WINTER– 16 EXAMINATION

Model Answer

Subject Code: 17440

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.

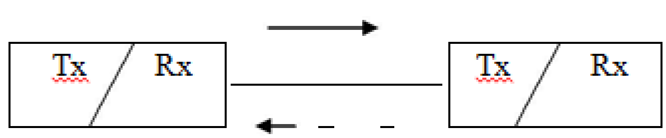
Marks

Q 1. a) Attempt any SIX of the following: **12**

(i) Define half duplex and full duplex type of communication.

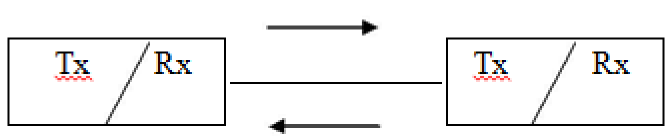
Ans: (1 mks each definition)

Half Duplex:-Form of communications where only one party transmits at a time is known as half duplex. The communication is two way but the direction alters. Examples of half duplex communication are most radio communications such as those used in the military, fire, police and other services



Half duplex

Full Duplex :-The bulk of electronic communication is two way. When individuals communicate with one another over the telephone, each can transmit and hear simultaneously such two way communications is referred to as full duplex.

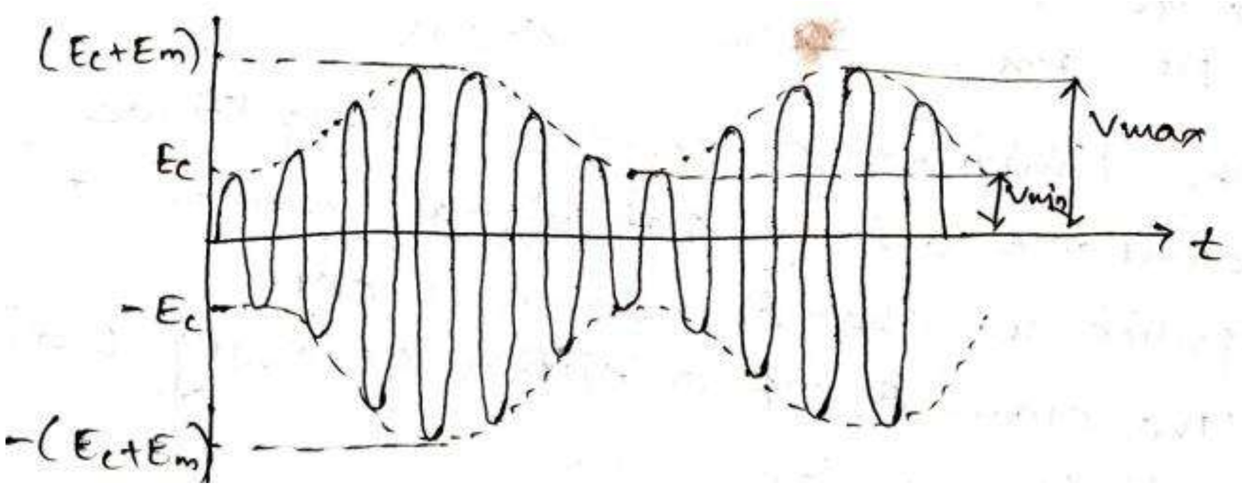


Full duplex

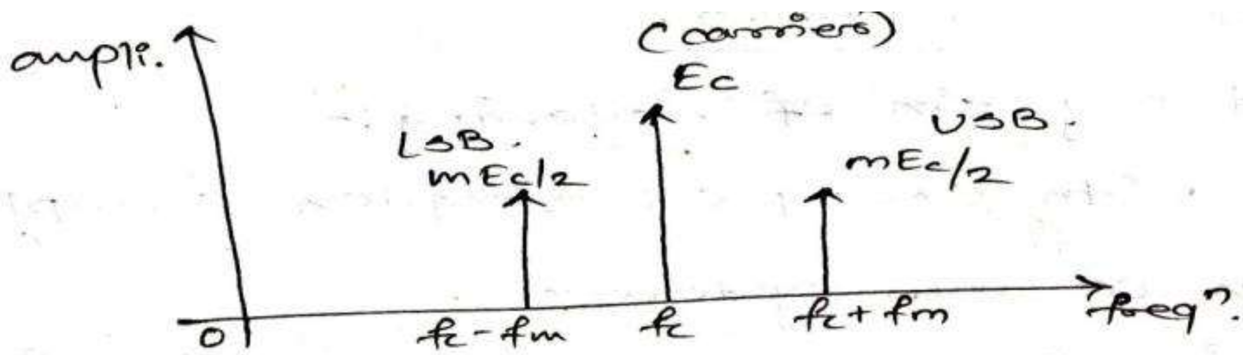
(ii) Draw the time domain and frequency domain representation of AM.

Ans:

AM in Time domain **(1M)**



AM in frequency domain **(1M)**



(iii) Define modulation index in AM with equation.

Ans: The ratio of amplitude of modulating voltage to amplitude of carrier voltage is known as modulation index. (1 mks)

It is expressed as $ma = \frac{Vm}{Vc}$ **(1 mks)**

(iv) List the different methods of demodulation of FM.

Ans: **(any two methods- 2 mks)**

1) Single slope detector

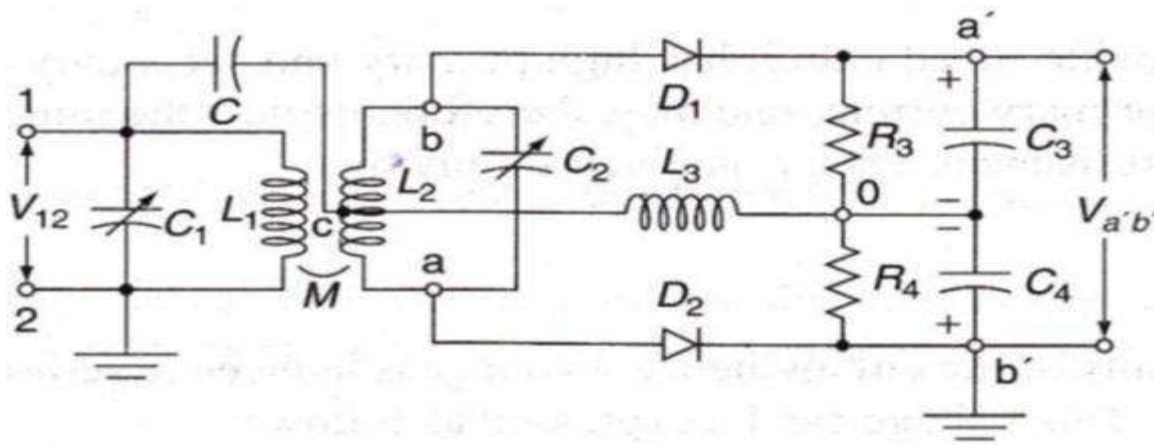
2) Balanced slope detector

3) Phase discriminator

4) Ratio detector

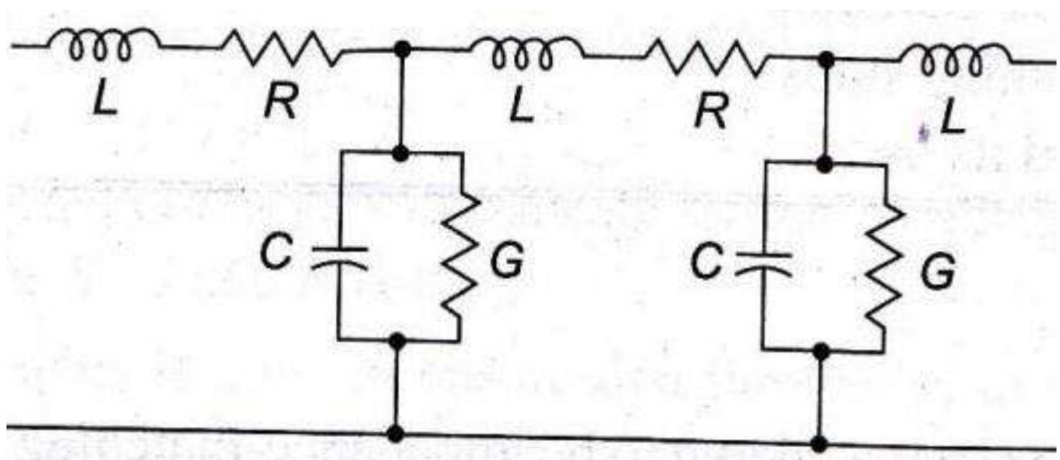
(v) Draw the circuit diagram of phase discriminator.

Ans:- (Relevant diagram- 2 mks)



(v) Draw the general equivalent circuit of transmission line.

Ans: (Proper diagram- 2 mks)



(vi) Define:

(1) Critical frequency

(2) MUF

Ans: (Each definition- 1 mks)

(1) 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 900 (normal) to it. The critical frequency for F2 layer is between 5 to 12 MHz.

(2) MUF: The limiting frequency when the angle of incidence is other than the normal is known as maximum unstable frequency.

$$MUF = f_c \sec\theta$$

(vii) List the application of space wave propagation.

Ans: (Any two applications- 2 mks)

1) Space wave propagation is normally used for frequencies above 30 MHz i.e. for TV , frequency modulation broadcast etc**.**

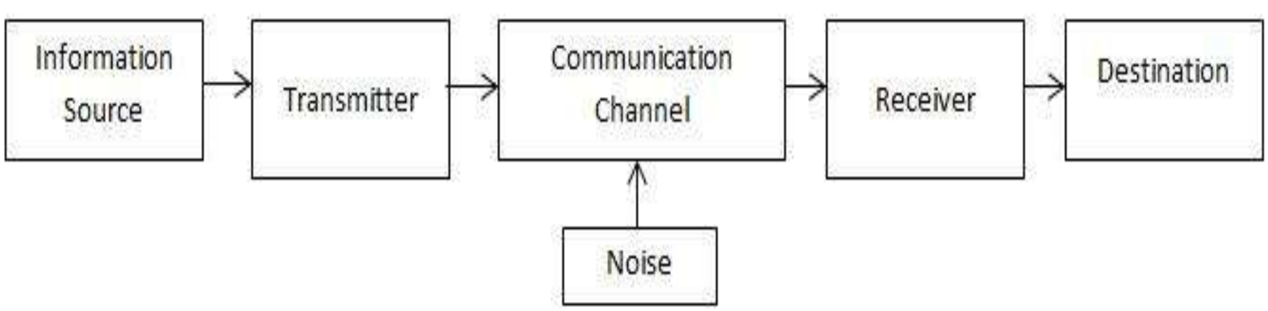
2) Satellite communication

3) RADAR system

b) Attempt any TWO of the following: 8

(i) Describe the block diagram of basic communication system.

Ans: Block Diagram :- 02M



Function of each block:- 02M

1. 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.

2. The information from transmitter is sent to receiver through the communication medium/channel.
3. The channel may be wired (co-axial cable/optical fiber cable) or wireless (microwave link).
4. 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).

(ii) Describe folded dipole antenna with the help of diagram. List any two advantages.

Ans:-(description- 2 mks, diagram-1 mks, any two applications- 1 mks)

Ans. Folded dipole :

- The folded dipole is made of two half wavelength dipoles, one a continuous rod and the other splits, in the centre connected in parallel.
- The transmission line is connected to the split dipole. Its half-wave dimensioning is done exactly as for the ordinary half wave dipole. Its behaviour differs from the conventional half wave dipole in several respects.
- The directivity of the folded dipole is bi-directional, but due to the distribution of the currents in the parts of folded dipole, its input impedance is very high.

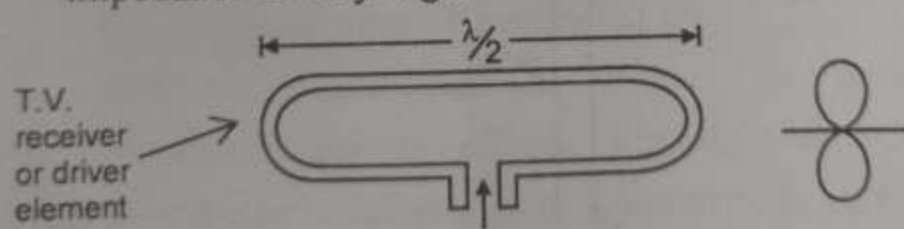


Fig. Folded dipole antenna and its radiation pattern

Advantages :

(i) Higher input impedance.
(ii) Greater bandwidth.
(iii) Ease and cost of constant and impedance matching.

(iii) Distinguish between ground wave and sky wave propagation.

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

Q 2. Attempt any FOUR of the following: **16**

a) Describe the loop antenna in brief.

Ans:- (diagram-2 mks, explanation-2 mks)

Ans. Loop antenna :

- A loop antenna has a single turn and its dimension is practically always less then the wavelength by very large amount. The radiation pattern is independent of the shape of loop.

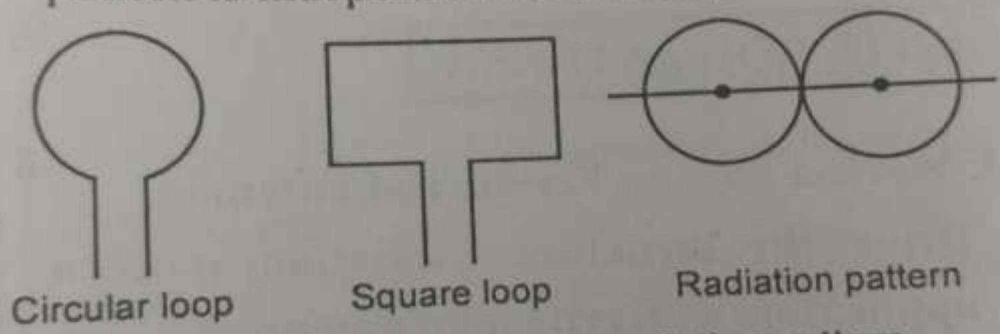


Fig. Loop antenna and its radiation pattern

- Figure shows a circular and a square loop. It is seen from the radiation pattern that the electro-magnetic energy is radiated in the direction parallel to the plane of antenna. No energy is radiated in a direction perpendicular to the plane of the antenna.
- Loop antenna is suitable for direction finding applications. For this purpose any of the highly

b) State the need of modulation.

Ans: (4 point 01M each)

Need of modulation:-

1. The message signal which is to be transmitted to the receiver, cannot travel for long distance by itself. Hence it should take the help of carrier which has the capacity to take the message to the receiver. This is the basic reason why we need to do modulation, so that message can sit on the carrier and reach the receiver.

2. One more reason for modulation is the length of the antenna. The distance that can be travelled by a signal in an open atmosphere is directly proportional to its frequency and inversely proportional to its wavelength. Most of message signals like speech and music are in the audio frequency range (20Hz- 20 KHz) and hence they can hardly travel for few meters on their own. For efficient reception, the transmitting and receiving antenna would have to have lengths comparable to a quarter wavelength of the frequency used. The length of an antenna 5000m is impracticable. Hence we modulate signal to increase its frequency and reduce size of antenna.

3. All the message is concentrated within the same range (20Hz – 20KHz) for speech and music (few MHz for videos) so that all signals from the different sources would be hopelessly and inseparably mixed up. In order to separate the various signals it is necessary to convert them all to different portions of the electromagnetic spectrum. Each must be given its own carrier frequency location. This also overcomes the difficulties of poor radiation at low frequencies and reduces interference. Once signals have been translated, a variable tuned circuit is employed in the front end of receiver to make sure that desired section of spectrum is received and all unwanted ones are rejected.

4. The use of modulation process help in shifting the given message signal frequencies to a very high frequency range where it can occupy only negligible percentage of the spectrum. For example at 1000 KHz the 10 KHz wide message signal represented 1% of spectrum. But at 1GHz same 10KHz represented 0.001% of spectrum. This means that more number of message signal can be accommodated at higher frequency.

c) Describe electromagnetic spectrum with diagram.

Ans: (spectrum diagram-3 mks, description- 1 mks)

The frequency of electromagnetic eq. ranges from few Hertz to several GHz. This entire range of frequency of EM waves is called EM spectrum.

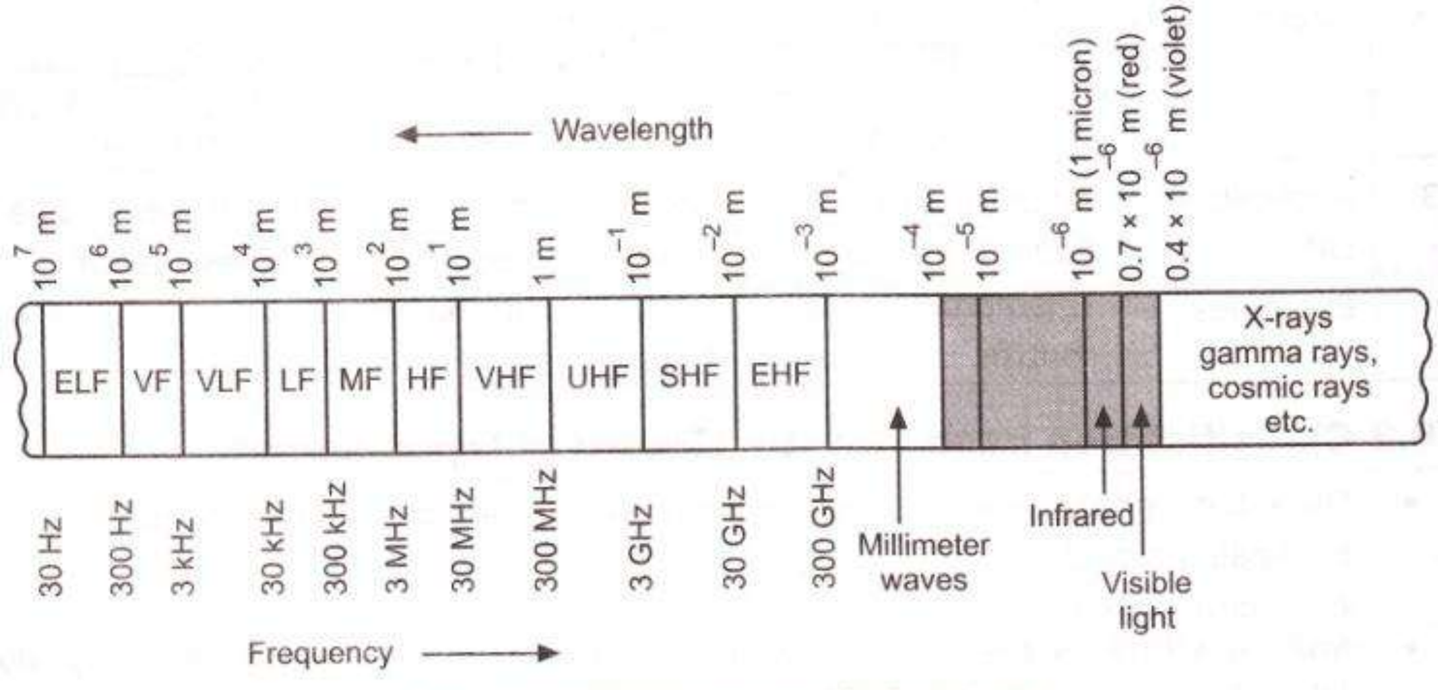
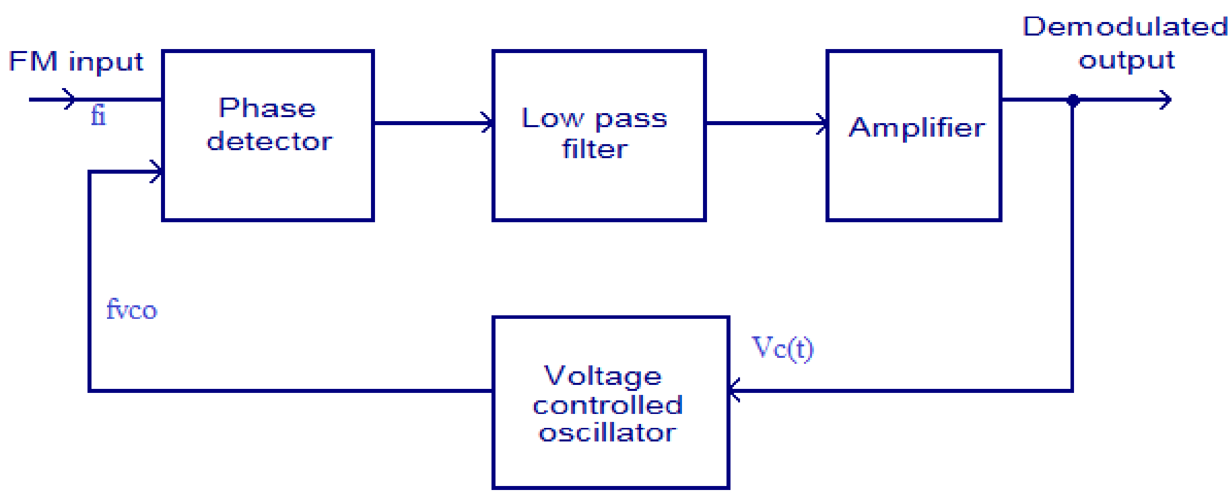


Fig. 1.10: Electromagnetic Spectrum

d) Describe the working of PLL as FM demodulator.

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

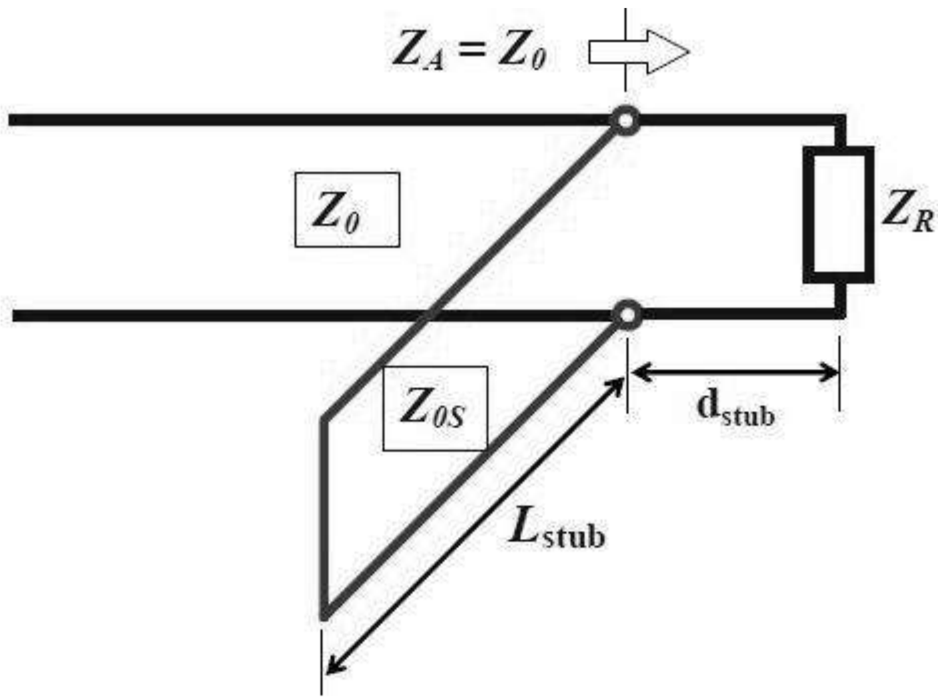
- The error voltage produced at the output of the amplifier is proportional to the deviation of the input frequency from the centre frequency FM.
- Thus AC component of the error voltage represents the modulating signal. Thus at the error amplifier output we get demodulated FM output.

e) Describe single stub and double stub matching.

Ans. (Each type - 2 marks- diagram and explanation)

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 m ain 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.

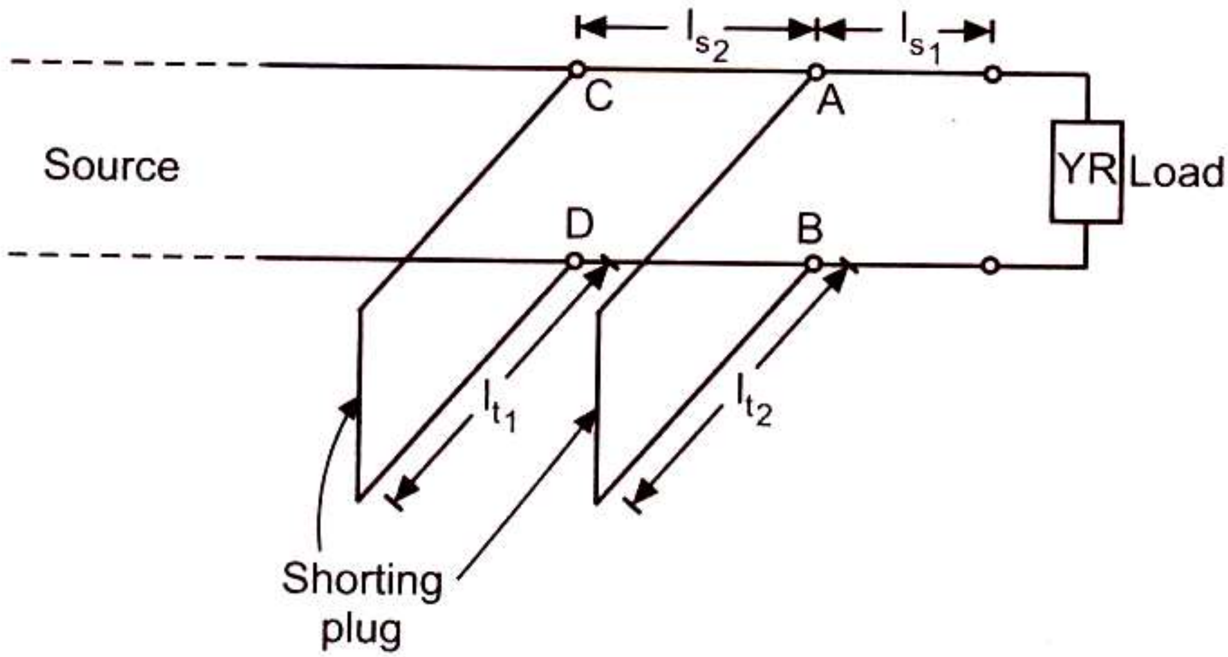
4. Where the input conductance at that point is equal to the characteristic conductance of the line, and the stub length is adjusted to provide a susceptance equal in value but opposite in sign, to the input susceptance of the main line at that point.

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:

(i) 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 4 apart are utilized.

(ii) Their positions are fixed but lengths are independently adjustable.

(iii) The double stub matching provides wide range of impedance matching.

f) Describe varactor modulator used for FM generation.

(Diagram- 2 mks, description – 2 mks)

Ans. Varactor Diode Modulation:

- Varactor diode is a specially fabricated P-N junction diode which is used as a variable capacitor in the reverse biased condition. This capacitor is dependent upon the magnitude of the reverse bias as shown in figure (a) and its capacitance is given by,

$$C \propto \frac{1}{\sqrt{V}}$$

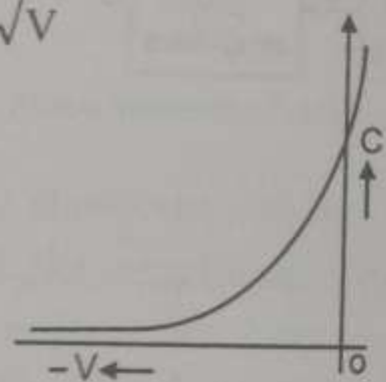


Fig. (a) Varactor diode capacitance for reverse bias.

- Silicon varactor diode shows an average variation of (10-15) pF per volt variation of reverse bias and have capacitance, lying in the range of 150 to 200 pF for 1 volt reverse bias.

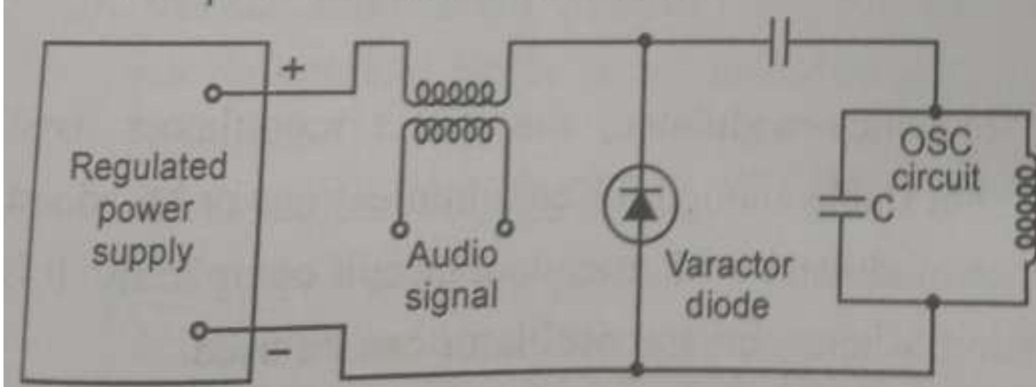


Fig. (b) A typical varactor diode modulator.

- Figure (b) depicts a typical varactor diode modulation circuit. Here, the varactor diode is connected across the resonant circuit of an oscillator through a coupling capacitor of relatively large value.
- This capacitor isolates the varactor diode from the oscillator as far as DC is concerned while providing an effective short circuit at operating frequencies.
- The DC bias to the varactor diode is regulated so that the oscillator frequency is not affected by varactor supply fluctuations.
- The modulating signal is fed in series with this regulated supply and at any instant, the effective bias to the varactor diode equals the algebraic sum of the DC bias voltage V and the instantaneous value of the modulating signal resulting in frequency modulation of the oscillator output.

Q 3. Attempt any FOUR of the following : **16**

a) A frequency modulated signal is represented by voltage equation as $e_{FM} = 10 \sin (6 * 10^8 t + 5 \sin 1250t)$.

Find out:

(i) Carrier frequency

(ii) Modulating frequency

(iii)Modulation index

(iv)Max. deviation

Ans: - **(1mark each for proper answer)**

Given equation: e_{FM} =10 sin (6x108t+5 sin 1250 t)

Now consider equation

EFM = A sin (ωct +mf sin ωm t)

Compare this equation with the given equation

mf = 5

1. Carrier frequency:

ωc = 6 x 108 rad/sec

2πfc = 6 x 108

fc = 6 x 108/ 2π =95.5 MHz

fc = 95.5 MHz

2. Modulating frequency:

ωm = 1250 rad/sec

2 π fm = 1250

fm = 1250/2π =199 Hz

fm = 199 Hz

3. Modulating index:

mf = 5

4. Maximum deviation:

mf = δ/ fm

δ = mf x fm

= 5 x ωm / 2 π

= 5 x 1250/2 π = 995 Hz

δ = 995 Hz

b) The desired signal frequency is 93 MHz and the intermediate frequency is 10.7 MHz calculate the local oscillator frequency and image frequency.

Ans:-(formula- 1 mks each, proper calculated answer- 1mks each)

Given

$f_i = 10.7$ MHz

$f_s = 93$ MHz

$f_o = ?$

$f_{si} = ?$

$f_o = f_s + f_i$

$= 93 + 10.7$

$\boxed{f_o = 103.7 \text{ MHz}}$

$f_{si} = f_s + 2f_i$

$= 93 + 2 \times 10.7$

$\boxed{f_{si} = 114.4 \text{ MHz}}$

c) Describe various layers of ionosphere with neat diagram.

Ans: (diagram-2 mks, explanation-2 mks)

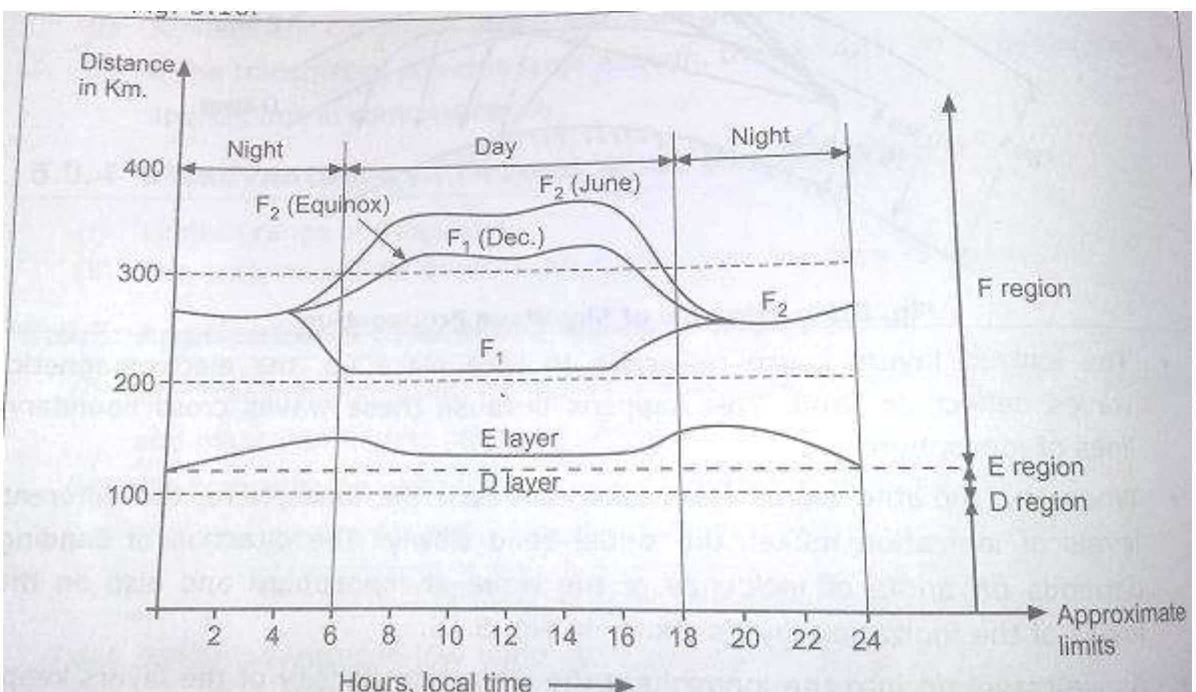


Fig. 5.16: Ionospheric Layers and Their Regular Variations

The Ionosphere is the upper portion of the atmosphere. The ultra violet radiation from the sun will ionize the upper layer of the atmosphere. Due to ionization these part of the atmosphere becom3es electrically charged. In this layer free electrons and positive and negative ions are present and hence this layer of ions is known as ionosphere.

There are four layers: D, E, F1 and F2.

1. D Layer: It is lowest layer at an height of 70 kms with thickness 10 km. The ionization density is maximum at noon and disappears at night.

2. E Layer: It is the next layer at an height of 100 kms with thickness 25 km. The layer disappears at night due to recombination of ions and molecules.

3. F1Layer: It is the next layer at an height of 180 kms with thickness 20 km. It provides more absorption for HF waves.

4. F2Layer: It is the next layer at an height of 250-400 kms with thickness 200 km. It is having highest electron density of all layers, due to this F2 layer remains present at night time.

Ionosphere Propagation:

In this propagation, the transmitted signal transmits into the upper atmosphere where it is bent i.e reflected back to earth. This bending of the signal takes place due to the presence of the ionosphere layer.

Its Frequency Range is from 3 MHz to 30 MHz

Polarization: Vertical

d) If R is reflection co-efficient what will be its value.

(i) If there is no reflected voltage

(ii) If reflected voltage is same as incident voltage

(iii)If reflected voltage = 15V and incident voltage = 25 V

(iv)If reflected voltage = 20V and incident voltage = 10 V

Ans:- (each answer – 1 mks)

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

i) If $V_r = 0$

$$\boxed{R = 0}$$

ii) If $V_r = V_i$
then

$$\boxed{R = 1}$$

iii) If $V_r = 15V$, $V_i = 25V$

$$R = \frac{15}{25}$$

$$\boxed{R = 0.6}$$

iv) If $V_r = 20V$, $V_i = 10V$

$$R = \frac{20}{10}$$

$$\boxed{R = 2}$$

e) Calculate the directivity for the antennas having following specifications:

(i) Power gain , efficiency 90%

(ii) Power gain 45 dB , efficiency 90%

Ans:-(each proper answer- 2 mks)

Given

i) $A_P = 30\,dB$

$\eta = 90\%$

$$D = \frac{A_P}{\eta}$$

$$D = \frac{30}{90}$$

$$\boxed{D = 0.33}$$

ii) $A_P = 45\,dB$

$\eta = 90\%$

$$D = \frac{A_P}{\eta}$$

$$= \frac{45}{90}$$

$$\boxed{D = 0.5}$$

f) Describe the generation of PPM with waveforms.

Ans: (Diagram 02M, waveform 01M, Explanation 01 M)

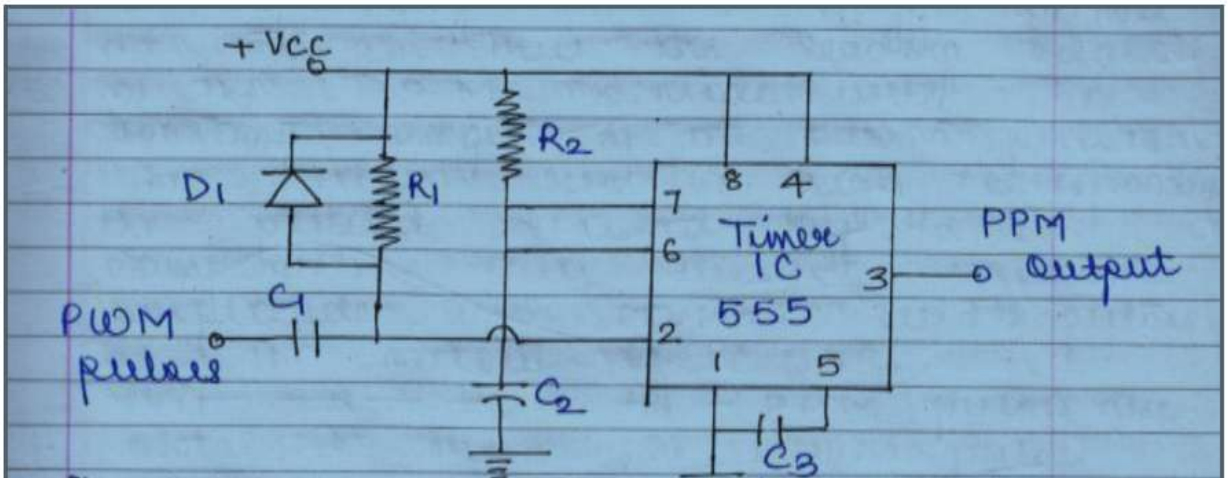


Fig: PPM generation using IC 555

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.

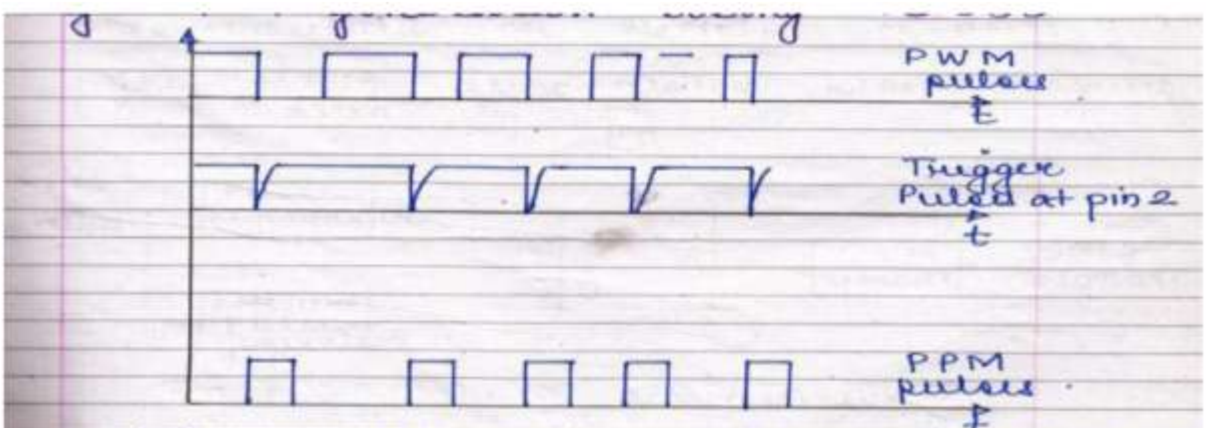


Fig Waveforms for generation of PPM

Q 4. Attempt any FOUR of the following : **16**

a) Describe the Pre- emphasis with graph.

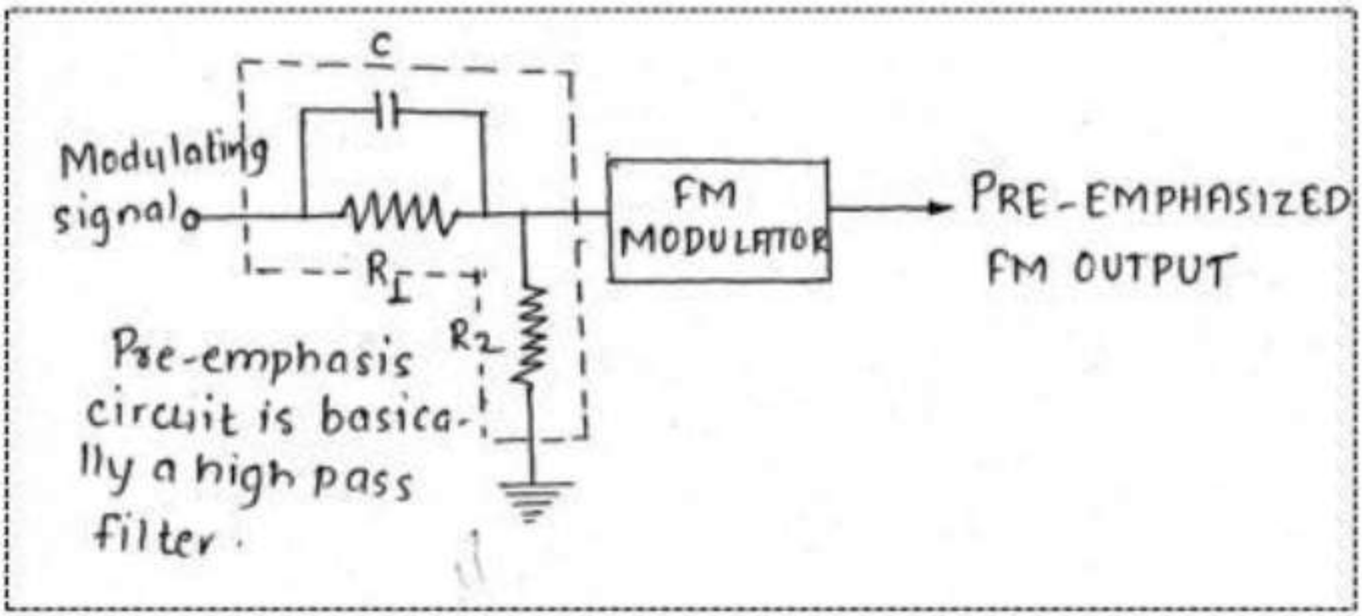
Ans: Description- 1 mks, diagram- 2 mks, graph -1 mks)

The artificial boosting of higher modulating frequencies to reduce the effect of noise is called as pre-emphasis.

Need:-

- The artificial boosting of higher audio modulating frequencies in accordance with prearranged response curve is called pre-emphasis.
- In FM, the noise has a greater effect on the higher modulating frequencies. This effect can be reduced by increasing the value of modulation index (mf).
- This can be done by increasing the deviation and can be increased by increasing the amplitude of modulating signal at higher frequencies.

Circuit diagram:-



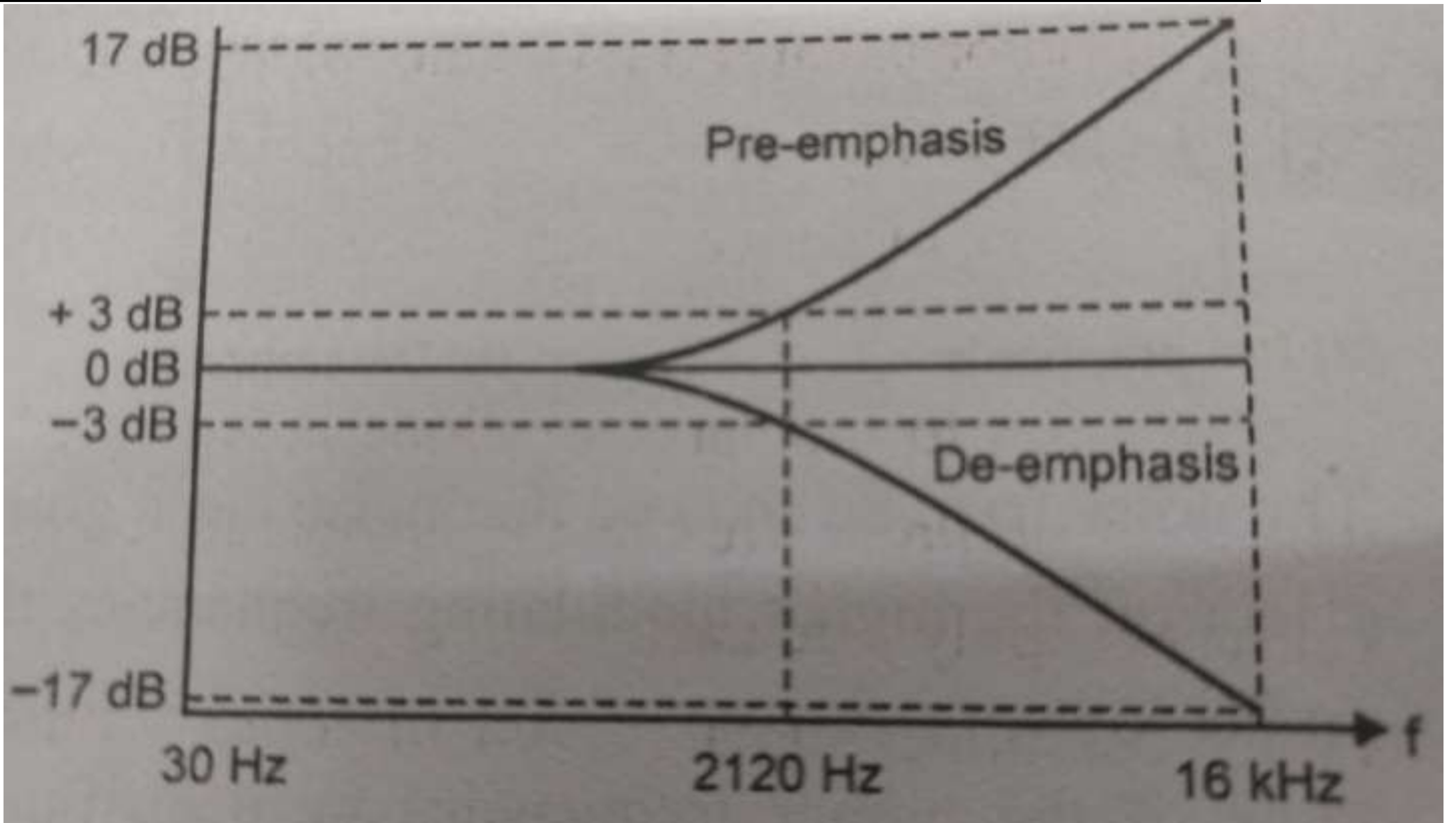


Fig. Emphasis curves

b) A 10 kW carrier is amplitude modulated by two sine waves to a depth of 0.5 and 0.6 respectively. Calculate total power content of modulated carrier.

Ans:- (proper solution- 4 mks)

Ans. Given : $P_c = 10\ kW$

$m_1 = 0.5$

$m_2 = 0.6$

To find : $P_t = ?$

Soln. $m_a = \sqrt{m_1^2 + m_2^2}$

$m_a = \sqrt{0.5^2 + 0.6^2}$

$m_a = \sqrt{0.25 + 0.36}$

$$m_a = \sqrt{0.61}$$

$$\therefore \; m_a = 0.78$$

$$P_t = P_c\left(1 + \frac{m_a^2}{2}\right)$$

$$P_t = 10\left(1 + \frac{(0.78)^2}{2}\right)$$

$$= 10 \times \left(1 + \frac{0.61}{2}\right) = 10 \times (1 + 0.305)$$

$$\therefore \; \boxed{P_t = 13.05 \text{ kW}} \quad \textbf{Ans.}$$

c) Derive the relation between reflection co-efficient (K) in VSWR.

Ans: (proper derivation 4 marks)

$$V\max = |V_i| + |V_r|$$

$$V\min = |V_i| - |V_r|$$

Where-

Vi = r.m.s. value of incident voltage

Vr = r.m.s. value of reflected voltage

By definition:

$$VSWR = \left|\frac{V_{max}}{V_{min}}\right| = \frac{|V_i| + |V_r|}{|V_i| - |V_r|} = \frac{V_i\left(1 + \frac{V_r}{V_i}\right)}{V_i\left(1 - \frac{V_r}{V_i}\right)} = \frac{1 + |k|}{1 - |k|}$$

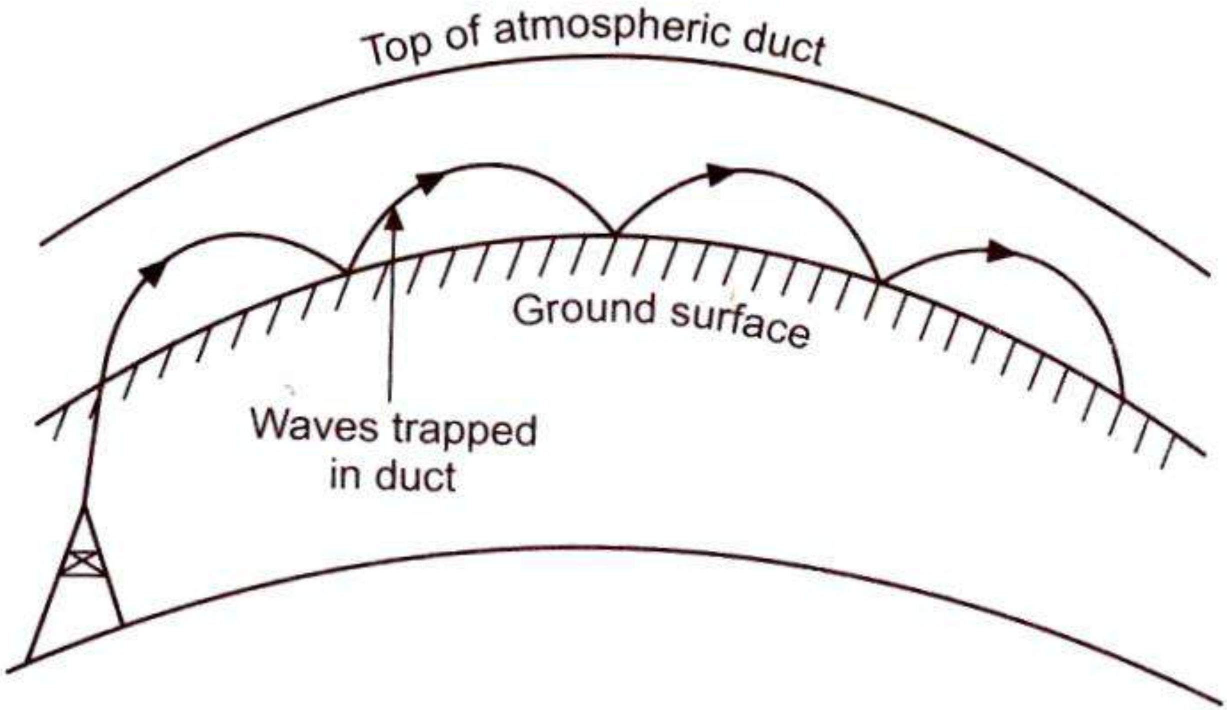
Applying Componendo and Dividendo,

$$\frac{VSWR - 1}{VSWR + 1} = \frac{1 + |k| - 1 - |k|}{1 + |k| + 1 - |k|} = \frac{2\,|k|}{2} = |k|$$

$$\text{Therefore, } |k| = \frac{VSWR - 1}{VSWR + 1} = \frac{S - 1}{S + 1}$$

d) Describe duct propagation with neat diagram.

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 6.50C/km in the standard atmosphere.

- The Duct propagation is used for very high frequencies in GHz range.

e) Why dish antenna is having parabolic shape and meshy surface?

Ans:- (proper explanation- 2 mks each)

- A practical reflector employing the properties of the parabola will be a three dimensional bowl-shaped surface, obtained by revolving the parabola about the axis AB.

Cable Television

- The resulting geometric surface is the paraboloid, often called a parabolic reflector or microwave dish.
- When it is used for reception exactly the same behaviour is manifested, so that this is also a high gain receiving directional antenna reflector.
- The principle of reciprocity which states that the properties of an antenna are independent of whether it is used for transmission or reception.
- The reflector is directional for reception because only the rays arriving from BA direction i.e. normal to the directrix are brought together at the focus.
- On the other hand, rays from any other direction are canceled at that point, again owing to path length differences.
- The reflector provides a high gain because like the mirror of a reflecting telescope, it collects radiation from a large area and concentrates it all at the focal point.

Why dish antenna having meshy structure:

- While installing the dish antenna look angles are taken into consideration.
- Once look angle adjusted installation should not be disturbed.
- Due to atmospheric changes like rain, winds there is a possibility of change in look angle of dish, due to meshy structure, rain and wind will go through holes by keeping fix position of dish antenna.

The parabola is a plane curve defined as the locus of a point which moves so that its distance from another point (called the focus) plus its distance from a straight line (directrix) is constant. These geometric properties yield an excellent microwave or light reflector.

f) Describe resonant and non-resonant type of transmission line.

Ans:- (each description- 2 mks each)

Ans. Resonant transmission line :

- A line having length multiples of half wave length is called as resonant transmission line.
- The half wave length line has distributed capacitance and inductance and acts like a resonant circuit.

Non-resonant transmission line :

- A line terminated at far end that produces no standing waves is called as non-resonant transmission line.
- The standing waves are suppressed by the use of a correct termination resistor and no power is reflected; ensuring that only forward travelling waves will exist.
- In a correctly matched transmission line, all the transmitted power is dissipated in the terminating resistance.

Q 5. Attempt any FOUR of the following : 16

a) AM transmitter transmits signals at 50 kW with modulation depth as 85%. Calculate carrier power and total side band power in transmitted signal.

Ans:- (carrier and total power -2 mks each)

Ans. Given: $P_t = 50\,kW$, $m_a = 0.85$

To find: $P_c = ?$, $P_{USB} = ?$, $P_{tSB} = ?$, $P_{LSB} = ?$

Soln. P_{tSB} = total sideband power

$$P_t = P_c\left(1 + \frac{m_a^2}{2}\right)$$

$$50 \times 10^3 = P_c \left(1 + \frac{0.85}{2}\right)$$

$$P_c = \frac{50 \times 10^3}{1.425}$$

$$P_c = 35.087 \times 10^3$$

$$P_c = \text{Carrier Power} = 35.087 \text{ kW.}$$

$$\therefore \boxed{P_c = 35.087 \text{ kW}} \text{ Ans.}$$

Also, $P_t = P_{USB} + P_{LSB} + P_c$

$$P_{USB} = P_{LSB}$$

$$\therefore P_t = 2P_{LSB} + P_c$$

$$50 = 2P_{LSB} + 35.087$$

$$2P_{LSB} = 50 - 35.087$$

$$2P_{LSB} = 14.913$$

$$P_{LSB} = \frac{14.913}{2}$$

$$\therefore \boxed{P_{LSB} = 7.45 \text{ kW}} \text{ Ans.}$$

As $P_{LSB} = P_{USB}$

$$\therefore \boxed{P_{USB} = 7.45 \text{ kW}} \text{ Ans.}$$

P_{tSB} = total sideband power

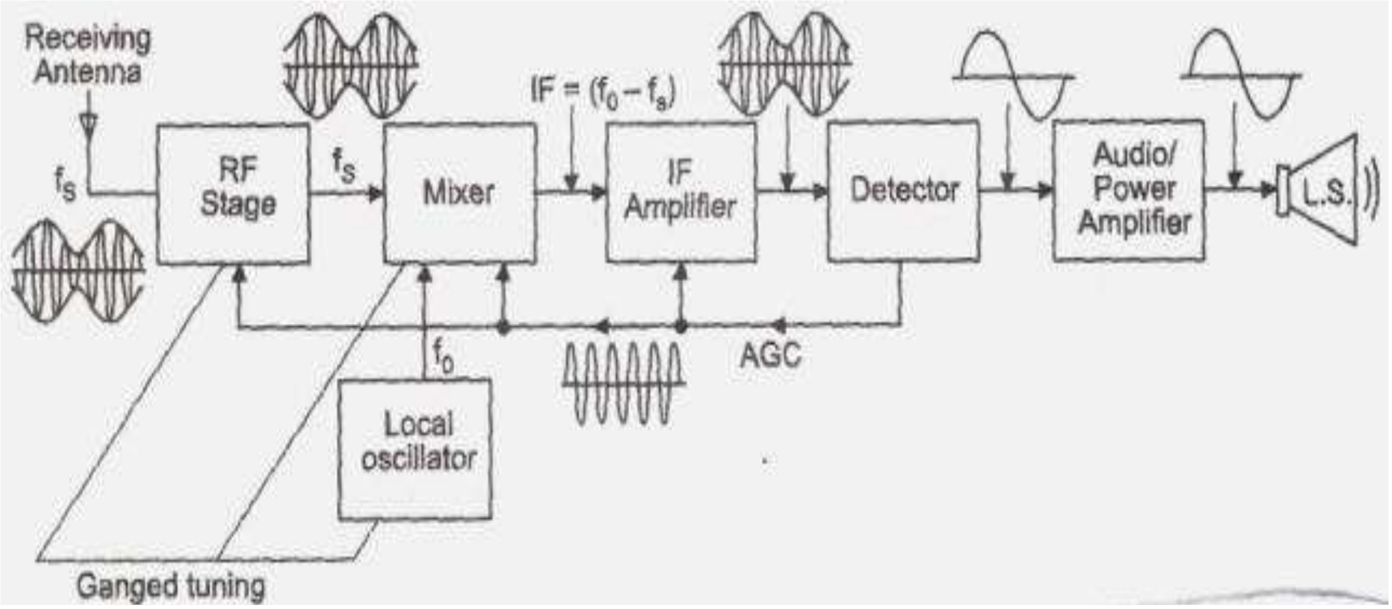
$$= P_{LSB} + P_{USB}$$

$$= 2P_{LSB} = 2 \times 7.45 \text{ kW}$$

$$\therefore \boxed{P_{tSB} = 14.9 \text{ kW}} \text{ Ans.}$$

b) Describe operation of AM superheterodyne receiver with block diagram.

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



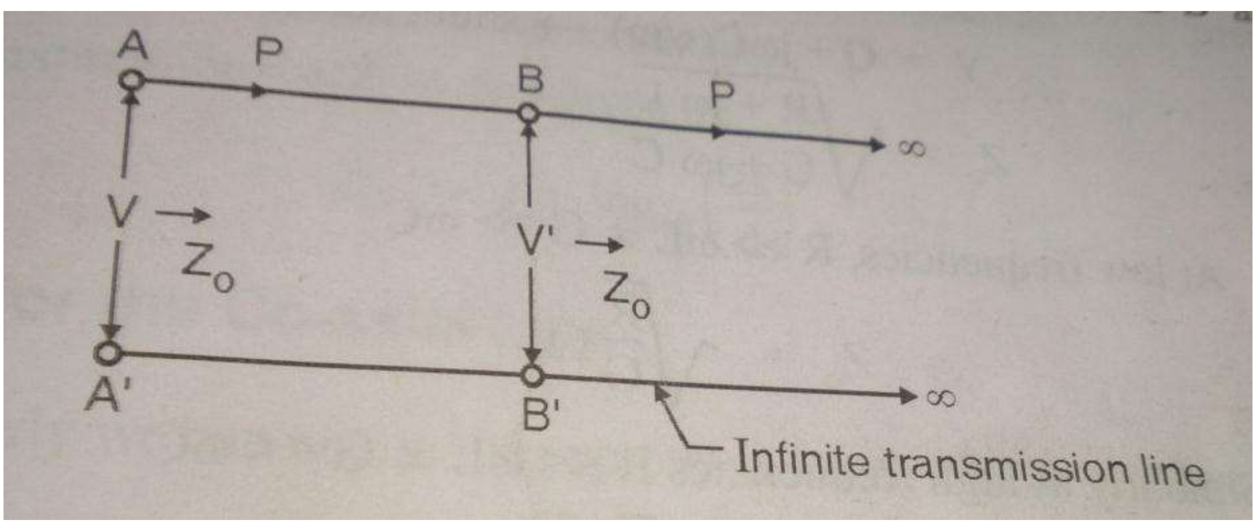
AM super heterodyne receiver works on the principle of super heterodyning.

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.

c) Derive the equation for characteristic impedance of transmission line at low frequency and high frequency.

Ans: Characteristics impedance- Characteristic impedance of a transmission line, Z0 is the impedance measured at the input of this line when its length is infinite. **(1/2 marks)**



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,

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

Where, Z0 = Characteristic impedance

Z = series impedance per section

=R + jωL (Ω/M)

Y= Shunt admittance per section

=G+jωC (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.

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

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

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

At low frequency:

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

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

d) An antenna has a radiation resistance of 72Ω, a loss resistance of 8Ω and power gain of 16. What is efficiency and directivity.

Ans:- (proper solution- 4 mks)

Given

Radiation resistance = 72 Ω (R)

loss resistance = 8 Ω (R_L)

efficiency (η) = ?

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

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

$$= 0.9 \times 100\%$$

$$\boxed{\eta = 90\%}$$

Directivity = ?

$$D = \frac{A_P}{\eta}$$

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

$$\boxed{D = 0.17}$$

e) State and explain types of AGC with its characteristic.

Ans:- (types-m 1 mks,characteristics- 1 mks, explanation- 2 mks)

Ans. Types of AGC :

1) Simple AGC.
2) Ideal AGC.
3) Delayed AGC.

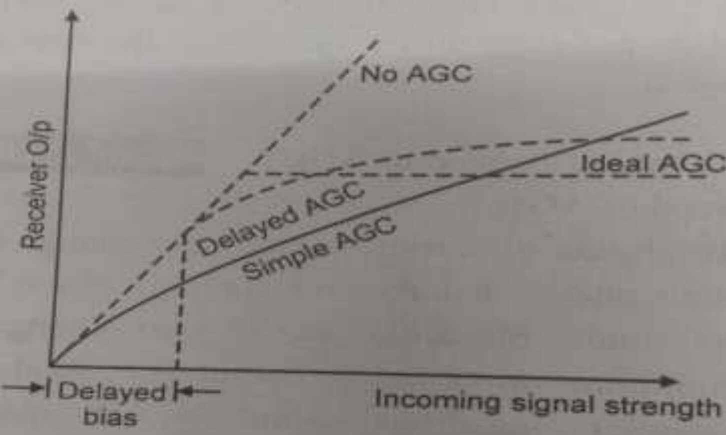


Fig. (a) Graph for different types of AGC

1) Simple AGC :

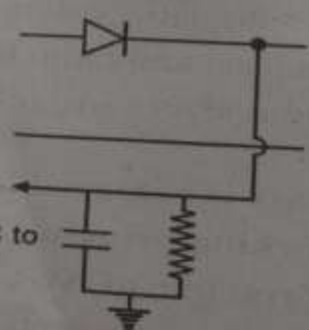


Fig. (b) Circuit of simple AGC

- AGC bias, that provides a proportional dc bias to the signal strength is termed as Simple AGC. Obviously, this circuit tends to smoothen the variation which would otherwise occur in the receiver output because of difference in signal strength from different transmissions or due to path loss.
- Simple AGC reduces the receiver gain in proportion to the incoming signal strength. As a result of this arrangement, receiver gain is reduced even for weak signals. This is obviously undesirable.

2) Ideal AGC :

- Ideally, an AGC that remains inoperative for signal strength below a certain limit and is capable of providing a constant output for signal strengths exceeding this limit is desired. Figure (a). shows the characteristics of such an AGC system called as an Ideal AGC.
- Though simple AGC provides sufficient improvement upon no AGC, it is not at all close to ideal characteristics desired.

3) Delayed AGC :

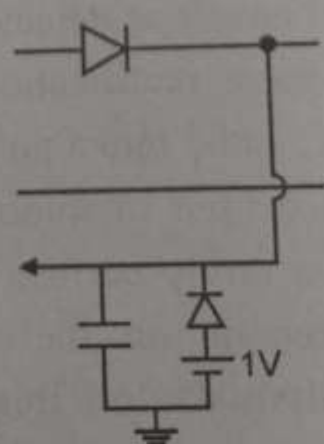


Fig. (c) Circuit of delayed AGC

f) Describe different types of losses in transmission line.

Ans: (4 types – 1 mks each)

Losses in Transmission Line:-

There are three ways in which energy, applied to a transmission may desperate before reaching the load. They are

(1) Radiation Losses:-

- Its occurs when a transmission line may act as an antenna when the separation of the conductor is an appreciable fraction of a wave length .
- This loss increase with frequency for any given transmission line eventually ending that lines usefulness at some high frequency.
- This loss is more in parallel wire lines than to coaxial lines.

(2) Conductor Or I2 R loss:-

- This loss is proportional to the current and their fore inversely proportional to characteristics impedance
- It also increases with frequency, this time because of the skin effect.

(3) Dielectric loss:

- This loss is proportional to the voltage across the dielectric and hence inversely proportional to the characteristic impedance for any power transmitted.
- It again increases with frequency because a gradually worsening properties with increasing frequency for any given dielectric medium.

(4) Corona Effect:-

- Corona is a luminance discharge that occurs between the two conductors of a transmission line when the difference of proportional between them exceeds the break down voltage of the dielectric insulator.
- Generally when corona occurs, the transmission line is destroyed.

Q 6 . Attempt any FOUR of the following : **16**

a) Describe with diagram FM signal generation using IC 566.

Ans☹ diagram – 2 mks, description -2 mks)

Ans. FM signal generation using IC 566 or PLC

IC 566 :

- FM generation needs a linear voltage-to-frequency converter. If a voltage-controlled capacitor is laced in the feedback loop of an oscillator and the modulation signal is applied across this capacitor, then the oscillator will change its frequency and the resulting output signal is an FM signal.
- In the figure below the LM 566C is used to generate the FM signal. The LM 566 is a linear voltage-to-frequency converter which can generate an FM signal up to 1 MHz and for a ±10% deviation from the center frequency, it has an FM distortion of less than 0.2%. The center frequency f_o is set by a resistor R_o and a capacitor (C_o).

where,

$$f_o = \frac{2.4}{R_o C_o}\left(1 - \frac{V_5}{V^+}\right)$$

$$0.75\,V^+ < V_5 < V^+$$

$$2k\Omega < R_o < 20\,k\Omega$$

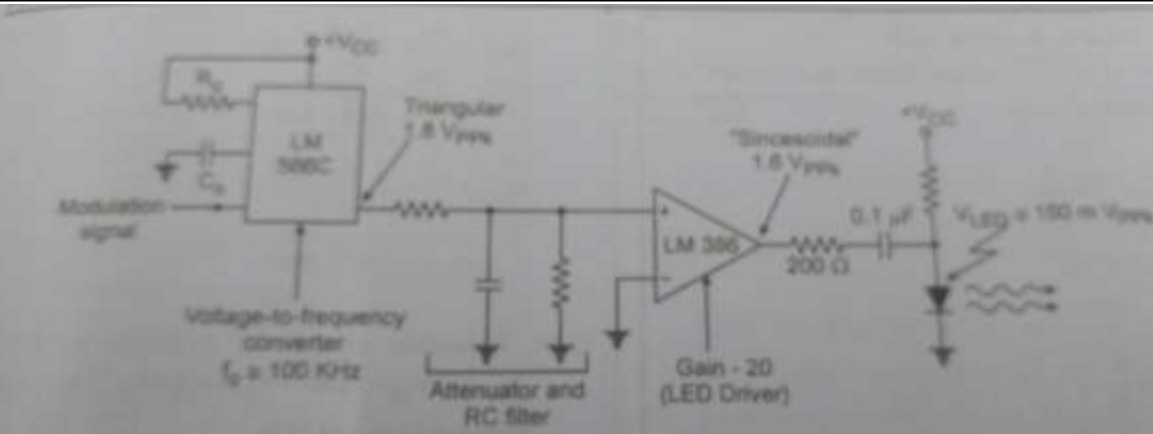


Fig. FM signal generation using IC 566

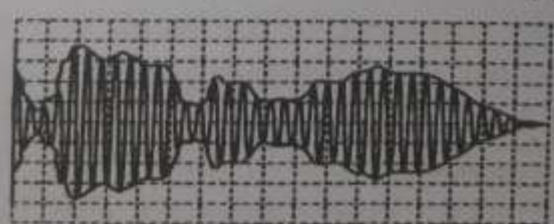
- *The LM 566 delivers either an FM square wave or an FM triangular wave. The square/triangular wave is converted into sine wave with the use of a simple RC filter. The input impedance for the modulation signal is $1M\Omega$ and the output impedance of the square/ triangular wave is 50Ω.*
- *In above case, if the modulating signal is a digital waveform, then the resulting FM signal is a frequency-shift-keying signal (FSK).*

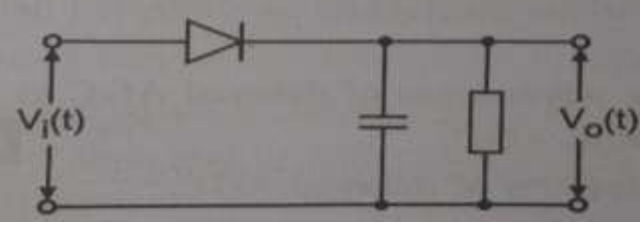
b) Describe with neat circuit diagram and waveforms of envelope of detector.

Ans:-(circuit diagram-1 mks, waveforms-1 mks, description- 2 mks)

Ans. Envelope Detector :

- An envelope detector is an electronic circuit that takes a high-frequency signal as input and provides an output which is the "envelope" of the original signal.
- The capacitor in the circuit stores up charge on the rising edge, and releases it slowly through the resistor when the signal falls. The diode in series rectifies the incoming signal, allowing current flow only when the positive input terminal is at a higher potential than the negative input terminal.
- Most practical envelope detectors use either half-wave or full-wave rectification of the signal to convert the AC audio into a pulsed DC signal.
- Filtering is then used to smooth the final result. This filtering is rarely perfect and some "ripple" is likely to remain on the envelope follower output, particularly for low frequency inputs such as nodes from a brass guitar.
- More filtering gives a smoother result, but decreases the responsiveness thus, real-world designs must be optimized for the application.





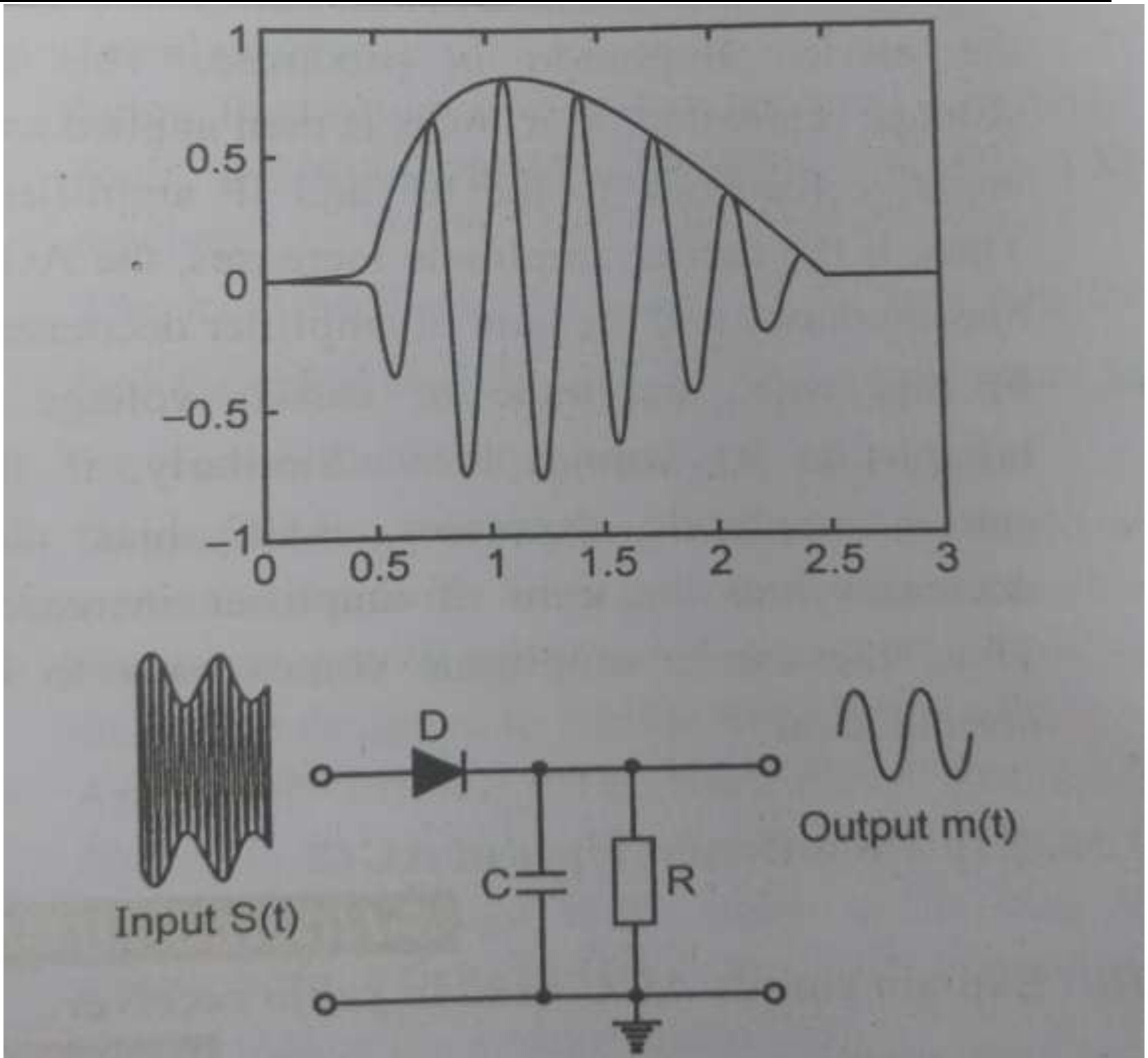
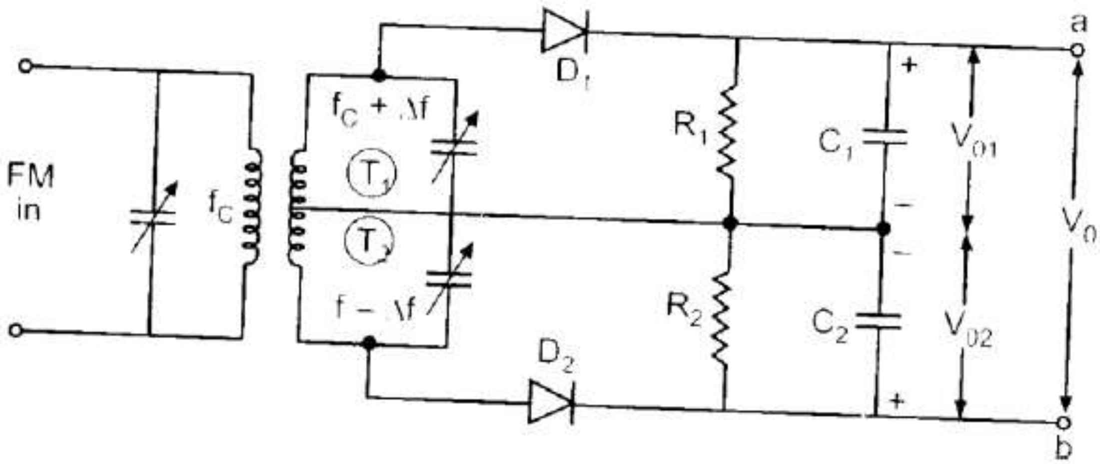


Fig. Envelope Detector (AM Demodulator/Detector).

c) Describe with diagram balanced slope detector.

Ans: **Circuit diagram:-** **02M**



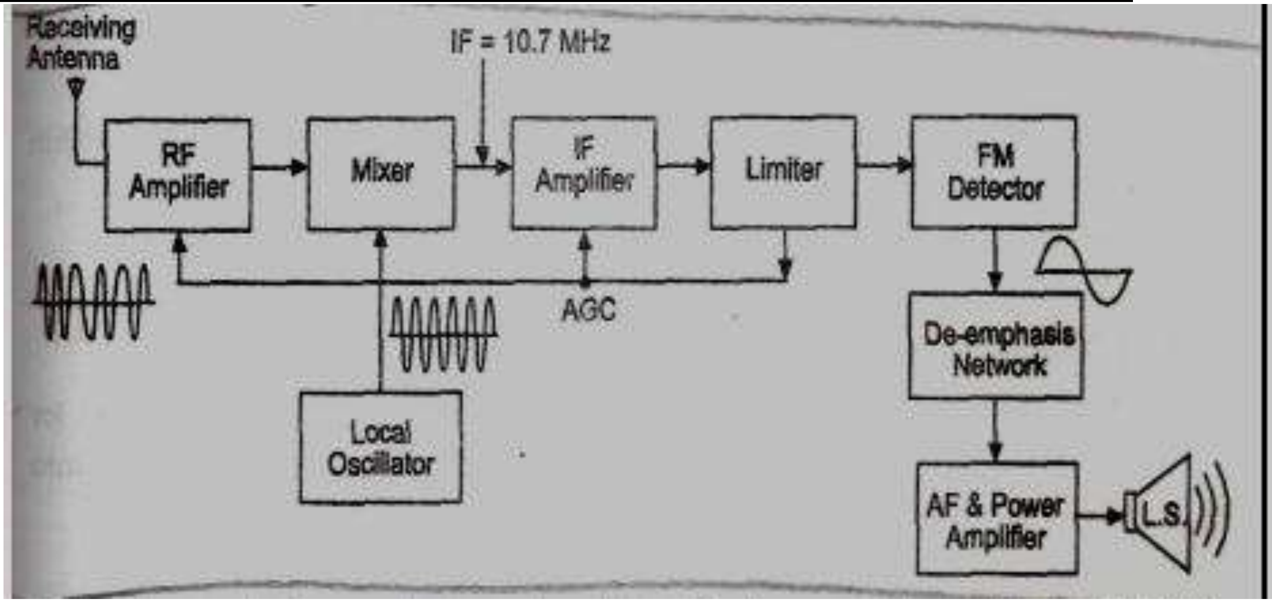
Working Principle: **02M**

- The difficulties arising in simple slope detector circuit are overcome balanced slope detector.
- The circuit uses two slope detectors, connected back to back to the opposite ends of center tapped transformer and hence fed 180o out of phase.
- The circuit is divided in to three tuned circuits.
- Primary side tuned circuit is tuned to center frequency fc.
- Secondary side top of tuned circuit in tuned above If i.e. (fc +Δf) and bottom of tuned circuit is below IF i.e. (fc-Δf).
- Each tuned circuit is connected to diode detector and RC load.
- R1C1 and R2C2 are filtered to remove RF ripple.
- Final output voltage V0 is
  V0 = V01- V02

d) Describe the block diagram of FM superheterodyne receiver.

Ans:

Superhetrodyne FM radio receiver- 2 mks



Explanation of each block:- 2 mks

RF amplifier:

There are two important functions of RF amplifier:

1) To increase the strength of weak RF signal.

2) To reject image frequency signal. In FM broadcast the channel bandwidth is large as compared to AM broadcast. Hence the RF amplifier must be design to handle large bandwidth.

Frequency Mixer:

The function of frequency mixer is to heterodyne signal frequency fs and local oscillator frequency fo. At the output, it produces the difference frequency known as intermediate frequency fi. The intermediate frequency used in FM receiver is higher than that in AM receiver. Its value is 12MHz (practical value of IF is 10.7MHz).

Local oscillator:

Since FM broadcast operates in VHF and UHF band, a separate local oscillator is used in FM receiver The local oscillator frequency fo is kept smaller than the signal frequency fs by an amount equal to the intermediate frequency fi (fi = fs-fo).

IF amplifier:

Two or more stages of IF amplifier are used to provide large gain to the receiver. This increases the sensitivity of a receiver. If amplifier should be designed to handle large bandwidth.

Amplitude limiter:

The function of amplitude limiter is to remove all amplitude variation of FM carrier voltage that may occur due to atmospheric disturbances. Use of amplitude limiter makes the system less noisy.

FM Discriminator or detector:

It separates modulating signal from frequency modulated carrier signal. Thus it produces audio signal at its output.

Audio frequency voltage and power amplifier:

Audio amplifier increases voltage and power level of audio signal to a suitable level.in FM broadcast, the maximum modulating frequency is 15 kHz. Hence the audio amplifier must have large bandwidth.

e) Describe the function of mixer and local oscillator in radio receiver.

Ans:- (each function- 2 mks)

Frequency Mixer: The function of frequency mixer is to heterodyne signal frequency f_s and local oscillator frequency f_o. At the output, it produces the difference frequency known as intermediate frequency f_i.

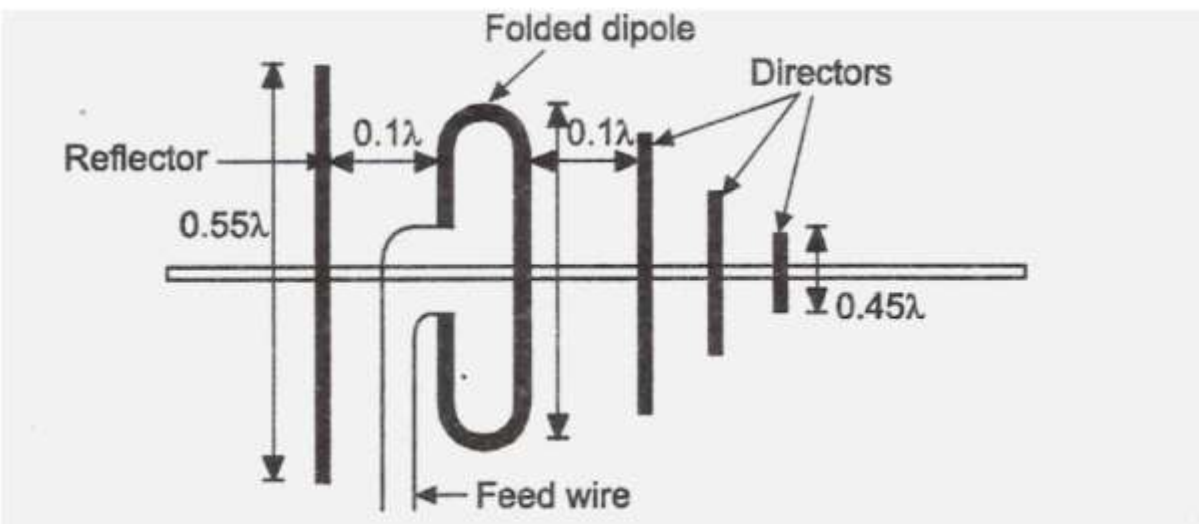
The intermediate frequency used in FM receiver is higher than that in AM receiver. Its value is 12 MHz (practical value of IF is 10.7 MHz).

Local oscillator: Since FM broadcast operates in VHF and UHF band, a separate local oscillator is used in FM receiver

The local oscillator frequency f_o is kept smaller than the signal frequency f_s by an amount equal to the intermediate frequency f_i ($f_i = f_s - f_o$).

f) Explain Yagi Uda antenna with its radiation pattern.

Ans: (Construction – 2 marks, Radiation Pattern –1 marks, explanation- 1 mks)



Explanation- 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.