MODEL ANSWER
SUMMER– 18 EXAMINATION

Subject Title: ANALOG COMMUNICATION **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.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	**a)**	**Attempt any SIX of the following:**	**12 Marks**
	i)	**State and explain concept of bandwidth.**	**2 Marks**
	Ans:	**1.** Bandwidth is defined as a range within a band of frequencies or wavelengths. ... For digital devices, the bandwidth is usually expressed in bits per second (bps) or bytes per second. For analog devices, the bandwidth is expressed in cycles per second, or Hertz (Hz) **2.**Suppose the frequency range is f1 to f2 , then B.W= f2 – f1 **Note:- Any other relevant explanation should be considered.**	**01 mark definition, 01 mark Concept.**
	ii)	**Define pulse modulation. State its types.**	**2 Marks**
	Ans:	**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.	**01 mark definition, 01 mark types**
	iii)	**Give the expression for modulation index for AM and FM.**	**2 Marks**

	Ans:	**1.Modulation index for AM** m_a=Vm / Vc Where Vm is modulating voltage Vc is the carrier voltage **2.Modulation index for FM** m_f=δ /fm where δ is the deviation fm is the modulating frequency	**01 mark each**
	iv)	**Define selectivity and sensitivity of AM Receiver.**	**2 Marks**
	Ans:	**Selectivity**:-It needs to accept signals of the wanted frequency and reject other unwanted frequencies. **Sensitivity**:-The sensitivity of a radio receiver is its ability to amplify weak signals. It is often defined in terms of the voltage that must be applied to the receiver input terminals to give a standard output power, measured at the output terminals.	**01 mark each**
	v)	**Define the term baluns and explain where is it used?**	**2 Marks**
	Ans:	A type of electrical transformer used to connect an unbalanced circuit to a balanced oneORA balun is a type of transformer: it's used to convert an unbalanced signal to a balanced one or vice versa. **Application**:- In audio applications, baluns convert between high-impedance unbalanced and low impedance balanced lines.	**01 mark definition , 01 mark application.**
	vi)	**Define electromagnetic wave and polarization.**	**2 Marks**
	Ans:	**Electromagnetic wave:-**An **electromagnetic wave** such as light consists of a coupled oscillating electric field and magnetic field which are always perpendicular; by convention **Polarization:-**polarization" of electromagnetic waves refers to the direction of the electric field.	**01 mark each**
	vii)	**Define fading? List the causes.**	**2 Marks**
	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. • Fading can be caused due to natural weather disturbances, such as rainfall, snow, fog, hail and extremely cold air over a warm earth.	**01 mark for defination , 01 mark causes**

		• Fadingcan also be created by man-made disturbances, such as irrigation, or from multiple transmission paths, irregular earth surfaces, and varying terrains.	
b)	**Attempt any TWO of the following :**		**8 Marks**
i)	**Explain any four different frequency bands and give their two applications of each.**		**4 Marks**
Ans:			**Any four 01 mark each**

Sr.no	Frequency Band	Application
1	V_F – 30 H_Z – 3KH_Z	Voice or Audio communication used in Telephone lines.
2	V_{LF} 3KH_Z – 30KH_Z	Submarine, Military communication
3	LF 30KH_Z – 300KH_Z	Marine, Navigation.
4	MF 300KH_Z – 3MH_Z	MW band of AM R_x
5	HF 3MH_Z-30MH_Z	SW band of AM R_x
6	VHF 30MH_Z-300 KH_Z	T.V & FM Radio broadcast
7	UHF 300MH_Z- 3GH_Z	UHF TV channel, Mobile phone
8	SHF-3GH_Z-30GH_Z	Satellite and Radar
9	EHF 30 GH_Z- 300 GH_Z	Satellite and Radar

ii) **Describe microwave antenna with suitable diagram.** — **4 Marks**

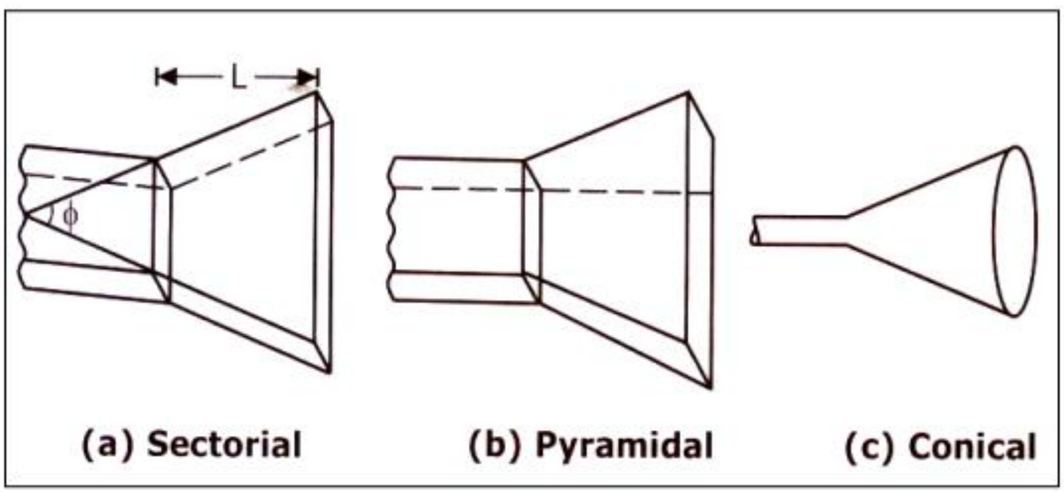
Ans:

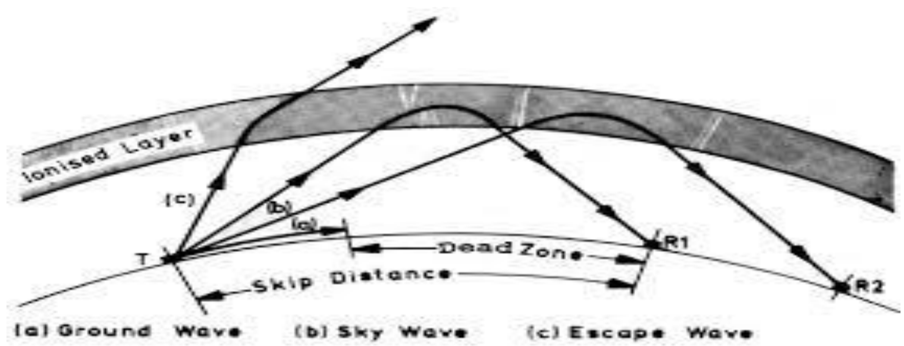
Types of microwave antennas: i) Dish antenna ii) Horn antenna

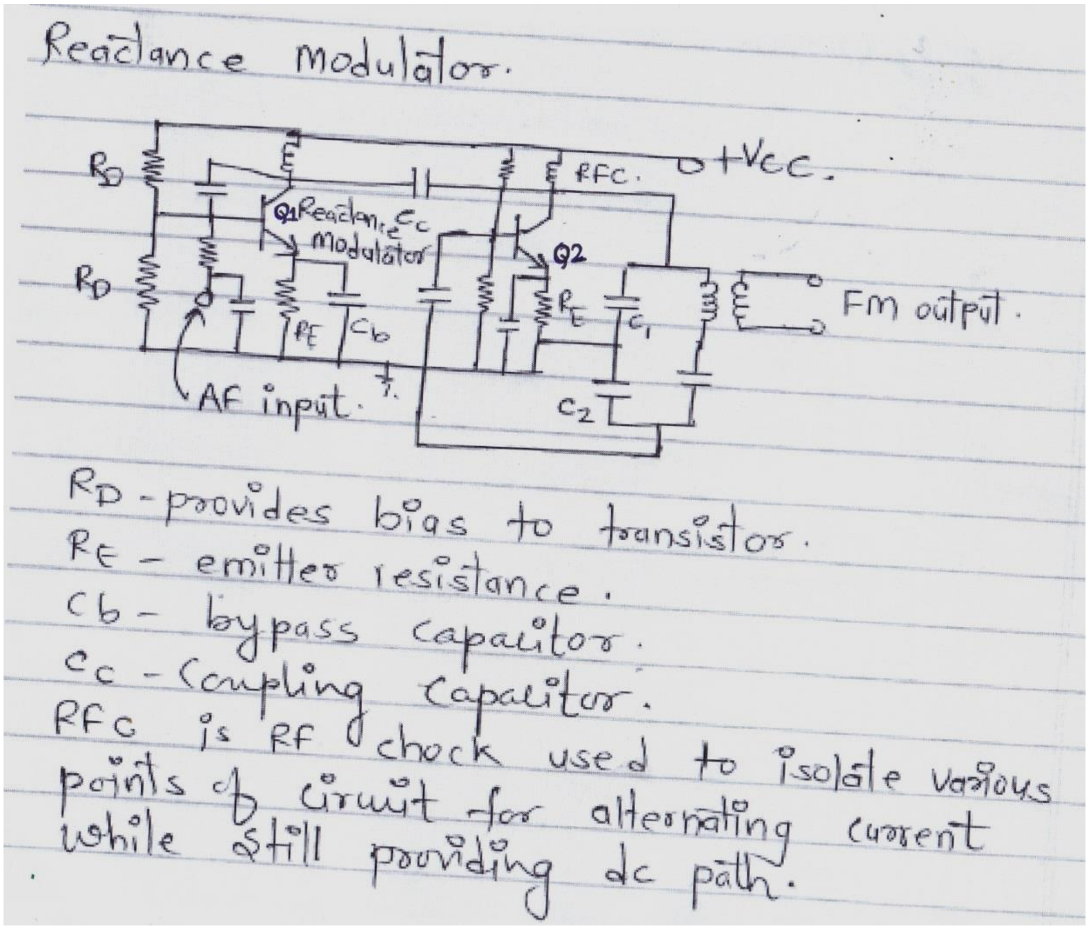
Horn antenna:

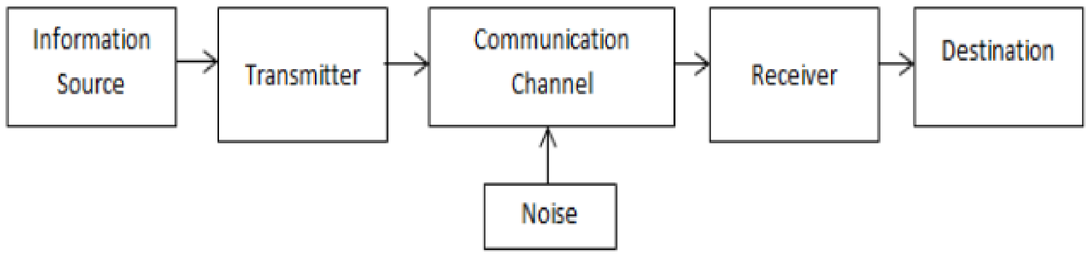
1. It is basically a waveguide terminated by horn.
2. Waveguide is a hollow metallic pipe used to carry electromagnetic waves at microwave frequencies.
3. All the energy travelling forward in the waveguide is radiated very effectively with the addition of the horn.
4. There are three configuration s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

List Antennas– 1 mark, any one diagram of horn antenna – 1 mark, explanation- 2 marks



		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/λ 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	
	iii)	**Explain skip zone and skip distance with neat diagram.**	**4 Marks**
	Ans:	**Skip distance:-**Skip distance is defined as the shortest distance from a transmitter, measured along the surface of earth at which a sky wav of fixed frequency returns back to the earth.  **Skip zone:** skip zone where signal is not detectable	**Definition 01 mark each ,02 marks diagram**
Q 2		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**Describe with respect to antenna** **(i) radiation pattern** **(ii) directive gain** **(iii) power gam** **(iv) polarization**	**4 Marks**
	Ans:	**(i) Radiation pattern:-**A graph or diagram which tells us about the manner in which an antenna radiates more power in different directions is known as the radiation patteren of antenna. **(ii) Directive gain**:- Directive gain is defined as the ratio of the power desity in a particular direction of one antenna to the power density that would be radiated byisotropic antenna in the same direction. **(iii)Power gain:-**The power gain of an antenna is defined as the ratio of power fed to an isotropic antenna to the power fed to a directional antenna, to develop the same field strength at the same direction.	**01 mark each**

		(iv) Polarization:- Polarization is defined as the direction of the electric vector in the electromagnetic wave radiated by the transmitting antenna.	
	b)	**Explain reactance modulator for FM generation.**	**4 Marks**
	Ans:	 **Explanation :-** • Audio modulating signal is applied to Q_1 which varies the base voltage and current of Q_1 according to the input information to be transmitted. • The collector current amplitude varies which changes the capacitance • Increase capacitance lower the frequency & decrease capacitance increase the frequency and thus produce direct FM at output.	**02 marks diagram, 02 marks explanation**
	c)	**Describe the block diagram of basic communication system.**	**4 Marks**
	Ans:		**Diagram 02 marks, explanation 02 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).

d) **Explain with neat diagram and waveform, generation of PPM using IC 555.** **4 Marks**

Ans:

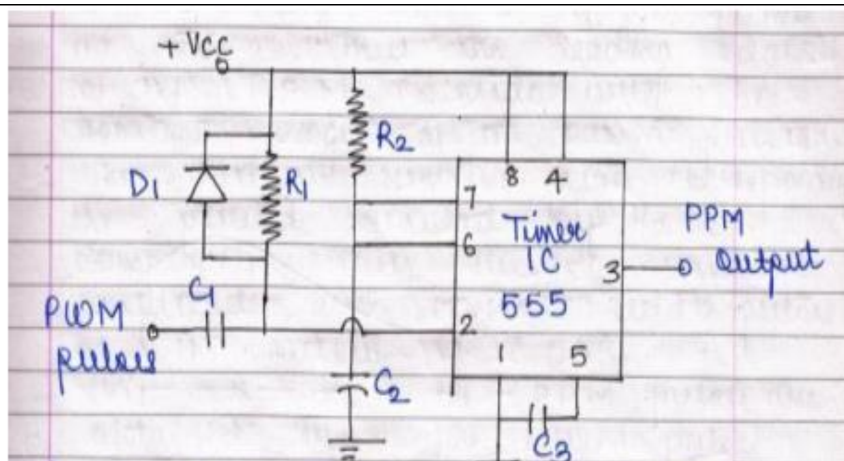
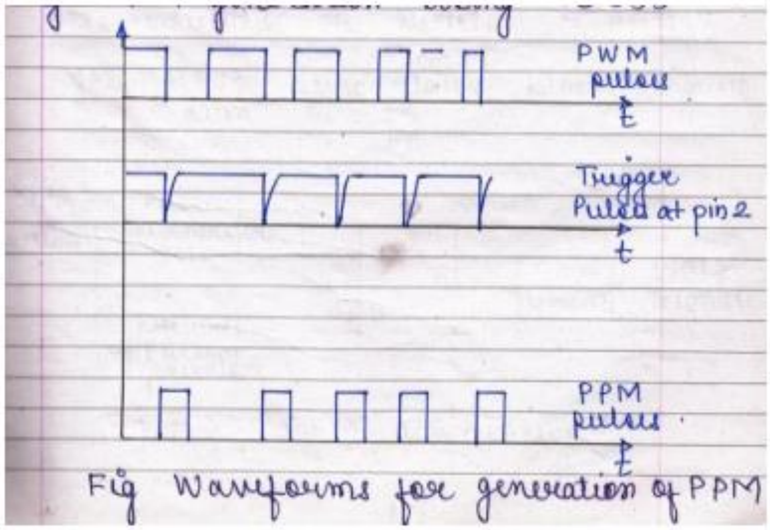


Fig: PPM generation using IC 555

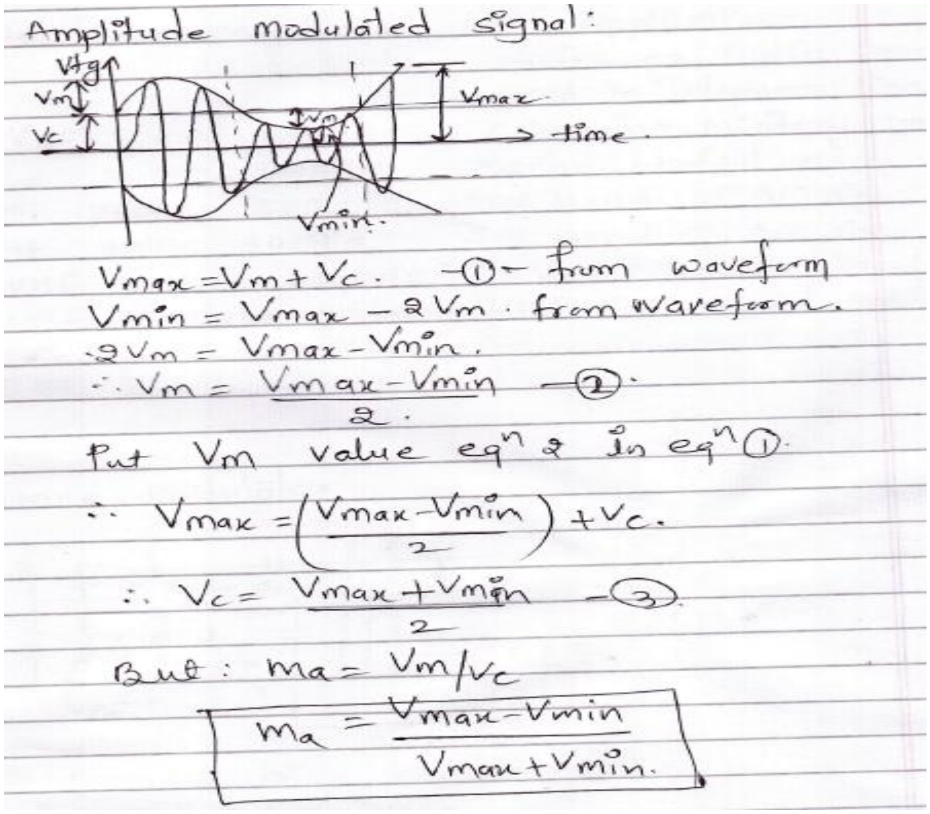
Diagram – 2marks, explanation- 1mark, waveforms- 1 mark

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.



	e)	**Describe different types of losses that affect the transmission line signal.**	**4 Marks**
	Ans:	**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 I^2 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.	**01 mark for each loss explanation**
	f)	**Define modulation index. Derive the expression - M=$\frac{Vmax-Vmin}{Vmax+Vmin}$using AM waveform.**	**4 Marks**
	Ans:	**Modulation index**:- It is the ratio of modulating voltage to the carrier voltage.	**01 mark definition , 01 mark**

			**diagram , 02 marks derivation.**
Q. 3		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**What will be effect of total AM transmitter power if modulation index changes from 0.5 to 1, for ·500 watt carrier power? Conclude the result.**	**4 Marks**
	Ans:	$P_t = P_c\ (1 + m^2/2)$ $P_c = 500W$ $m = 0.5$ $P_{t\,1} = 500(1 + (0.5)^2/2)$ $= 562.5W$ $P_{t\,2} = 500(1 + (1)^2/2)$ $= 750W$ if modulation index changes from 0.5 to 1, for ·500 watt carrier power,Total AM transmitter power is increase .	**Calculation: 3 marks, Result:1 mark**
	b)	**State the need of AGC. List the different types of AGC with neat graph.**	**4 Marks**
	Ans:	**Need of AGC:-** •The need or purpose of AGC circuit is to maintain the output voltage level (volume) of radio receiver constant over a wide range of RF input signal level.	**Need of AGC 2 marks and**

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• AGC also helps to smooth out the rapid fading which may occur with long distance short wave reception & prevents overloading of the last IF amplifier which might otherwise have occurred

Types of AGC:-

1) Simple AGC

2) Delayed AGC

Graphical representation of AGC:- (optional)

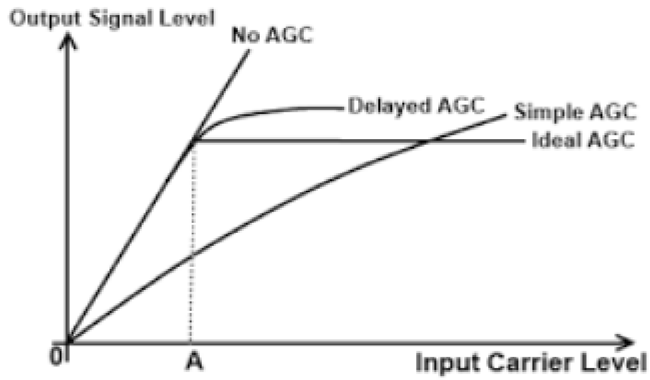

Figure (c): AGC Characteristics for Various Techniques

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Types of AGC 1 mark , graph 1 mark

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Describe line of sight propagation in brief.

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Ans:

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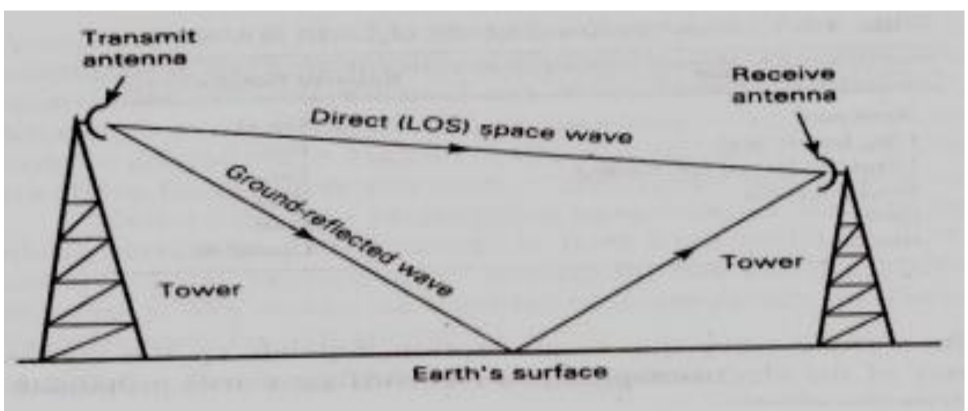
Line of sight propagation or Space wave propagation:-



Explanation:-

• Space wave propagation of electromagnetic energy includes radiated energy that travels in the lower few miles of Earth’s atmosphere. Space waves include direct and ground – reflected waves.

• Direct waves travel essentially in a straight line between the transmit and receive antennas. Space wave propagation with direct waves is commonly called line-of sight (LOS) transmission. Therefore, direct space wave propagation is limited by the curvature of the Earth. Ground reflected waves are waves reflected by Earth’s

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Sketch-2 marks , Explanation -2 marks

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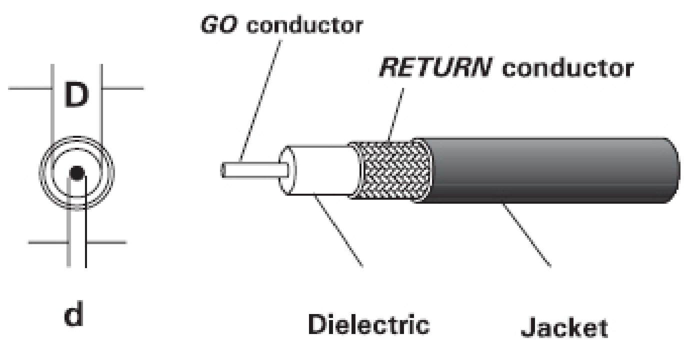
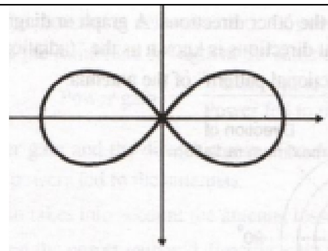
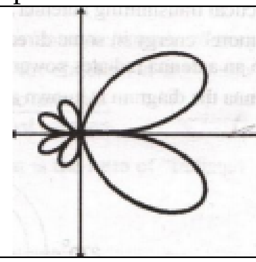
		surface as they propagate between the transmit and receive antennas.	
	d)	**Calculate characteristic impedance (Zo) for parallel and co-axial cables.**	**4 Marks**
	Ans:	**characteristic impedance for parallel cable**  $$Z_0 = \frac{138}{\sqrt{k}} \log \frac{d_1}{d_2}$$ *Where,* Z_0 = Characteristic impedance of line d_1 = Inside diameter of outer conductor d_2 = Outside diameter of inner conductor k = Relative permittivity of insulation between conductors **characteristic impedance for co-axial cable**  FIGURE I $Z_0 = (138/\sqrt{E}) \times \log_{10}(D/d)$ **Zo =Characteristic impedance** **D=Diameter of outer conductor** **d= Diameter of inner conductor** **E=Dielectric constant**	**2 marks Each**

e) Distinguish between resonant and non-resonant antennas. **4 Marks**

Ans: **1 mark each point**

Parameter	**Resonant antenna**	**Non resonant antenna**
i) Definition	It is transmission Line of length equal to multiples of λ/2 and open at both and.	It is transmission line whose length is not a multiple of λ/2
ii) Reflection Pattern	Standing wave present	Standing wave not present
iii) Radiation Pattern		
iv) Applications	i) Portable receiver ii) Direction finding equipment	i) TV broadcasting ii) wave propagation

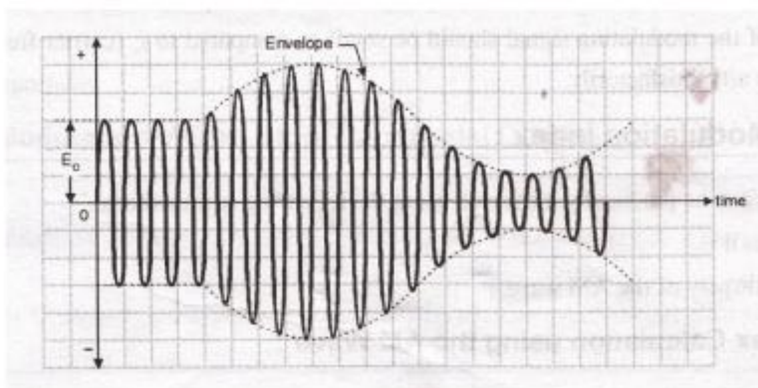
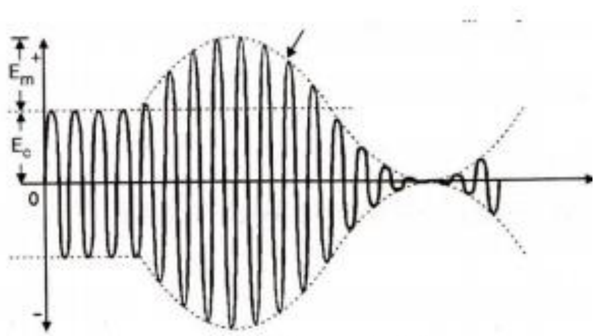
f) A FM signal is represented by the voltage equation - **4 Marks**
U_{FM} = 10 sin (6 x 10^6 ± 5 sin 1250 t)
Calculate
(i) Fe
(ii) Fm
(iii) δ
(iv) m_f

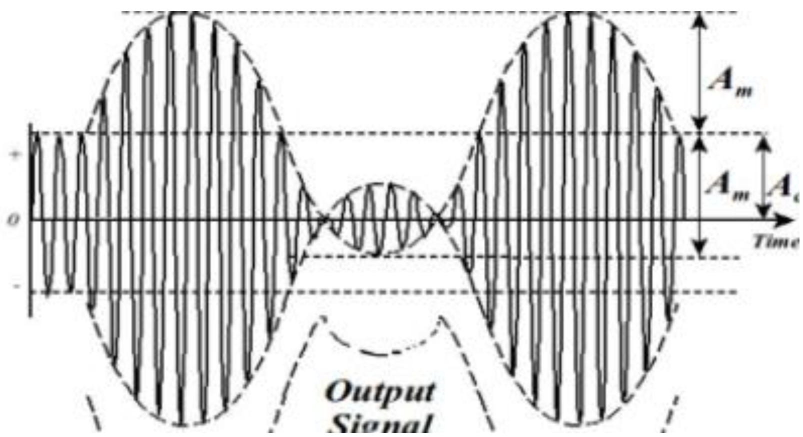
Ans: **Given equation:** **1mark each for correct answer**
U_{FM} = 10 sin (6 x 10^6 ± 5 sin 1250 t)

Now consider equation,

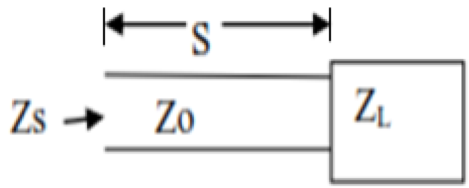
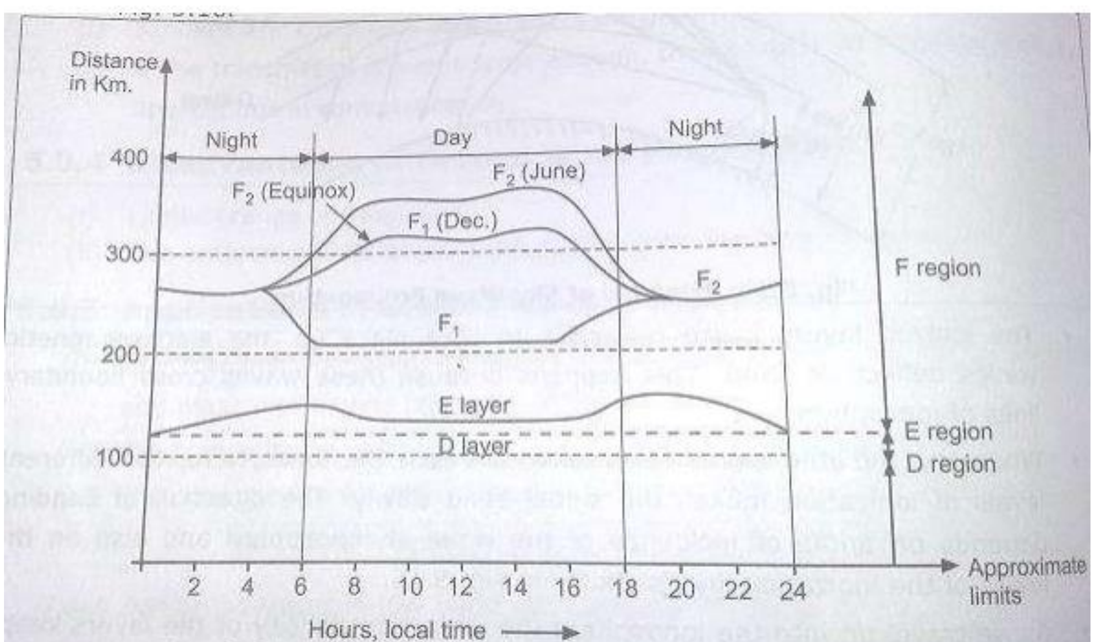
EFM = A sin (ωct +mf sin ωm t)
Compare this equation with the given equation mf = 5
1. Carrier frequency:ωc =6 x 10^6 rad/sec
2πfc =6 x 10^6
fc = 6 x 10^6 / 2π
=0.955MHz
fc = 0.955 MHz

2. Modulating frequency: ωm = 1250 rad/sec
2 π fm = 1250
fm = 1250/2π
=199 Hz

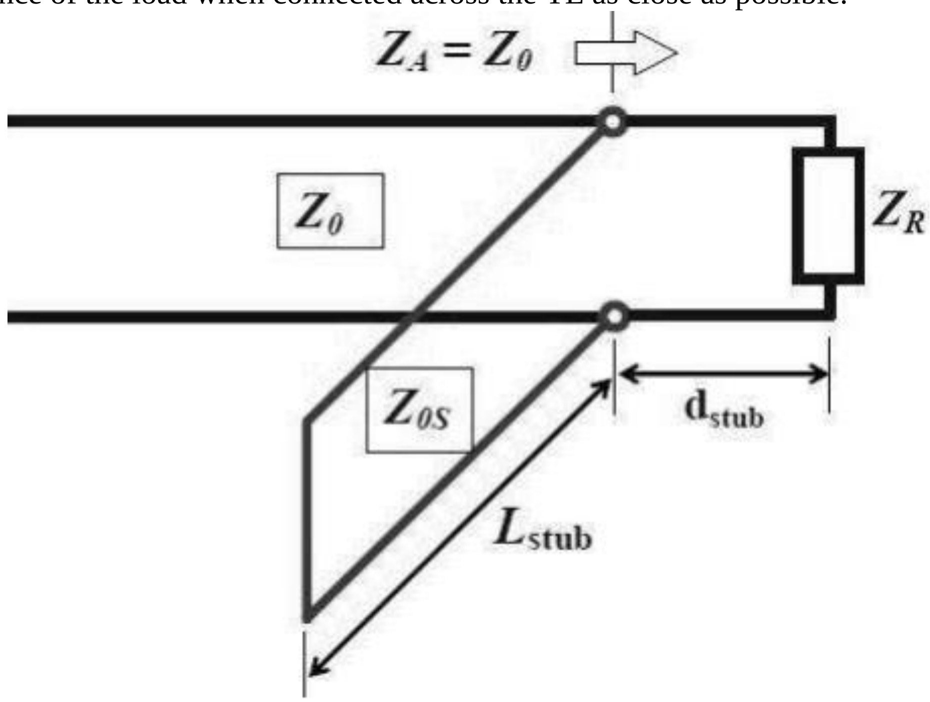
		3. Maximum deviation: mf = δ/ fm δ = mf x fm = 5 x ωm / 2 π = 5 x 1250/2 π = 995 Hz δ = 995 Hz **4.** Modulating index: mf = 5	
Q. 4		**Attempt any FOUR of the following:**	**16 Marks**
	a)	**Explain effect of 'm' on AM with neat waveforms.**	**4 Marks**
	Ans:	**i)m< 1** If m < 1 or if the percentage of modulation is less than 100% the this type of modulation is known as under modulation • The amplitude of modulating signal less than carrier amplitude, no distortion will occur.  **ii) m = 1** If m = 1 or percentage of modulation is 100 this type modulation is 100% modulation The ideal condition for AM is m =1, since this will produce the greatest output at the receiver with no distortion  	**Effect – 2.5 marks , Waveform- 1.5 marks**

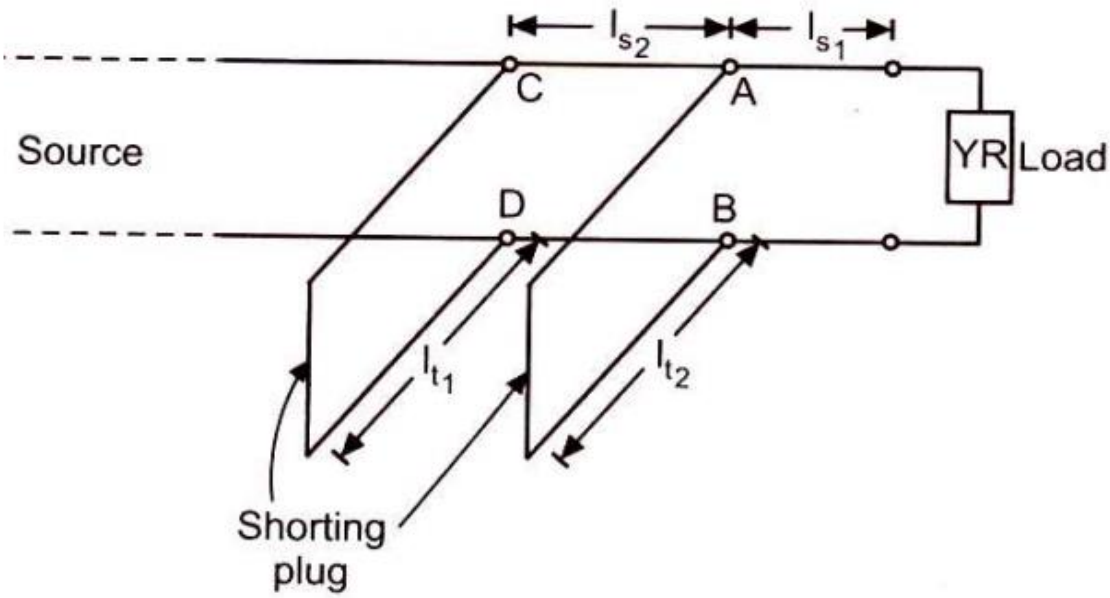
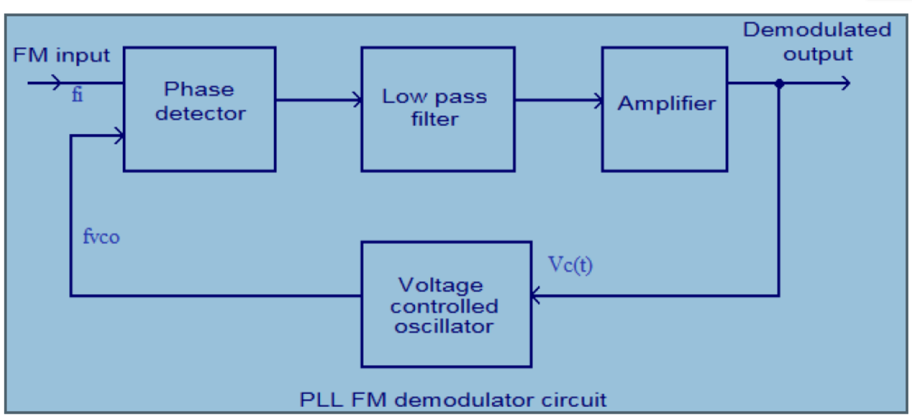
		iii)m>1 If m > 1 or if the percentage of modulation is greater than 100% the this type of modulation is known as over modulation the modulating signal being of greater amplitude part of its information is lost in the process of modulation which is undesirable.  	
	b)	**Derive the expression of total power transmitted Pt in terms of PC and m_a .**	**4 Marks**
	Ans:	**i) The Total power in AM (Pt) :** Pt = (Carrier power) + (Power in USB) + (Power in LSB) $Pt = P_C + P_{USB} + P_{LSB}$ $\therefore \quad Pt = \frac{Er^2carr}{R} + \frac{Er^2USB}{R} + \frac{Er^2LSB}{R}$ **(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. Dissipated.	**1 mark for each step**

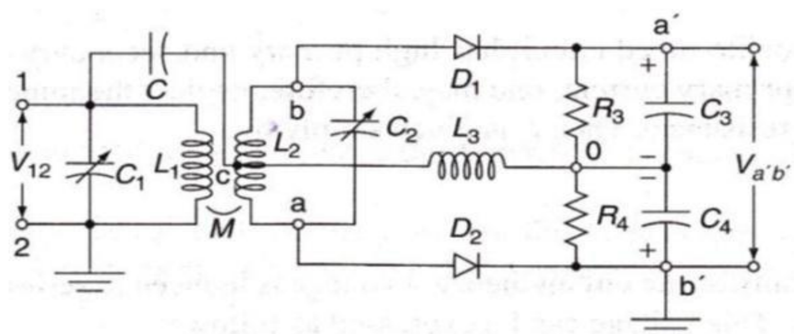
		ii) Carrier power (Pc): $$Pc = \frac{Er^2carr}{R}$$ $$= \frac{(E\sqrt{2})^2}{R}$$ $$\mathbf{Pc = \frac{E^2c}{2R}}$$ **(1 mark)** Where, Ec = Peak carrier amplitude **iii) Power in sidebands:** The power in USB and LSB is same as, $$P_{USB} = P_{LSB} = \frac{Er^2SB}{R}$$ $$\text{Peak amplitude of sideband} = \frac{mEc}{2}$$ $$\therefore \quad P_{USB} = P_{LSB} = \frac{(mEr2\sqrt{2})^2}{R}$$ $$= \frac{m^2E^2c}{8R}$$ $$\therefore \quad P_{USB} = P_{LSB} = \frac{m^2}{4} X \frac{E^2c}{2R}$$ $$\frac{E^2c}{2R} = Pc$$ $$\therefore \quad \mathbf{P_{USB} = P_{LSB} = \frac{m^2}{4} Pc}$$ **(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)**	
	c)	**How quarter wave transformer is used for impedance matching.**	**4 Marks**

	Ans:	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 Zo 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 turns ratio 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 ZL. 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	**Explanation 4 mark**
	d)	**Describe ionosphere with neat sketch.**	**4 Marks**
	Ans:	 Fig. 5.16: Ionospheric Layers and Their Regular Variations	**diagram-2 marks, explanation-2 marks**

		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	
	e)	**Dish antenna is parabolic in shape and has meshy structure. Give reasons.**	**4 Marks**
	Ans:	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. • 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 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.	**Correct explanation 2 marks each**

		• Due to atmospheric changes like rain, winds there is a possibility of change a 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)	**Define stub. Explain single and double stub in brief with neat sketch.**	**4 Marks**
	Ans:	**Stub**:- 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 **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.  • The most important feature of single stub matching is that the stub should be located as near to the load as possible. • The characteristic admittance of the stub so connected in shunt should be same as that of the main line. • 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. • 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. • So the total susceptance of the main line at that point is zero.	**Define:2 marks, Single stub:1 mark, Double stub:2 marks**

		• 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.	
Q.5		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**Draw and explain PLL as an FM demodulator.**	**4 Marks**
	Ans:	 	**Diagram:2 marks, Explanation :2 marks**

		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.	
	b)	**With the help of neat diagram, explain the working of phase discriminator.**	**4 Marks**
	Ans:	 **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. • If explanation is given in 3 cases fin = fc, fin > fc + Δf and fin<fc- Δf should be given marks	**Diagram :2 marks, Explanation :2 marks**

	c)	**The parameters of transmission line are R = 50 Ωkm, L = 1.6 mH/km, C = 0.2 μf/km, G = 2.25 μ℧/km. Calculate characteristics impedance and propagation constant.**	**4 Marks**
	Ans:	$R = 50\ \Omega/km$ $L = 1.6\ mH/km$ $C = 0.2\ \mu F/km$ $G = 2.25\ \mu ℧/km$ Assume $f = 800Hz$ $\omega = 2\pi f = 2\pi(800) = 5024\ rad/sec$ Series impedance $Z = R + j\omega L$ $= 50 + j(5024)(1.6\times10^{-3})$ $= 50 + j8.03$ $= 50.64 \angle 9°$ Shunt admittance $Y = G + j\omega C$ $= 2.25\times10^{-6} + j(5024)(0.2\times10^{-6})$ $2.25\times10^{-6} + j1.0048\times10^{-3}$ $0.00000225 + j\,0.0010048$ $= 1.0048\times10^{-3} \angle 89.87$ characteristic impedance $Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{50.64\angle 9}{1\times10^{-3}\angle 89.8}}$ $225 \angle -40.4$ Propagation constant $\gamma = \sqrt{Z \times Y}$ $= \sqrt{(50.64\angle 9)(1\times10^{-3}\angle 89.8)}$ $= 0.225 \angle 49.4$ **Note: Value of characteristics impedance & propagation constant will change with respect to assumed value of frequency.**	**characteristics impedance: 2 marks, Propagation constant: 2 marks.**

d) **The operating frequency of pyramidal hom antenna is 10 GHz. The hom antenna is 10 cm high and 12 cm wide. Calculate**
(i) Beam width of antenna
(ii) Power gain of antenna if k = 0.6

4 Marks

Ans:

Beam width:2 marks, Power gain: 2 marks.

) Given $f = 10\,GHz$

$L = 10\,cm$

$W = 12\,cm$

⇒ Power gain $= \frac{4\pi A}{\lambda^2}$

$A = 10 \times 12 = 120\,cm$
$= 1.2\,m$

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

Power gain $= \frac{4\pi(1.2)}{(0.03)^2} = 16755$

gain in dB $= 10 \log(16755)$
$= 42.24$

Beam Width $= \frac{K\lambda}{L} = \frac{0.6 \times 0.03}{0.1}$
$= 0.18°$

The Beam Width can be different in two directions.

Beam Width $= \frac{K\lambda}{w} = \frac{0.6*0.03}{0.12}$=0.150

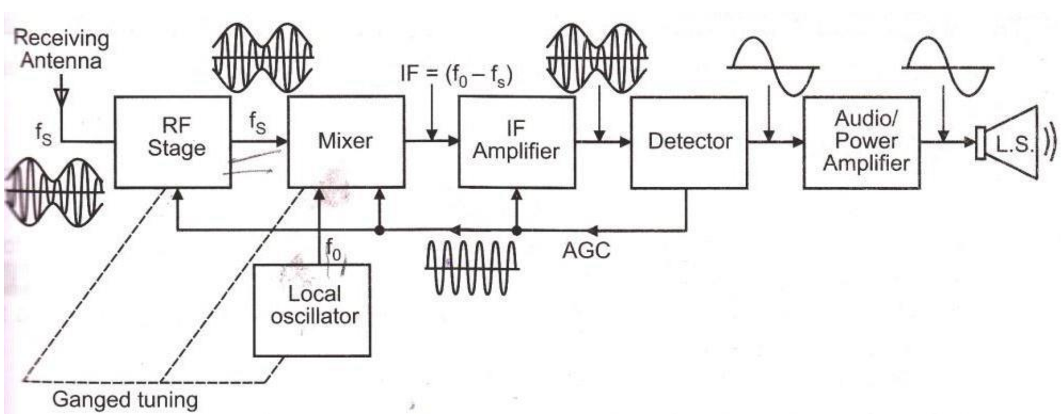
Marks can be awarded to any answer (0.18 or 0.15) for beam width.

e) **Explain with neat block diagram AM superheterodyne receiver.**

4 Marks

Ans:

block diagram:2 marks, Explanation : 2 marks.



Functions of each block:-

		Receiving antenna- AM receiver operates in the frequency range of 540 KHz to 1640 KHz. **RF stage-** Selects wanted signal and rejects all other signals and thus reduces the effect of noise. **Mixer-** Receives signal from RF stage Fs and the local oscillator Fo, and are mixed to produce intermediate frequency signal IF which is given as: IF=Fo-Fs **Ganged Tuning-** To maintain a constant difference between the local oscillator and RF signal frequency, gang capacitors are used. **IF stage-** The IF signal is amplified by the IF amplifier with enough gain. **Detector-**Amplified signal is detected by the detector to get original modulating signal. The detector also provides control signals to control the gain of IF and RF stage called as AGC. **AGC-** Automatic gain control controls the gain of RF and IF amplifiers to maintain a constant output level at the speaker even though the signal strength at the antenna varies.	
	f)	**Derive relation between reflection coefficient (k) and VSWR (s).**	**4 Marks**
	Ans:	$V\ max = \lvert V_i\rvert + \lvert V_r\rvert$ $V\ min = \lvert V_i\rvert - \lvert V_r\rvert$ Where- V_i = r.m.s. value of incident voltage V_r = r.m.s. value of reflected voltage By definition: $VSWR = \left\lvert\frac{V_{max}}{V_{min}}\right\rvert = \frac{\lvert V_i\rvert + \lvert V_r\rvert}{\lvert V_i\rvert - \lvert V_r\rvert} = \frac{V_i\left(1+\frac{V_r}{V_i}\right)}{V_i\left(1-\frac{V_r}{V_i}\right)} = \frac{1+\lvert k\rvert}{1-\lvert k\rvert}$ Applying Componendo and Dividendo, $\frac{VSWR-1}{VSWR+1} = \frac{1+\lvert k\rvert-1-\lvert k\rvert}{1+\lvert k\rvert+1-\lvert k\rvert} = \frac{2\lvert k\rvert}{2} = \lvert k\rvert$ Therefore, $\lvert k\rvert = \frac{VSWR-1}{VSWR+1} = \lvert\frac{S-1}{S+1}$ **OR**	**4 marks**

$$K = \frac{V_r}{V_i} \quad \text{--- (1)}$$

$$V_{max} = V_i + V_r \quad \text{--- (2)}$$

$$V_{min} = V_i - V_r \quad \text{--- (3)}$$

$$VSWR = \frac{V_{max}}{V_{min}} \quad \text{--- (4)}$$

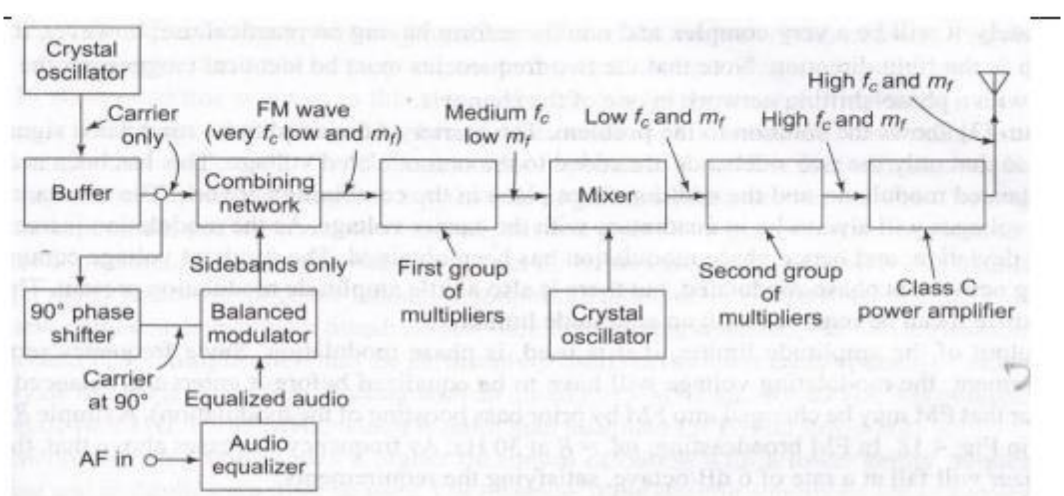
Put value of (2) & (3) in (4)

$$VSWR = \frac{V_i + V_r}{V_i - V_r}$$

$$= \frac{1 + \frac{V_r}{V_{in}}}{1 - \frac{V_r}{V_{in}}}$$

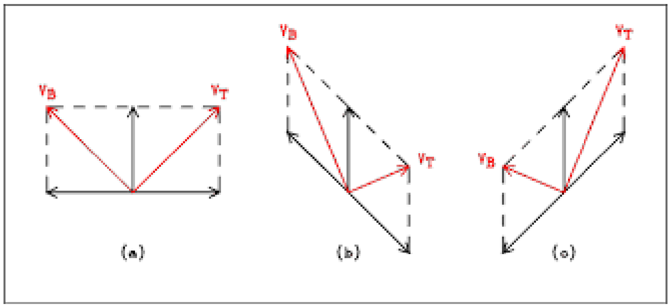
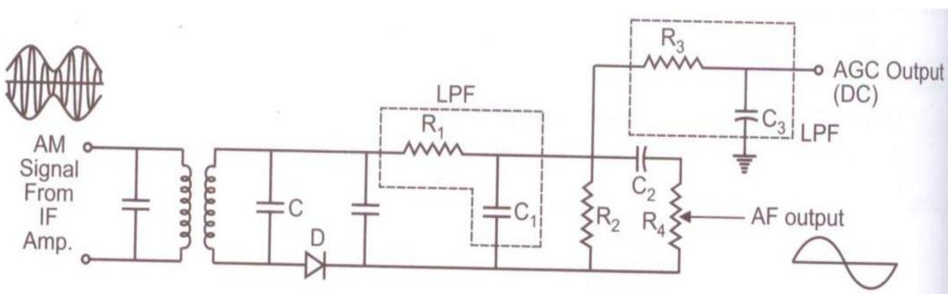
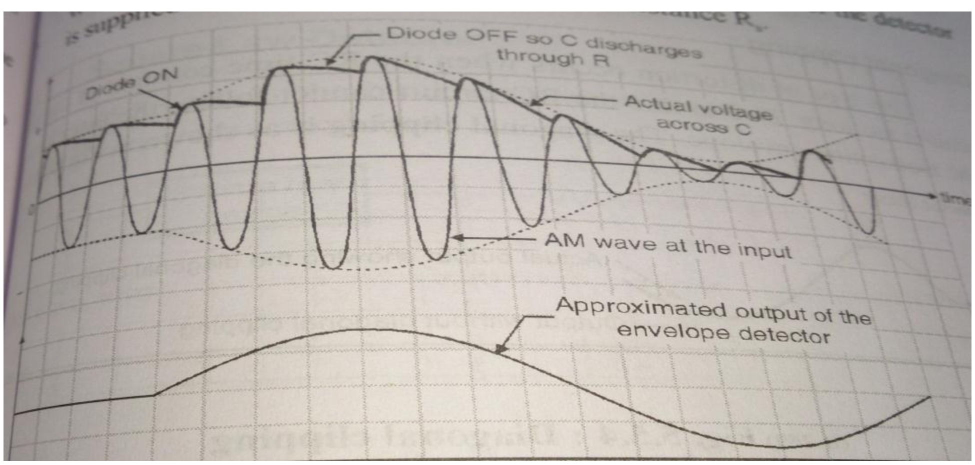
$$VSWR = \frac{1+K}{1-K}$$

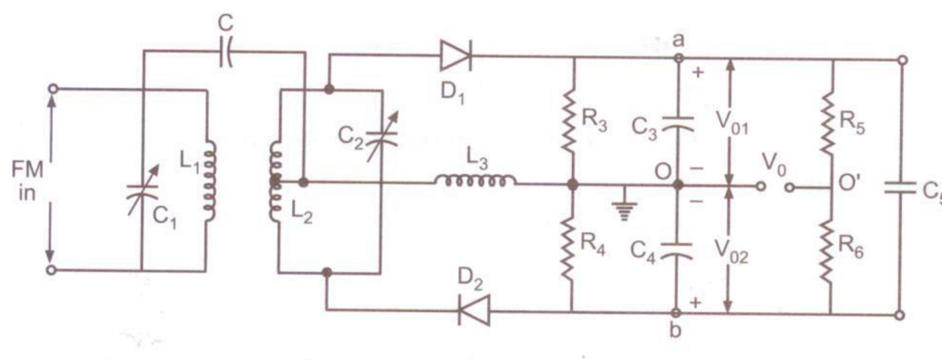
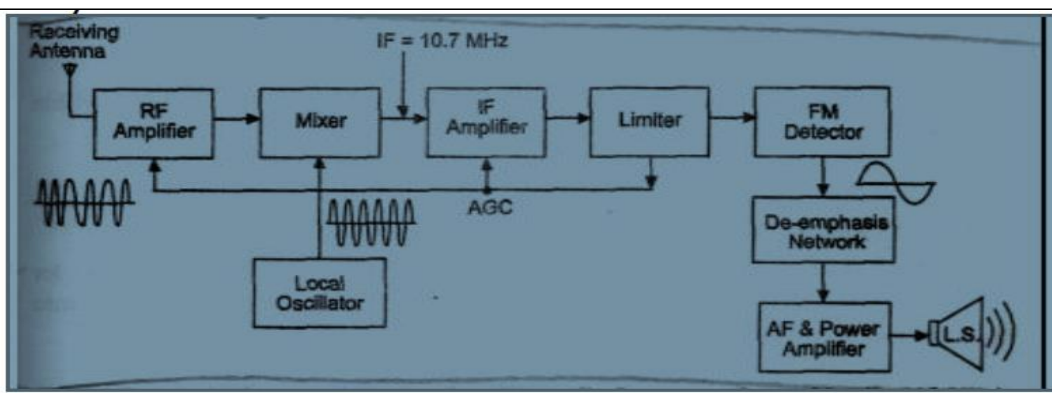
Q.6		Attempt any **<u>FOUR</u>** of the following:	16 Marks
	a)	**Explain with block diagram of Armstrong method of FM generation.**	**4 Marks**
	Ans:		**block diagram:2 marks, Explanation: 2 marks**



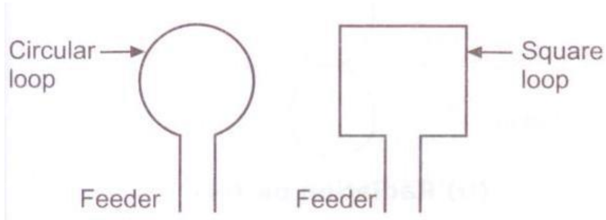
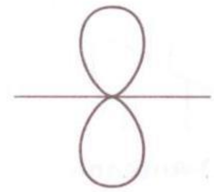
Explanation:-

- The crystal oscillator generates the carrier at low frequency typically at 1 MHz this is applied to the combining network and a 90o phase shifter.
- The modulating signal is passed through an audio equalizer to boost the low modulating frequencies for the reason discussed earlier. The modulating signal is than applied to a balanced modulator.
- The balanced modulator produces two sidebands such that their resultant is 90o phase shifted with respect to the un-modulated carrier
- The un-modulated carrier and 90o shifted sidebands are added in the combining network.

		• As discussed earlier, at the output of the combining network we get FM wave. This FM wave has a low carrier frequency fc and low value of the modulation index mf. • The carrier frequency and the modulation index are then raised by passing the FM wave through the first group of multipliers. The carrier frequency is then raised by using a mixer and then fc and mf both are raised to the required high values using the second group of multipliers. The effect of multiplication and mixing is as discussed earlier. • The FM signal with high fc and high mf is then passed through a class C power amplifier to raise the power level of the FM signal. **Phasor Diagram:-** 	
	b)	**Draw a practical AM diode detector circuit. Sketch i/p and olp waveforms.**	**4 Marks**
	Ans:	 	**Diagram:2 marks, Waveforms: 2 marks**

	c)	**Explain with a neat diagram of ratio detector. Why limiter stage is not used before ratio detector.**	**4 Marks**
	Ans:	 With diode D_2 reversed , O is positive with respect to b, so that V_{ab} is a sum voltage rather than the difference it was in the discriminator it is now possible to connect a large capacitor between a an b to keep this voltage constant . Once C_5 is connected V_{ab} is longer the output voltage thus the output voltage is now taken between O and O' $V_o = V_{b'o'} - V_{b'o} = \frac{V_{a'b'}}{2} - V_{b'o} = \frac{V_{a'o} + V_{b'o}}{2} - V_{b'o}$ $= \frac{V_{a'o} - V_{b'o}}{2}$ The above equation shows that the ratio dector output voltage is equal to half the difference between the output voltage from the individual diode. It behaves identically to the discriminator for input frequency changes. The ratio detector itself consists of limiter stage due to large capacitor C5 .Hence, limiter stage is not used in ratio detector**.**	**Diagram:2 marks, Explanation: 1mark, Why limiter:1 mark**
	d)	**Describe the block diagram of FM superhetrodyne receiver**	**4 Marks**
	Ans:	 **RF amplifier:-**	**Diagram 2 marks , Explanation 2 marks**

		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 functions of mixer and local oscillator in radio receiver**	**4 Marks**
	Ans:	**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. (practical value of IF is 10.7MHz) for FM and 455KH$_z$ for FM **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 then mixed with incoming frequency to give intermediate frequency.	**Mixer:2 marks, local oscillator:2marks**
	f)	**Explain loop antenna with neat sketch. Draw radiation pattern. State its advantages and applications.**	**4 Marks**
	Ans:	**Loop antenna:-**The single turn coil carrying RF current through it having length less than the wavelength.	**Definition:1 mark,**

		  **Advantages:-** 1. highly directive 2. Small size **Applications:-** 1. For direction finding 2. In portable receivers 3. In navigation	**Radiation pattern:1 mark, Advantages: 1mark, Application: 1 mark**