f_{carr} - f_c + \Delta f \sin w_{mt}}{k_o}$$

The ac component of vf(t) will be

$$vf(t) = \Delta f \sin w_{mt} / k_o$$

So that this will represent a true reproduction of the modulating voltage that is applied to the FM carrier at the transmitter.

We see that the VCO control voltage will be a linear function of the instantaneous frequency deviation so that the FM signal will be demodulated with little or no distortion.

Q.3(c) Describe different types of losses in transmission line. **[4]**

Ans.: [Any 4 point 1 mark each]

The different types of losses in transmission line are :

(i) **Conductor loss :** I^2R loss is proportional to the square of current and inversely proportional to characteristics impedance. This loss is called conductor loss. High frequency I^2R loss is mainly due to skin effect and at very high frequency skin effect is so great that coils cannot carry current. I^2R loss is also proportional to the length of wire.

(ii) **Dielectric loss :** Conductance of dielectric increase with frequency, so dielectric of transmission line also has some loss. Dielectric heating is proportional to the voltage across dielectric and inversely proportional to the characteristic impedance of any power transmitted.

(iii) **Radiation loss :** Open wire lines can radiate energy. This type of losses become more significant as frequency increases. These losses are reduced by proper shielding of cable.

(iv) **Coupling loss :** When two transmission line is at joint the losses take place at joints called as coupling losses.

(v) **Corona loss :** When the potential difference between two conductors of a transmission line exceeds the breakdown voltage, a luminous discharge occurs between the two conductors. It is also called as corona. Corona is a destructive phenomenon. It generally destroys the transmission line.

Q.3(d) An antennas has a radiation resistance of 72Ω a loss resistance of 8Ω and power gain of 16. What is the its efficiency and directivity. **[4]**

Ans.: Given

Radiation resistance = 72Ω (R)

Loss resistance = 8Ω (RL)

efficiency (n) = ?

$$n = \frac{R}{R + R_L} \times 100\%$$

$$= \frac{72}{80} \times 100\%$$

$$= 0.9 \times 100\%$$

n = 90% [2 marks]

Directivity = ?

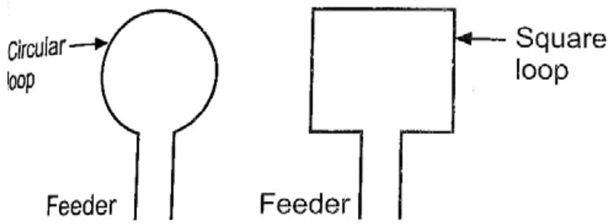
$$D = \frac{AP}{n}$$

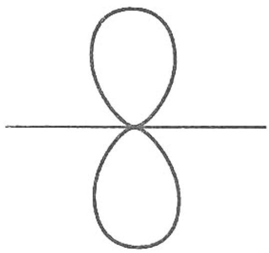
$$= \frac{16}{90}$$

D = 0.17 [2 marks]

Q.3(e) Draw a neat sketch of loop antenna with its radiation pattern. Explain how they are used for direction feeding. **[4]**

Ans.: [Sketch 1 mark, Radiation pattern 1 mark, Explain 2 marks]





- The circular and square loop antennas have the same radiation pattern as above.
- No radiation is received that is normal to the plane of the loop, because the radiation pattern is a doughnut pattern.
- Thus it makes the loop antenna suitable for direction finding applications.
- A simple direction finder consists of a small loop, a vertical and rotatable about a vertical axis that may be mounted on the top of a portable receiver, whose output is connected to the meter.

Q.3(f) Compare AM and FM **[4]**

Ans.: [Any four 1 mark]

	AM	FM
(i)	The amplitude of carrier changes with modulation	The amplitude of carrier remains constant with modulation
(ii)	The carrier frequency remains constant with modulation	The carrier frequency changes with modulation
(iii)	The value of modulation factor (m) cannot be more than 1 for distortionless AM signal	The value of modulation index (mf) can be more than 1.
(iv)	AM receivers are not immune to noise	FM receivers are immune to noise.
(v)	Bandwidth is lower compared to FM but independent of modulation index	Bandwidth is higher and depends on modulation index.

Q.4 Attempt any FOUR of the following. [16]

Q.4(a) A 500 watts carrier is modulated to depth of 80% calculate. [4]

(i) Total power in AM wave

(ii) Power in sidebands.

Ans.: Pc = 500 watts

m = 80%

m = 0.8

(i) Total power $P_T = \dfrac{Pc\left(1+m^2\right)}{2}$ [2 marks]

$$= 500\left(1+\frac{0.82}{2}\right)$$

P_T = 660 watts

(ii) Sidebands Power, $P_{sb} = \dfrac{m^2}{4} \times P_c$ [2 marks]

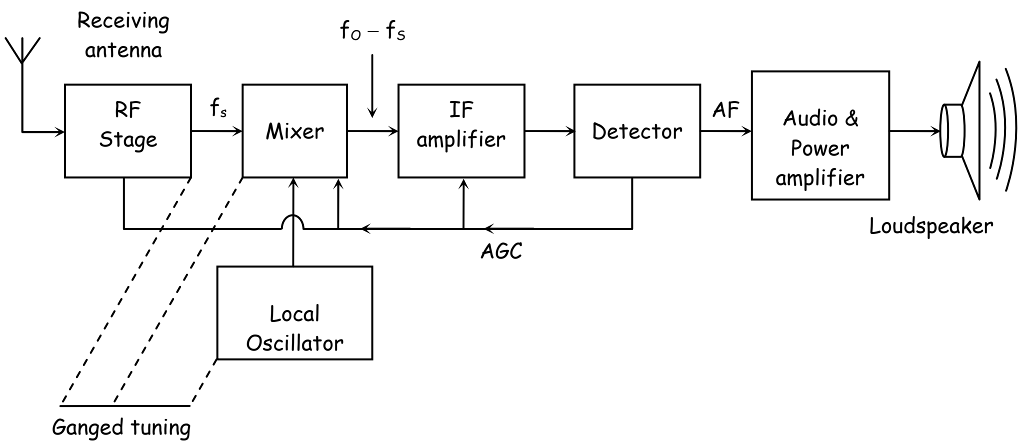
$$= \frac{(0.8)^2}{4} \times 500$$

= 80 watts

Q.4(b) Describe superhetrodyning principle with the help of block diagram. [4]

Ans.: [Diagram 2 marks and Explanation 2 marks]

Superhetrodyning



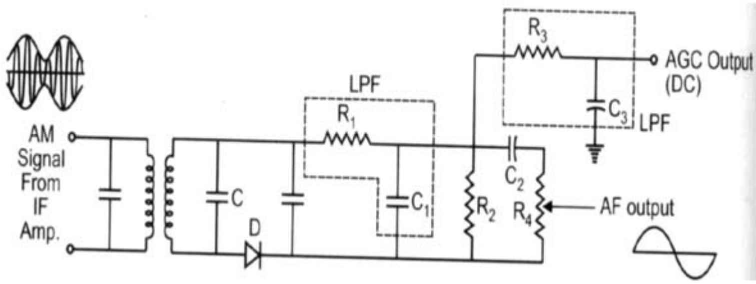
Description

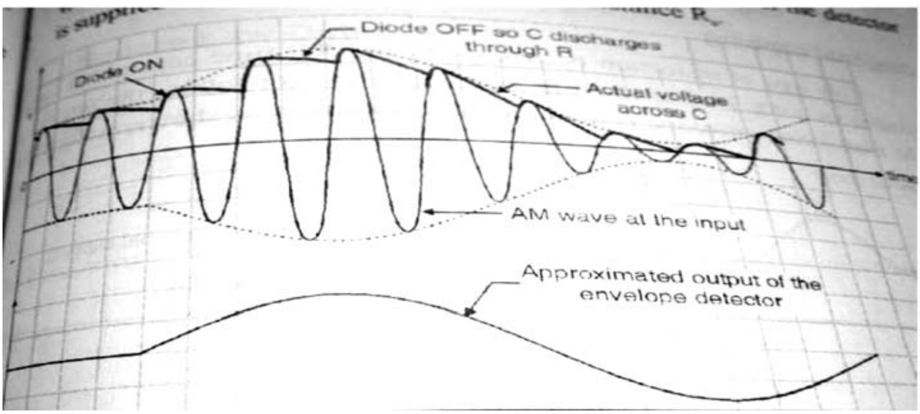
- AM signal transmitted by the transmitter travels through air and catches the receiving antenna, this signal is in the from of electromagnetic waves.
- **RF Stage :** It is used to select the wanted signal. To reject unwanted signal improve signal to noise ratio. Here the signal frequency is denoted by f_S.

- **Mixer :** Mixer mixes the signal f_S and f_O (f_O is received signal from local oscillator). After mixing it produces four different signal. These signals are f_S, f_O, $f_O + f_S$, $f_O - f_S$.
  Out of these the difference of frequency component ($f_O - f_S$) is selected and all other are rejected.
- **Intermediate frequency** : It selects only one frequency component i.e ($f_O - f_S$)
  Since IF = ($f_O - f_S$)
  The intermediate frequency will be the difference of the frequency component (f_S and f_O). In order to maintain a constant difference between f_S and f_O, gauge tuning is done. It is usually a capacitor circuit.
- **Detector :** It is used to check the output signal and receive the required signal.
- **Amplifier :** The intermediate frequency signal is amplified by one or more amplifier stages to provide most of the gain and bandwidth requirements. It raises the power level of the signal.

Q.4(c) Draw the circuit diagram of practical AM diode detector. Sketch its input and output waveforms. **[4]**

Ans.: [Diagram 2 marks and Waveforms 2 marks]



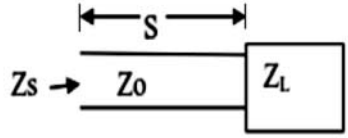


Q.4(d) Explain quarter wavelength transformer. **[4]**

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



$$Zs = \frac{Zo^2}{Z_L}$$

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 $\lambda/4$ 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 input impedance to match the load impedance. Quarter wave transformer works as filter to prevent unwanted frequencies from reaching the load such as antenna.

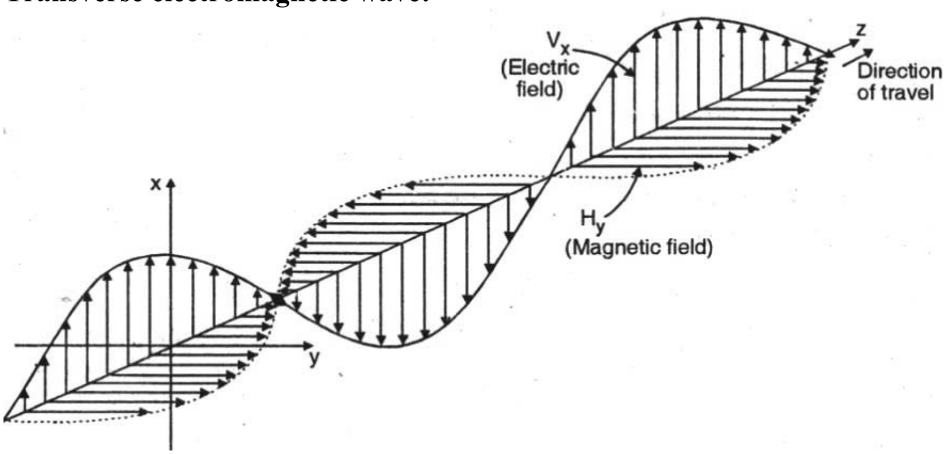
The name transformer is given to quarter wavelength transmission line since it behaves as a transformer depending upon the value of Z_L.

If $Z_L = Z_O$ then it acts as 1 : 1 transformer.
If $Z_L > Z_O$ then it acts as a Step down transformer
If $Z_L < Z_O$ then it acts as a Step up transformer

Q.4(e) Describe electromagnetic polarization? Explain types of polarization. **[4]**

Ans.: [Diagram, Explanation 2marks and Types of polarization 2 marks]

Transverse electromagnetic wave:



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)

- If the polarization remains constant then it is called as the linear polarization. The linear polarization can be of two types :
  (i) Horizontal polarization
  (ii) Vertical polarization

Horizontal Polarization:- If the electric field propagates in parallel with the earth surface then EM wave is said to be horizontally polarized

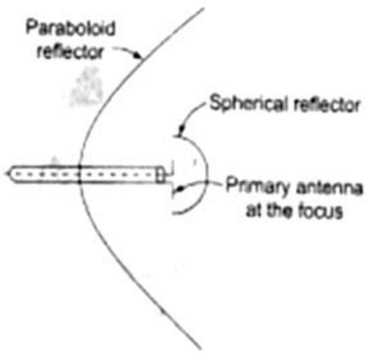
Vertical polarization:- If the electric field propagates in perpendicular to the surface of the earth then EM wave is said to be vertically polarized

Circular polarization:- If the polarization vector rotates 3600 as the Em wave travels wavelength through the space and the filed strength is equal at all angles of polarization then the EM wave is said to have a circular polarization.

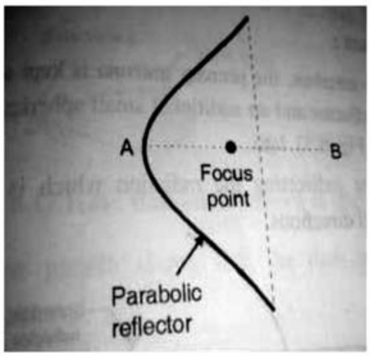
Elliptical polarization:- In the circular polarization if the field strength varies with change in polarization the wave is said to have an elliptical polarization

Q.4(f) Draw the sketch of dish antenna. Explain the same with radiation pattern. **[4]**

Ans.: [Sketch 1 mark and Explanation 2 marks]



(OR)

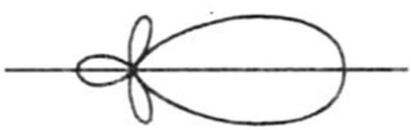


Dish antenna uses simple reflection principle, just as a mirror can reflect light and a curved mirror can reflect and focus light at a single point, the dish reflects and focuses the radio waves.

This is the same principle and shape that is used as reflector in a flashlight or headlight behing the bulb.

Dish antennas are used for systems that transmit and receive as well as receive only.

Radiation Pattern: [1 mark]



Q.5 Attempt any FOUR of the following. [16]

Q.5(a) Explain following terms with respect to wave propagation [4]
(i) Critical frequency (ii) Skip distance

Ans.: **(i) Critical Frequency** [2 marks]

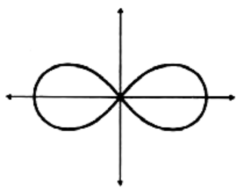
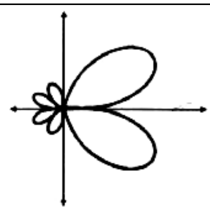
Critical frequency of a layer is defined as the maximum frequency that is returned back to the earth surface by that layer, when the wave is incident at angle 90° to it. It is denoted by f_c.

(ii) Skip Distance [2 marks]

The skip distance is defined as the shortest distance from a transmitter, measured along the surface of the earth at which a sky wave of fixed frequency returns back to the earth. This frequencies should be greater than the critical frequency, f_c.

Q.5(b) Compare resonant and non-resonant antenna. [4]

Ans.: [Each point 1 mark]

	Parameter	**Resonant antenna**	**Non Resonant antenna**
(i)	Definition	It is transmission Line of length equal to multiples of λ2 and open at both and.	It is transmission line whose length is not a multiple of λ2
(ii)	Reflection Pattern	Standing wave present	Standing wave not present
(iii)	Radiation Pattern		
(iv)	Applications	(a) Portable receiver (b) Direction finding equipment	(a) TV broadcasting (b) Wave propagation

Q.5(c) Compare PAM, PWM and PPM. [4]

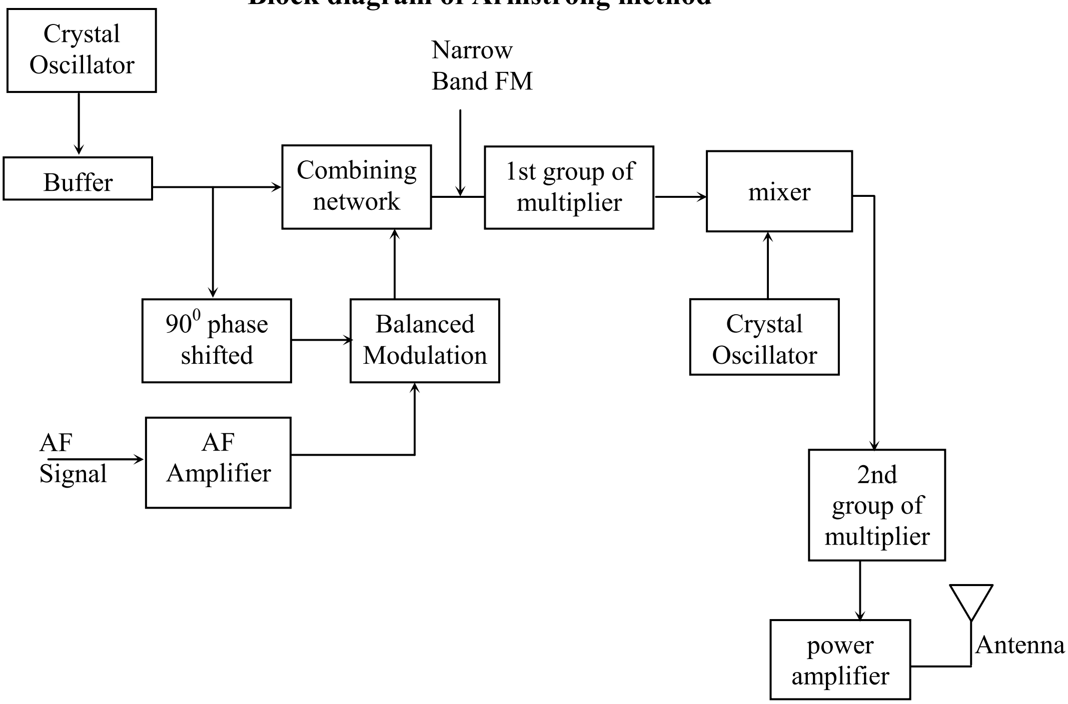
Ans.: [Each point 1 mark]

	Parameter	**PAM**	**PWM**	**PPM**
(i)	Information contained in	Amplitude variation	Width variation	Position variation
(ii)	Bandwidth requirement	Low	High	High
(iii)	Noise Immunity	Low	High	High
(iv)	Transmitted Power	Varies with amplitude and pulses	Varies with variation in width	Remains constant

Q.5(d) Why Armstrong method is known as indirect method FM generation? Draw the block diagram of Armstrong method. **[4]**

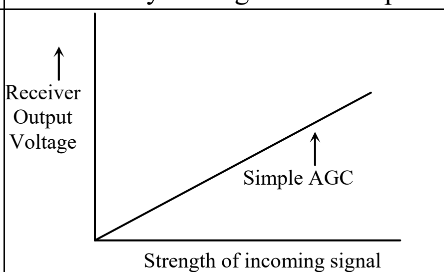
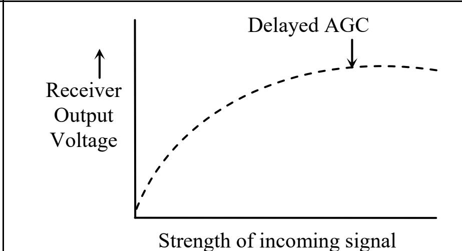
Ans.: In Armstrong method, the phase difference is directly proportional to modulating signal. Hence output is phase modulated signal. From PM, we obtain FM hence it is known as indirect method of FM generation

Block diagram of Armstrong method



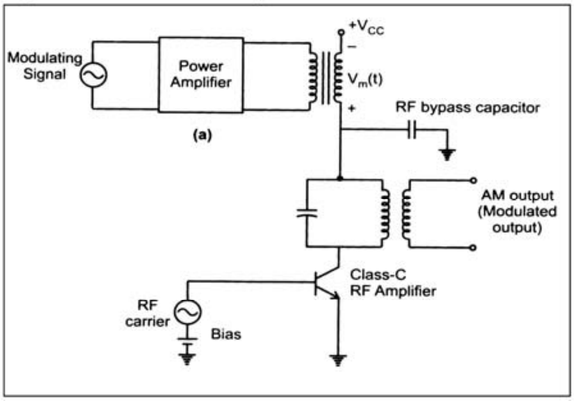
Q.5(e) Compare between simple AGC and delayed AGC (any four points) **[4]**

Ans.: [Any four points 1 mark each]

	Simple AGC	**Delayed AGC**
(i)	Simple AGC means which will change the overall gain of a receiver automatically starting from initial point	Delayed AGC means in which AGC bias is not applied until the input signal strength reaches at particular level.
(ii)	 **Fig.:** Simple AGC characteristic	 **Fig.:** Delayed AGC characteristic
(iii)	Reduction in gain for weak signals.	No reduction in gain for weak signals.
(iv)	Used in domestic radio receiver	Used in high quality receivers like communication receiver

Q.5(f) Draw and explain circuit of AM modulators using BJT. **[4]**

Ans.: [Diagram 2 marks and Explanation 2 marks]

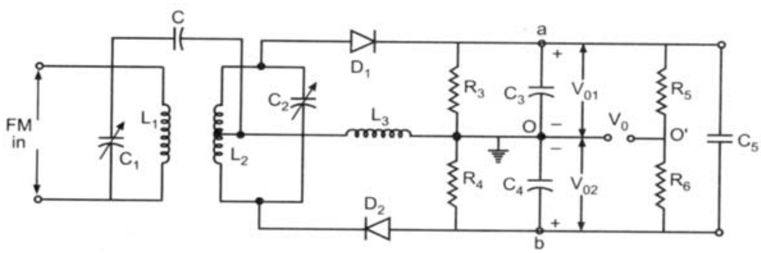


- AM modulator circuit is use to get the amplitude modulated signal as output.
- The transistor is normally operated in the class c mode in which it is biased well beyond cut-off.
- The carrier input to the base must be sufficient to drive the transistor into conduction over the part of RF cycle, during 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 Vcc = 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.

Q.6 Attempt any FOUR of the following. **[16]**

Q.6(a) Draw and label the circuit diagram of ratio detector. **[4]**

Ans.: [4 marks]

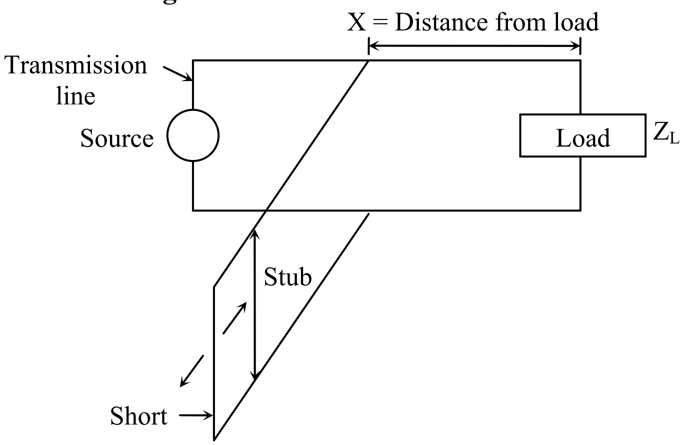


Q.6(b) Give the need for stub and explain single stub matching. List the advantages and disadvantages of single stub matching. **[4]**

Ans.: **Need for Stub** [1 mark]

Stub is a piece of additional transmission line which is connected across the primary transmission line as close as possible to the load.

Single Stub Matching [1 mark]



- In stub matching technique, either a shorted or an open stub can be used. But practically the shorted stubs are preferred because open stubs tend to radiate at high frequencies.
- It is necessary to use the smith chart for implementing the stub matching practically.

Advantages : [1 mark]

- The susceptance of the stub is used to nullify the susceptance of the load.

Disadvantages : [1 mark]

- The major disadvantage of single stub matching is that the matching conditions are correct only at one particular frequency.
- At all other frequencies, other than the desired one, the load impedance and SWR can be worse.

Q.6(c) An AF signal 20sin(2π×500t) is used to amplitude modulate a carrier of 50 sin (2π × 10^6t) Calculate **[4]**
(i) Modulation index
(ii) Total power delivered into a load of 600Ω

Ans.: Given

$V_c = 50V$
$V_m = 20V$
$f_m = 500$ Hz
$f_e = 10^6$ Hz

$\because$ Modulation indiex $m = \dfrac{V_m}{V_c} = \dfrac{20}{50}$

$m = 0.4$ [2 marks]

Total Power $P_T = P_c\left(1+\dfrac{m^2}{2}\right)$

$P_c = \dfrac{V_{C^2}}{2R} = \dfrac{(50)^2}{2\times 600}$

$P_C = 2.083$

$P_T = 2.083\left(1+\dfrac{0.4^2}{2}\right)$

P_T =2.249.9 watts [2 marks]

Q.6(d) Compare the bandwidth that would be required to transmit baseband signal with a frequency range from 300 H_2 to 3KH_2 using. [4]
(i) Narrow band FM with maximum deviation of 5KH_2
(ii) Wideband FM with maximum deviation of 75KH_2

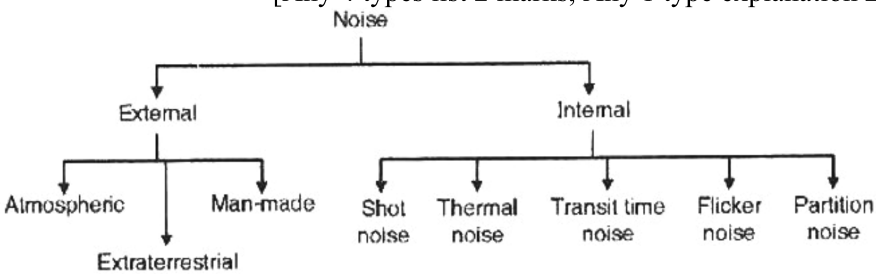
Ans.: Given : Baseband signal frequency range = 300 Hz to 3 KHz.

(i) Narrow band FM with maximum deviation of 5KHz [2 marks]
Given : the deviation δ_{max} = 5 KHz
$\therefore$ $B\omega = 2\,(\delta_{max} + f_m)$
$= 2\,(5 + 3) \times 10^3$
= 16 KHz

(ii) Wideband FM with maximum deviation of 75KHz [2 marks]
Given : the deviation δ_{max} = 75 KHz
$\therefore$ $B\omega = 2\,(\delta_{max} + f_m)$
= 2 (75 + 3) KHz
$\therefore$ $B\omega$ = 156 KHz

Q.6(e) State and explain the types of noise in communication system. [4]

Ans.: [Any 4 types list 2 marks, Any 1 type explanation 2 marks]



Explanation of External Noise:

Atmospheric Noise

Atmospheric noise or static is caused by lighting discharges in thunderstorms and other natural electrical disturbances occurring in the atmosphere. These electrical impulses are random in nature. Hence the energy is spread over the complete frequency spectrum used for radio communication.

Extraterrestrial Noise

There are numerous types of extraterrestrial noise or space noises depending on their sources. However, these may be put into following two subgroups.

(i) Solar noise
(ii) Cosmic noise

Solar Noise

This is the electrical noise emanating from the sun. Under quite conditions, there is a steady radiation of noise from the sun. This results because sun is a large body at a very high temperature (exceeding 6000°C on the surface), and radiates electrical energy in the form of noise over a very wide frequency spectrum including the spectrum used for radio communication. The intensity produced by the sun varies with time. In fact, the sun has a repeating 11-Year noise cycle. During the peak of the cycle, the sun produces some amount of noise that causes tremendous radio signal interference, making many frequencies unusable for communications. During other years, the noise is at a minimum level.

Cosmic noise

Distant stars are also suns and have high temperatures. These stars, therefore, radiate noise in the same way as our sun. The noise received from these distant stars is thermal noise (or black body noise) and is distributing almost uniformly over the entire sky. We also receive noise from the center of our own galaxy (The Milky Way) from other distant galaxies and from other virtual point sources such as quasars and pulsars.

Man-Made Noise (Industrial Noise)

By man-made noise or industrial- noise is meant the electrical noise produced by such sources as automobiles and aircraft ignition, electrical motors and switch gears, leakage from high voltage lines, fluorescent lights, and numerous other heavy electrical machines. Such noises are produced by the are discharge taking place during operation of these machines. Such man-made noise is most intensive in industrial and densely populated areas. Man-made noise in such areas far exceeds all other sources of noise in the frequency range extending from about 1 MHz to 600 MHz

Explanation of Internal Noise

Thermal Noise

Conductors contain a large number of 'free" electrons and "ions" strongly bound by molecular forces. The ions vibrate randomly about their normal (average) positions, however, this vibration being a function of the temperature. Continuous collisions between the electrons and the vibrating ions take place. Thus there is a continuous transfer of energy between the ions and electrons. This is the source of resistance in a conductor. The movement of free electrons constitutes a current which is purely random in nature and over a long time averages zero. There is a random motion of the electrons which give rise to noise voltage called thermal noise.

Thus noise generated in any resistance due to random motion of electrons i5 called thermal noise or white or Johnson noise.

Shot Noise
The most common type of noise is referred to as shot noise which is produced by the random arrival of 'electrons or holes at the output element, at the plate in a tube, or at the collector or drain in a transistor. Shot noise is also produced by the random movement of electrons or holes across a PN junction. Even through current flow is established by external bias voltages, there will still be some random movement of electrons or holes due to discontinuities in the device. An example of such a discontinuity is the contact between the copper lead and the semiconductor materials. The interface between the two creates a discontinuity that causes random movement of the current carriers.

Transit Time Noise
Another kind of noise that occurs in transistors is called transit time noise. Transit time is the duration of time that it takes for a current carrier such as a hole or current to move from the input to the output. The devices themselves are very tiny, so the distances involved are minimal. Yet the time it takes for the current carriers to move even a short distance is finite. At low frequencies this time is negligible. But when the frequency of operation is high and the signal being processed is the magnitude as the transit time, then problem can occur. The transit time shows up as a kind of random noise within the device, and this is directly proportional to the frequency of operation.

Flicker Noise
Flicker noise or modulation noise is the one appearing in transistors operating at low audio frequencies. Flicker noise is proportional to the emitter current and junction temperature. However, this noise is inversely proportional to the frequency. Hence it may be neglected at frequencies above about 500 Hz and it, Therefore, possess no serious problem.

Transistor Thermal Noise
Within the transistor, thermal noise is caused by the emitter, base and collector internal resistances. Out of these three regions, the base region contributes maximum thermal noise.

Partition Noise

Partition noise occurs whenever current has to divide between two or more paths, and results from the random fluctuations in the division. It would be expected, therefore, that a diode would be less noisy than a transistor (all other factors being equal) If the third electrode draws current (i.e.., the base current). It is for this reason that the inputs of microwave receivers are often taken directly to diode mixers.

Q.6(f) State and explain the concept of transmission bandwidth. [4]

Ans.: [State 2 marks and explanation 2 marks]

- Bandwidth is defined as the portion of the electromagnetic spectrum occupied by a signal
- We may also define the bandwidth as the frequency range over which as information signal is transmitted.
- Bandwidth is the difference between the upper and lower frequency limits of the signal.
- We already know different types of baseband signals such as voice signal, music signal, tv signal etc. Each of these signals will have it's own frequency range. This frequency range of a signal is knows as it's bandwidth.
- For example the range of music signal is 20 Hz to 15 KHz. Therefore the bandwidth is$(f_2 - f_1)$
  BW= $f_2 - f_1$ = 15000-20=14980H

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