



GOVT. POLYTECHNIC BALASORE

[LECTURE NOTES]

**WAVE PROPAGATION & BROADBAND COMMUNICATION
ENGINEERING
[TH 4]**

**DIPLOMA
IN
5TH SEMESTER, E&TC ENGINEERING**

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ENGINEERING**

Fundamental of Electromagnetic Waves -

The electromagnetic waves are energy of propagation through free space at the velocity of light.

Velocity of light $V_c = 3 \times 10^8 \text{ m/s}$ ✓

The electromagnetic is the combination of two waves.

(i) Electric field (V_x)

(ii) Magnetic field (H_y)

The energy reactions appreciate the electromagnetic wave and electro-static radiation pattern in free space.

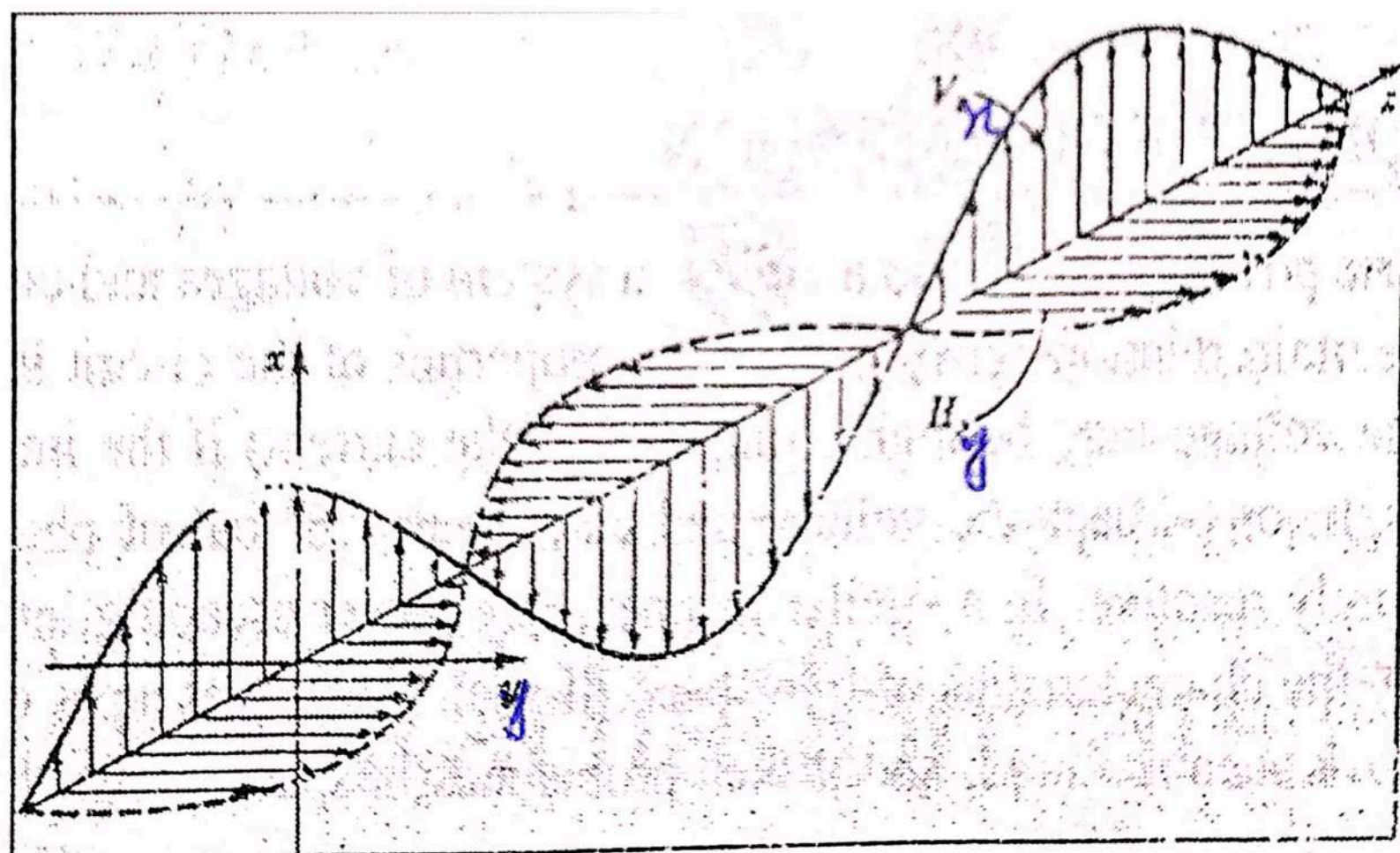
The propagation is the outward travels of waves on a pond after a stone has been thrown in it. It is the biggest difference in the propagation where as the water waves are longitudinal electromagnetic waves are transverse.

In transverse electromagnetic waves the electric field, magnetic field and propagation are mutually perpendicular in electromagnetic waves.

Application

- (i) Communication purpose
- (ii) Wireless (iii) Cellular
- (iv) Mobile communication

It is also used all types of Radars.



The effects of Environments on EM wave.

When propagation near the earth which several factors did not exist in free space must be considered.

These waves will be reflected by the ground mountains and buildings. They will be refracted as they pass through layers of the atmosphere which have different degree of ionization.

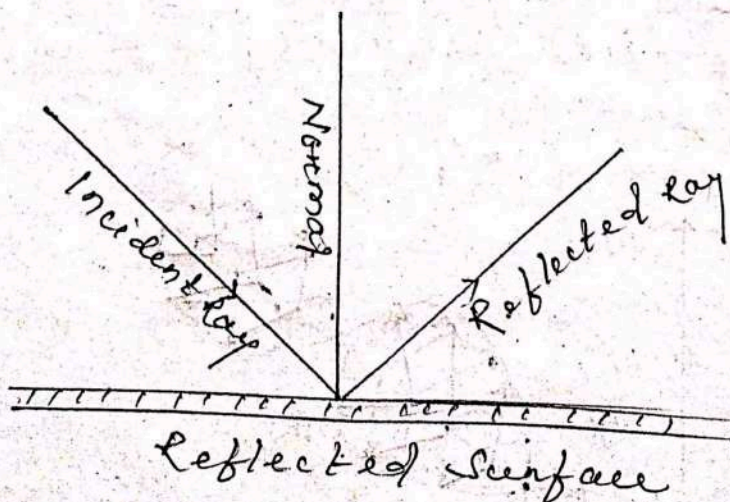
An EM wave may be deflected around tall massive objects etc.

The effects of environment mainly

- (i) Reflection
- (ii) Refraction
- (iii) Diffraction
- (iv) Absorption
- (v) Attenuation
- (vi) Interference.

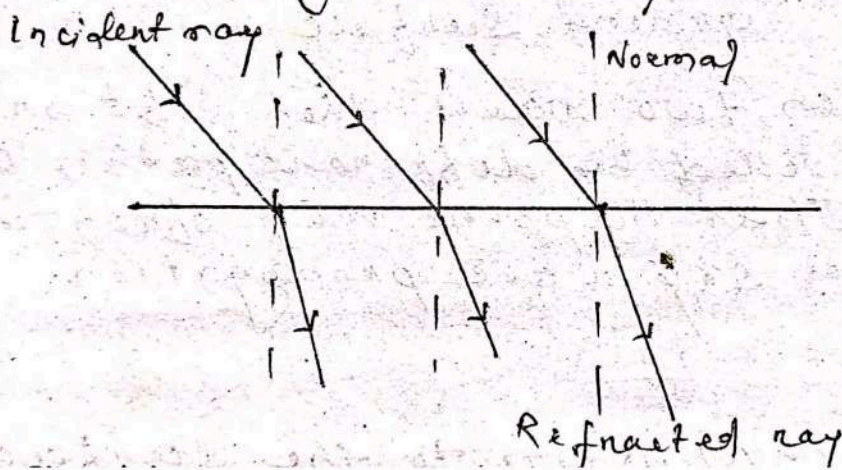
(i) Reflection -

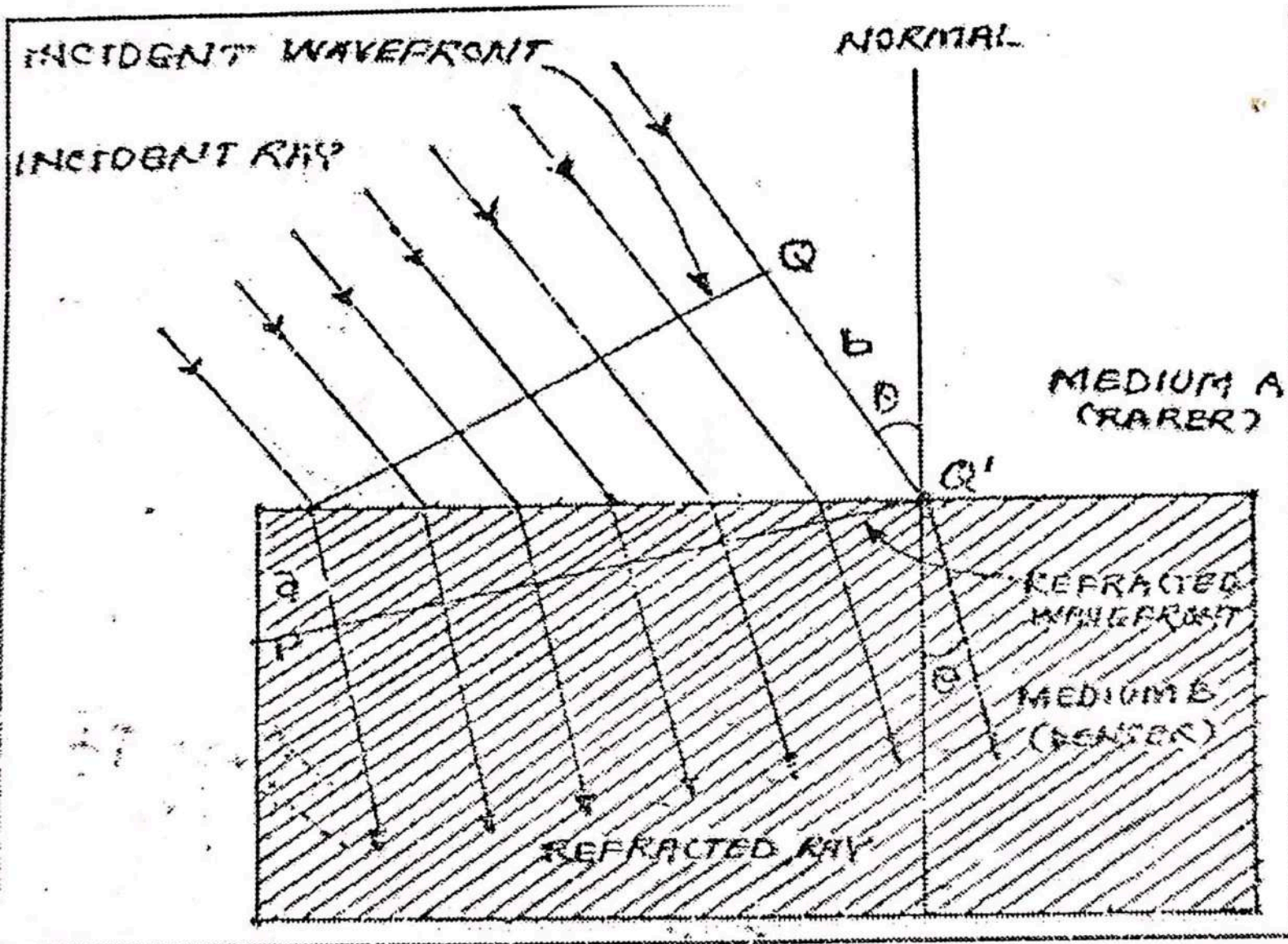
It is similar to reflection of light. In this case of EM wave through a connection media. As in case of light since the angle of incident is equal to the angle of reflection. The same principle obeyed by the EM wave



(iii) Refraction -

It takes place when EM wave crosses from one propagating medium to other having different intensity. It makes the wavefront to require a new direction in the second medium which change velocity.

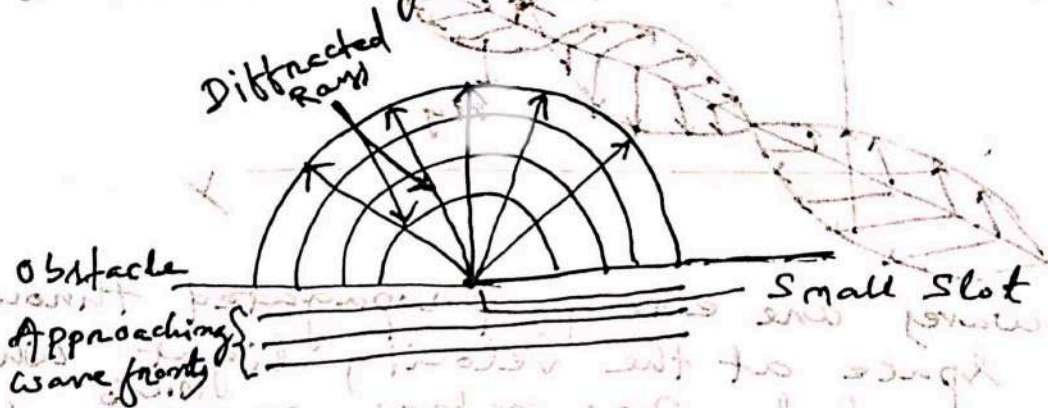




Diffraction

It is the behaviour of EM waves when effected by the presence of small slots in conducting medium on sharp

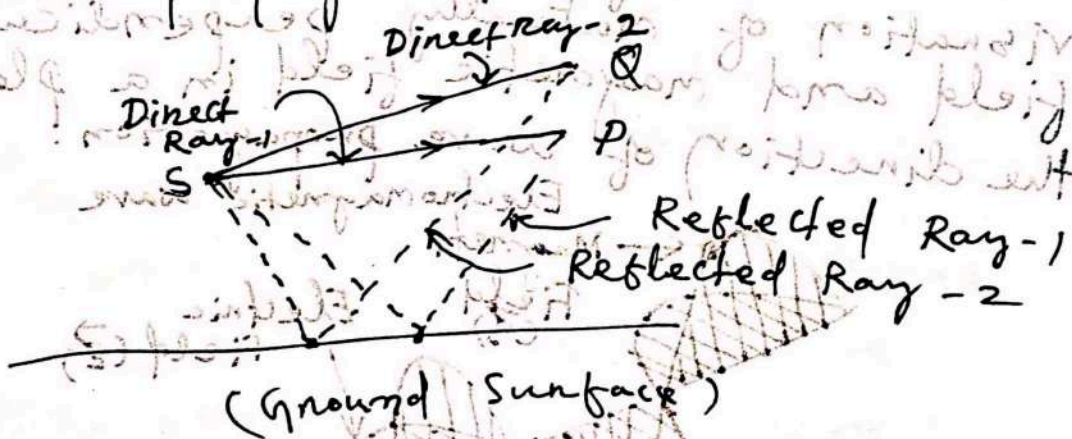
It is yet another property shared with optics and concerns itself with the behaviour of EM wave as affected by the presence of small slots in a conducting plane on sharp edges of obstacles.



Interference

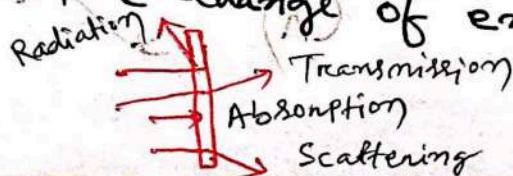
when two waves that left one source and traveled by different paths arrive at a point.

This happens very often in high frequency. Sky wave propagation



Absorption

It takes place when EM waves to the surface it convert in to bit to an exchange of energy with the other surface.

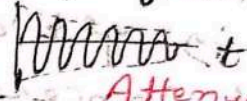
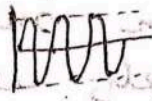


Attenuation

It occurs due to abstract during the propagation of electromagnetic wave.

Due to attenuation there is loss of signal.

original
Signal



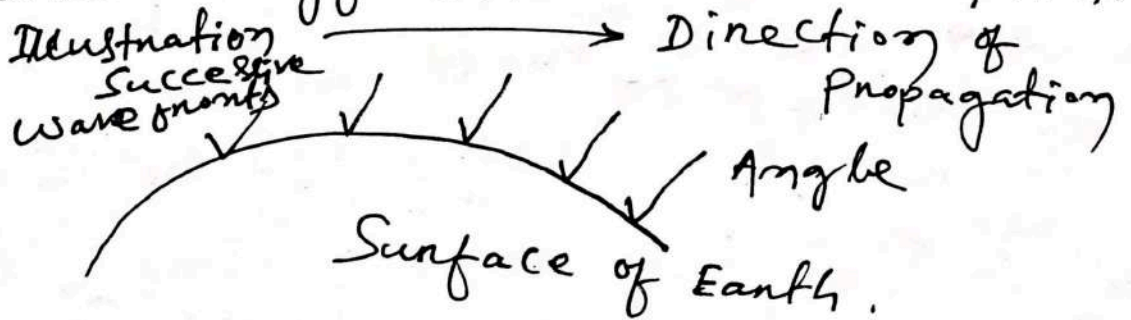
Attenuated Signal

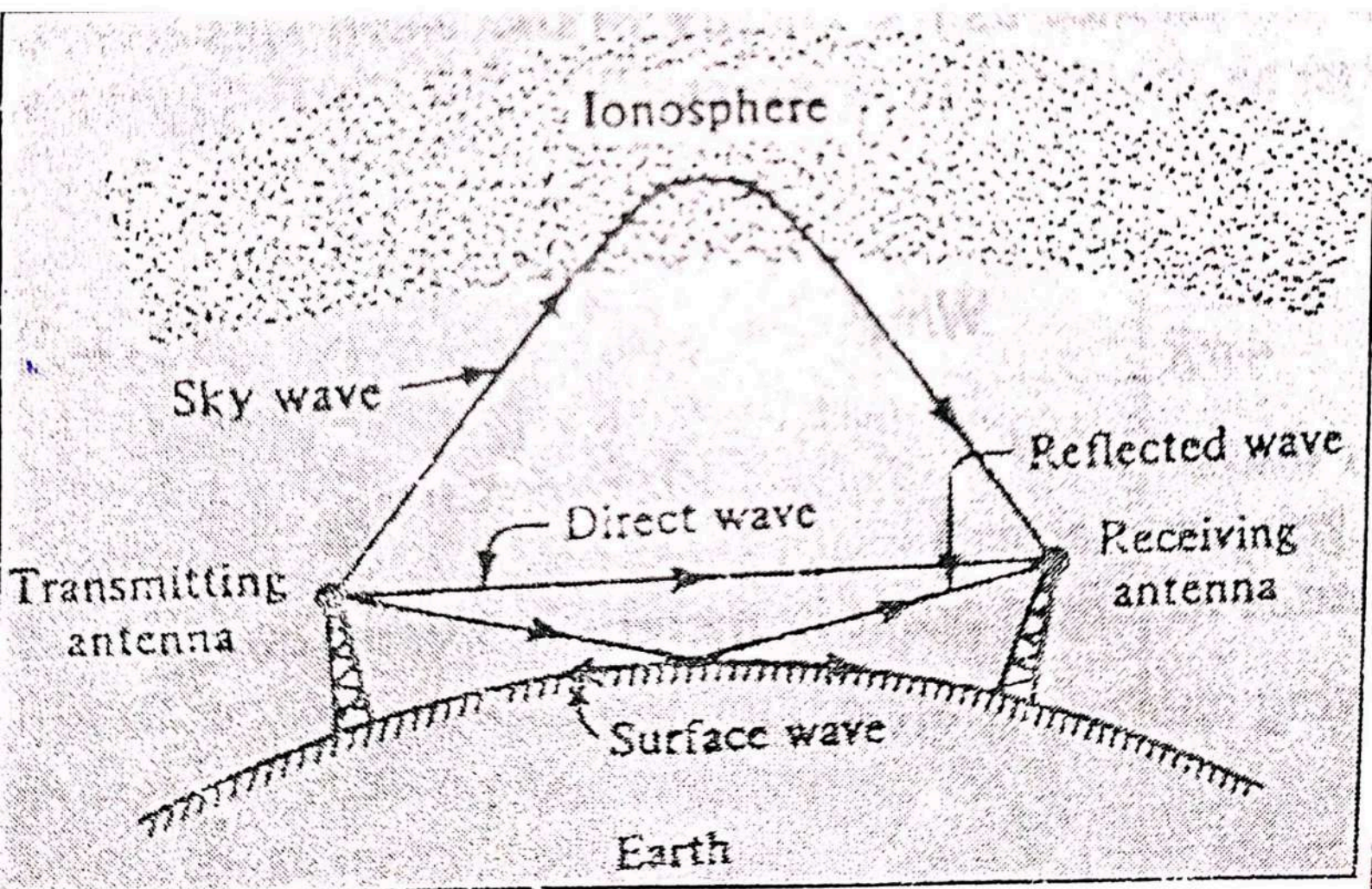
Modes of Propagation

Ground wave Propagation

Ground wave away progress along the surface of the earth which must be vertically polarized to prevent the short ckt of electric component.

In ground wave propagation current is induced in ground over it passes and some energy lost due to absorption.



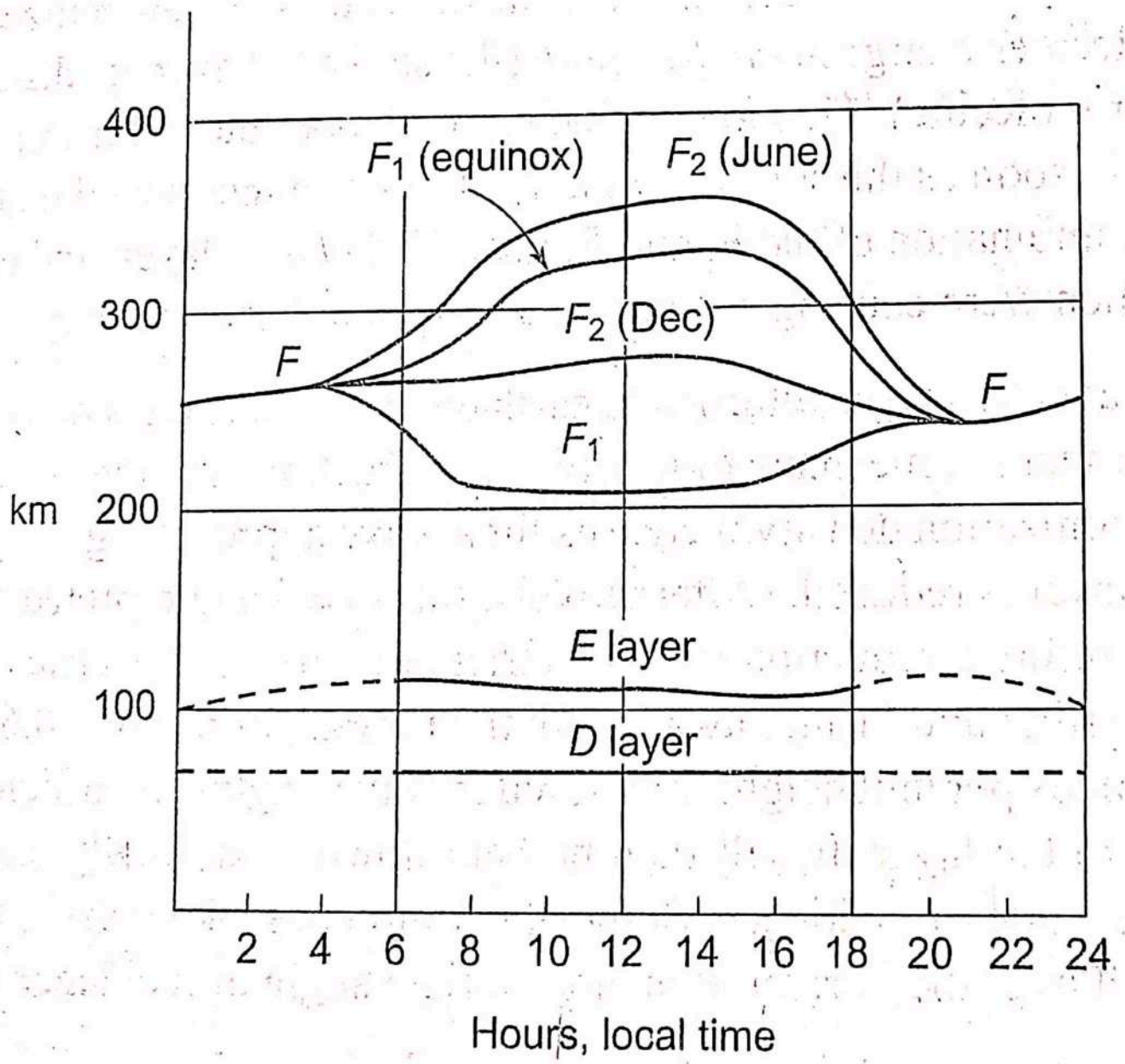


The propagation takes place in medium frequency range i.e. 0.3 Hz to 3 MHz.

It is used for broadcast lower frequency i.e. the medium wave, long wave and very long wave.

IONOSPHERE

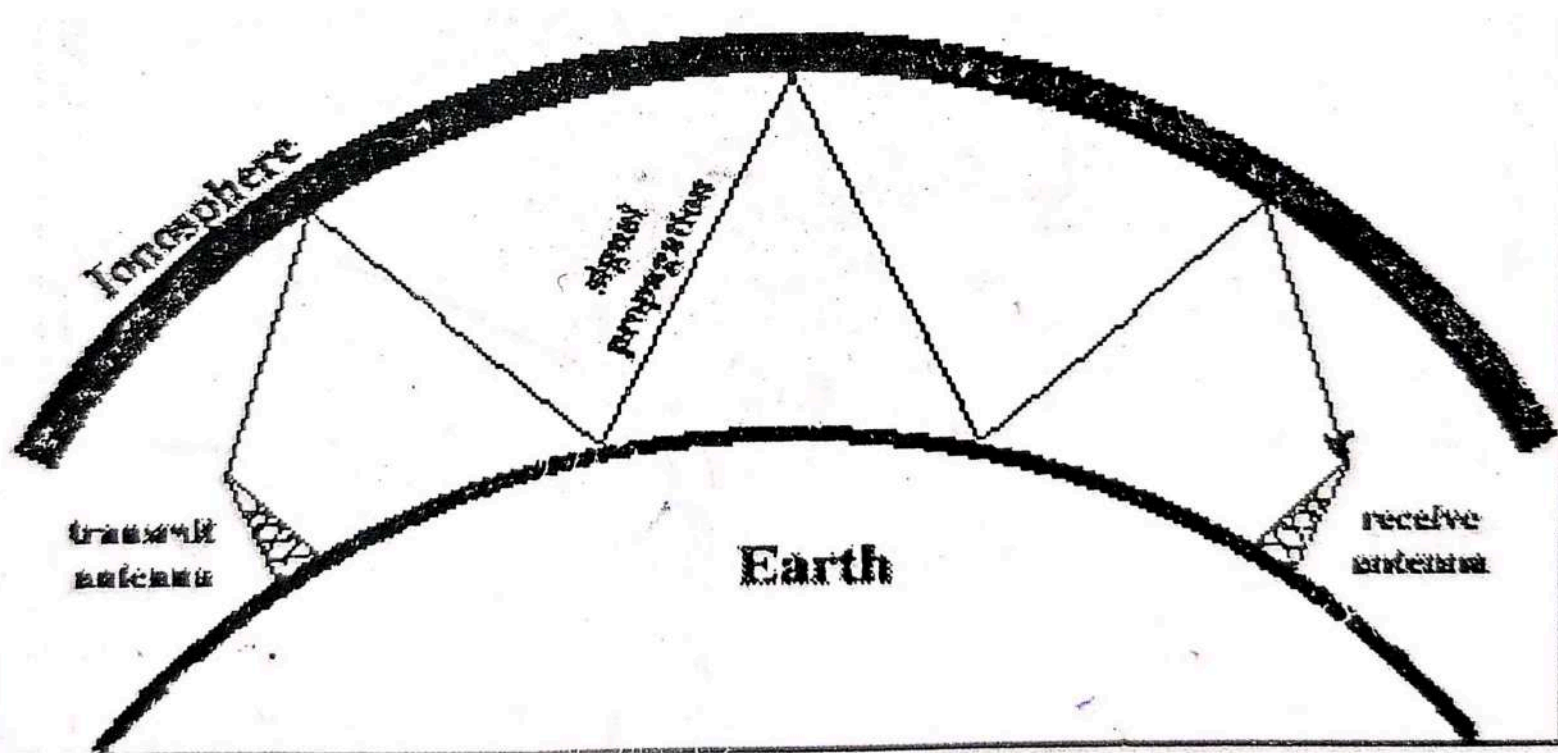
- Upper portion of atmosphere is called as Ionosphere.
- The Ionosphere absorbs large quantity of the radiate energy from the Sun and thus becoming heated and ionized.
- The most important ionising agents are Ultraviolet and α , β & γ radiation.
- The electromagnetic waves when returning to earth by one of the layers of the Ionosphere appear to be reflected.
- Different layers of the Ionosphere (F_2 -layer) are responsible for reflection of high frequency radio waves.



Sky Wave Propagation

At high freq. the earth atmosphere plays an important role for the propagation of radio wave or EM wave.

It is because of the atmosphere receives sufficient energy from the sun. So as to make its molecules to split into positive & negative ions & remain ionized for a long period of time in the form of sky wave.



The ionosphere as a reflecting surface and able to reflect back the EM wave i.e. frequency between 3 MHz to 30 MHz.

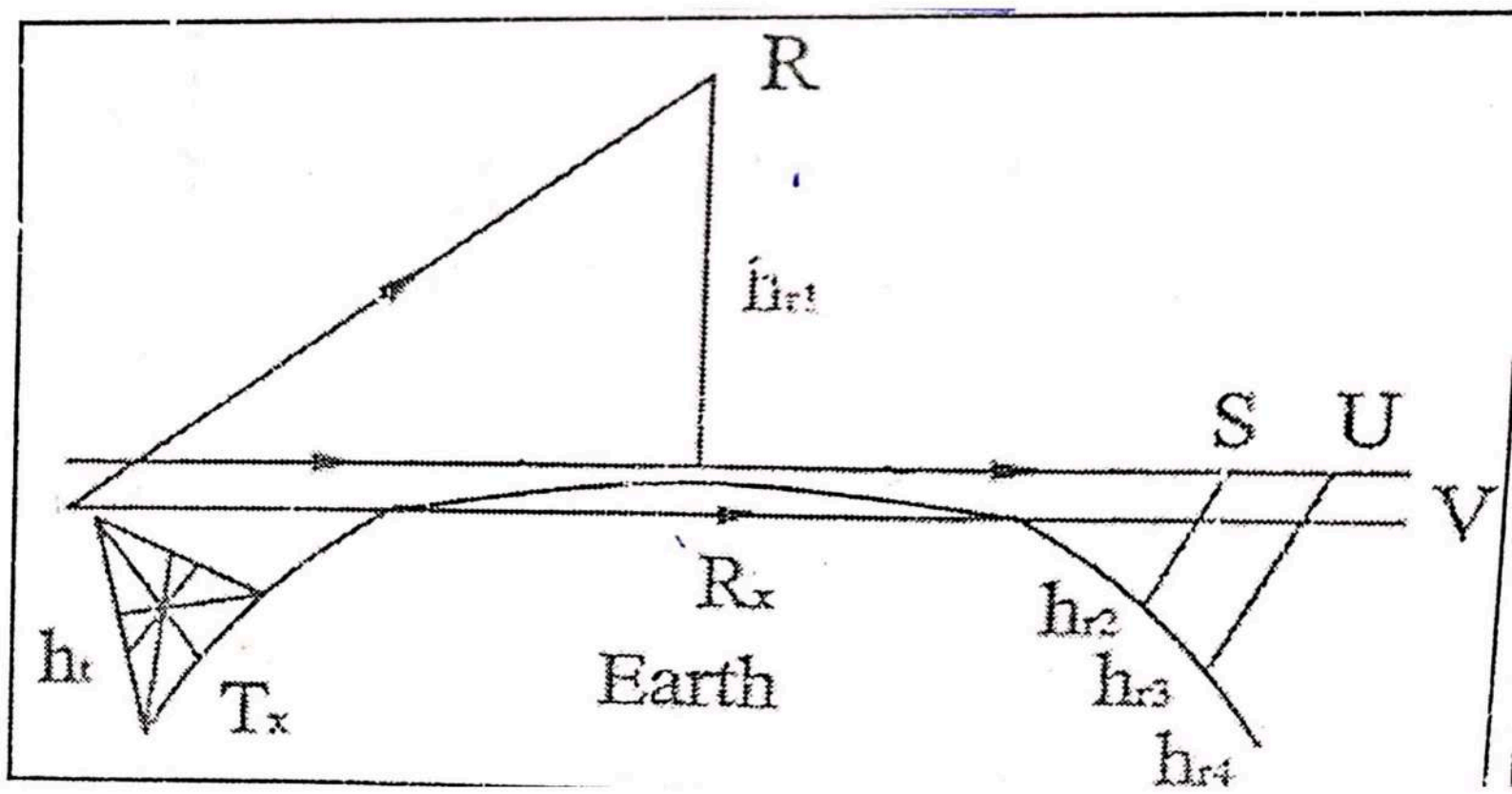
In a single reflection from the ionosphere the radiowave covers a distance not more than 4000 km.

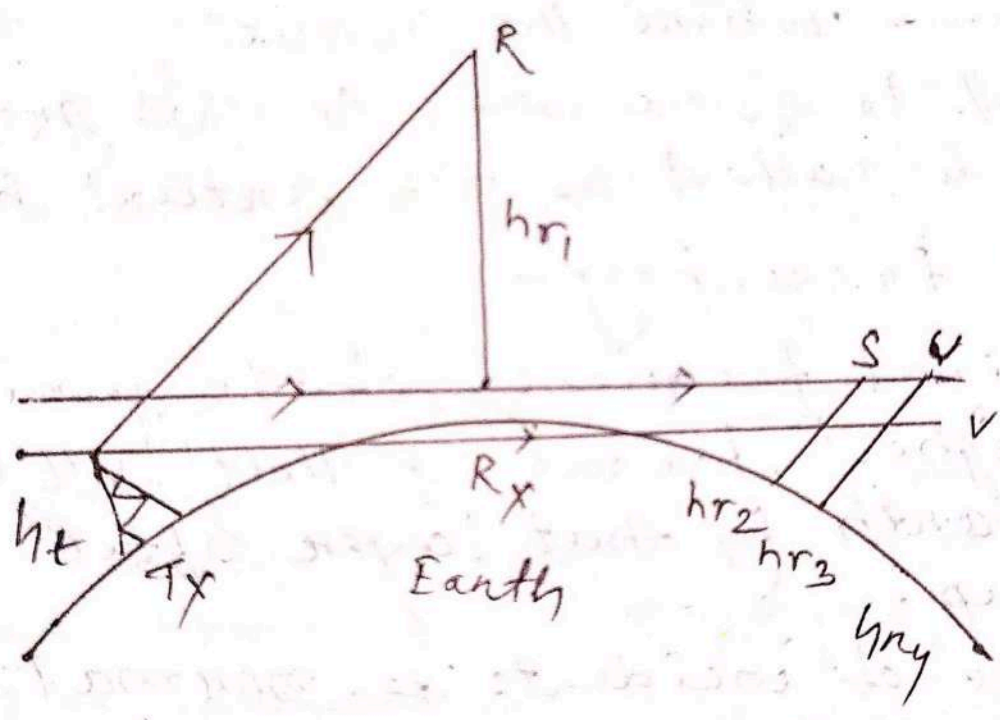
Space wave Propagation

This wave behaves with the simplicity they travel in (more or less) straight lines.

However since they depend on line of sight condition space waves are limited in their propagation by the curvature of the earth, except in very unusual circumstances.

Thus they are propagate very much like EM wave in free space. Such a mode of behaviour is forced on them because their wavelength are too short for reflected from the ionosphere and because the ground wave disappears very close to the transmitter owing to tilt.





It is that happens a frequency above 30 MHz. Due to frequency is high wave length is very narrow that results propagation of wave by straight path. At this frequency there is no reflection and settling will happen by ionosphere and troposphere.

This signal travel straight from transmitting antenna to receiving antenna.

Critical Frequency

The critical freq. of the given layer is the highest freq. that will be returning down to earth by that layer after beamed straight up.

The angle of incidence is normal as the name given to the maximum freq. is known as critical frequency and it is observed in F_2 -layer. i.e. The frequency range is 5 to 2 MHz.

Maximum useable Frequency

It is the ratio of critical frequency to the $\cos \theta$.

The range of MUF is 8 to 35 MHz.

$$\text{i.e. MUF} = \frac{\text{Critical freq.}}{\cos \theta} = f_c \sec \theta$$

Where,

θ = Angle of incident

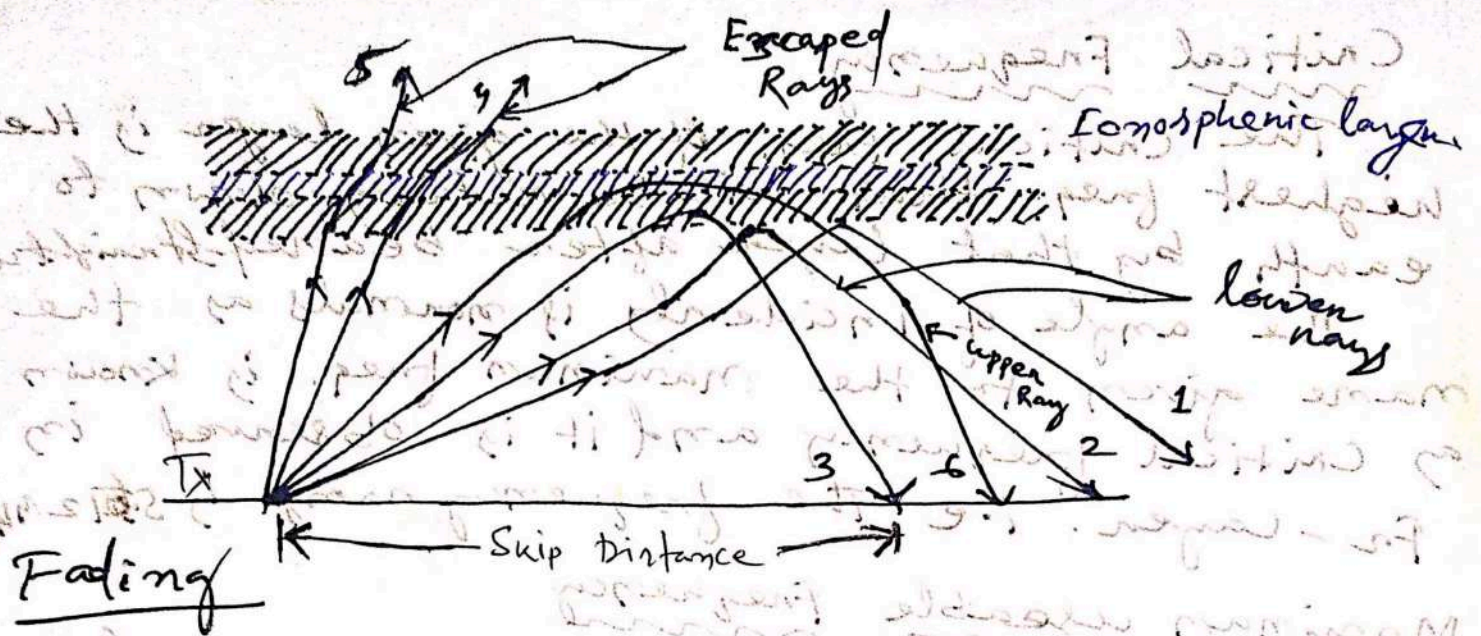
f_c = Critical frequency.

Skip Distance

It is the shortest distance from a transmitter and is measure along the surface of earth at which the sky wave returns to earth.

When the angle of incident is quit large then the sky wave returns to ground at a long distance from the transmitter.

At the skip distance only the normal or low ray only land destination.



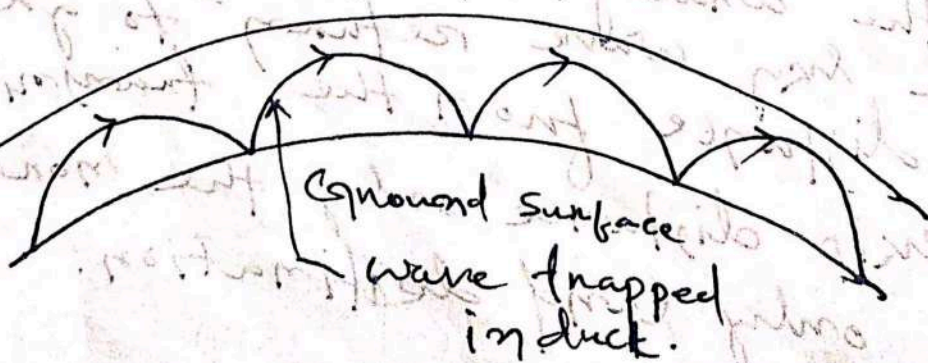
It is the "fluctuation in signal strength" that the receiver end which may be repeat on slow.

Frequency selective due to fading the interference occurs betⁿ two wave which left the same source but arrived at the same source but arrived at the destination in different path.

Fading can also occur because of interference betⁿ the low & upper range occur sky wave.

Duct Propagation

Top atmospheric duct



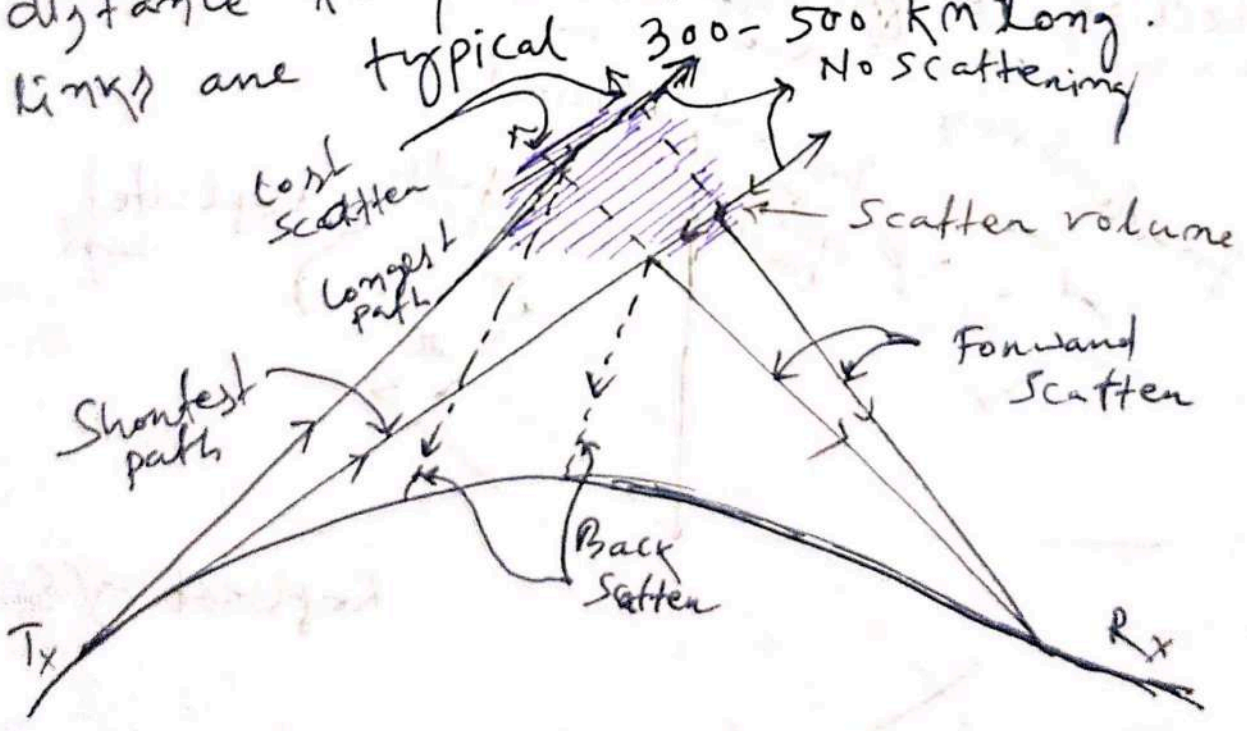
It is a mode of propagation usually obtained in the low layers of earth atmosphere where the waves are bent by atmospheric refraction.

Tropospheric Scatter Propagation

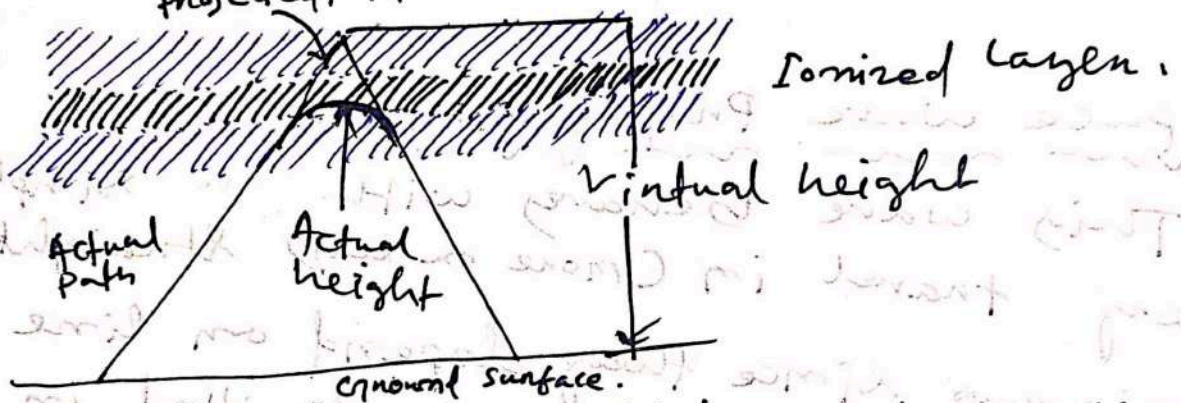
It is also known as Troposcatter, or forward scatter propagation, tropospheric scatter propagation is a means of beyond the horizon propagation for UHF signals.

It uses certain properties of the troposphere, the nearest portion of the atmosphere. (within about 15 km of the ground).

This propagation is used to provide long distance telephone & other commⁿ link. Path lengths are typical 300-500 km long.



Actual height & virtual height



Virtual Height :- The distance from the ground surface to a point, where the wave get reflected and send to come back to the ground surface is called as virtual height.

Actual Height → The distance from the ground surface to a point below the ionized layer where it is reflected back to the ground surface, is called as actual height.

WAVE PROPAGATION & ANTENNA

The space means the free space where there is no interference with the normal radiation & propagation of radio waves.

Thus, it has no magnetic or gravitational fields, no solid bodies & no ionized particles.

The radiation & propagation of radio waves cannot be seen.

Radiation is the process in which energy is emitted as particles or waves,

in which the energy is emitted by one body, transmitted through an intermediate medium (space) & observed by another body.

Propagation of waves

The waves travel in straight line with respect to the direction of the oscillation relative to the direction of the propagation we can distinguish between

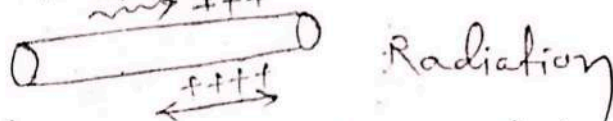
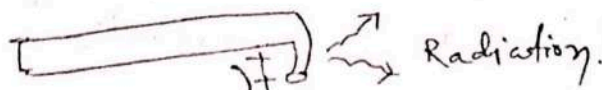
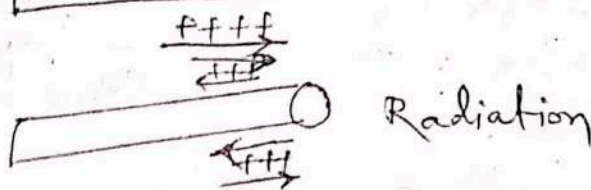
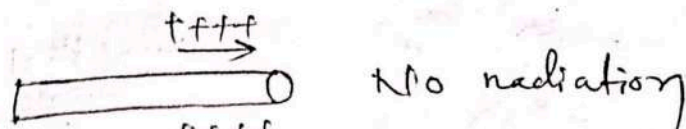
longitudinal wave and transverse wave. The radio wave from the Tx antenna may reach to the receiving antenna.

Radiation mechanism of antenna

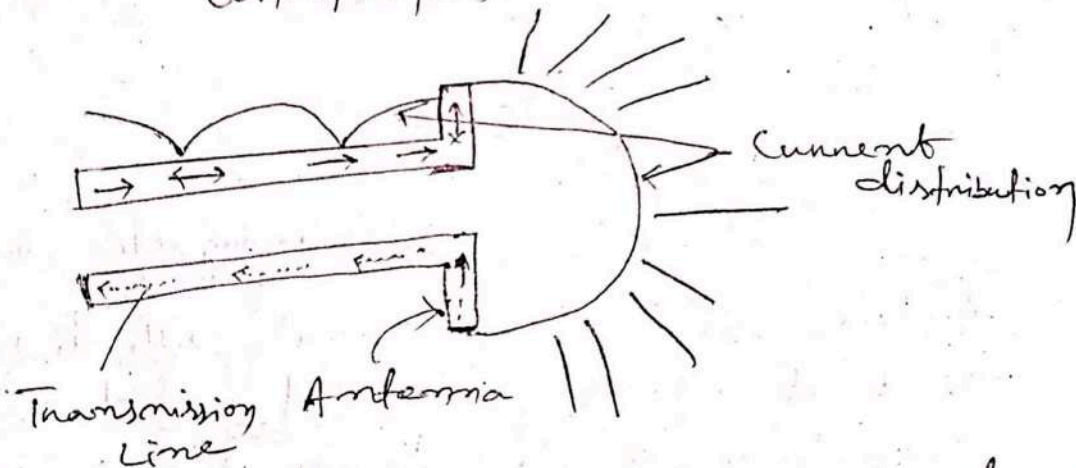
Antenna :- It is means for receiving radio waves or radiating radio waves.

The antenna is the transitional structure between free space and guided device.

(Co-axial line or Hollow pipe)



Condition for radiation.

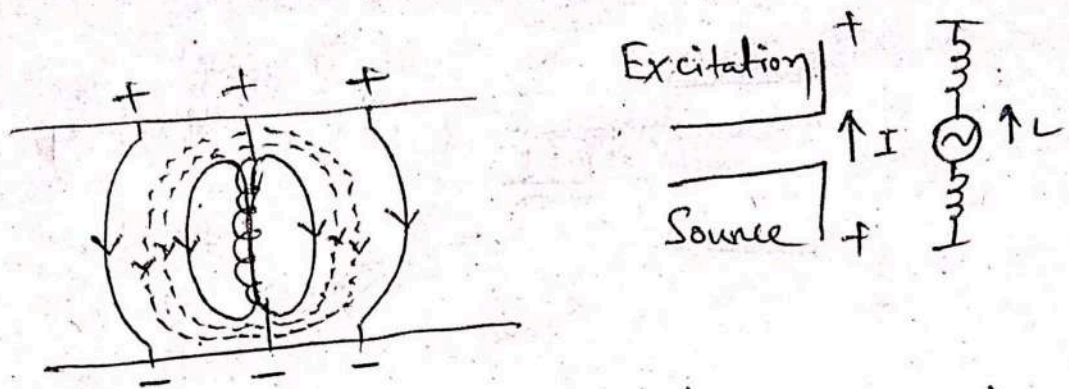


(Radiation mechanism of Antenna)

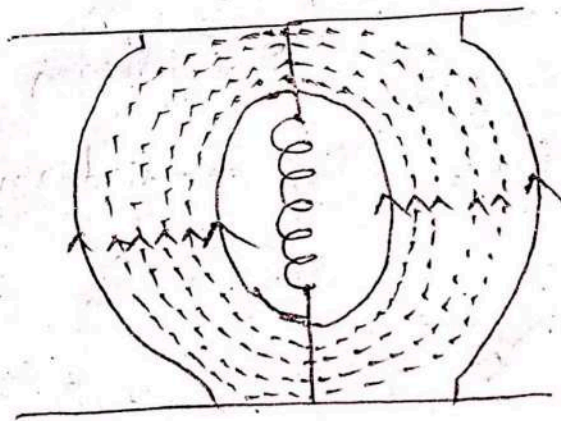
It is the change distribution / current distribution on the antenna that produces radiation.

When electric charges undergo acceleration or deceleration, electromagnetic radiation will be produced.

So, the motion of charges i.e. current, is the source of radiation.



(Release of electromagnetic energy)



(Release of electromagnetic energy)

Antenna represents circuits with distributed constant but the lumped inductance and capacitance of an antenna are in form of oscillatory circuit.

The circuit consists of a condenser whose plates are connected by a vertical wire which contains a certain amount of self inductance.

A radio frequency voltage is included at the centre of the circuit.

The cycle starts when condenser is charged to maximum potential difference. So the upper plate is positive.

At the moment of maximum potential difference the elements start flowing upwards constituting a current.

Due to electric inertia, the current continues to flow even after potential difference across the Condenser is reduced to zero.

This causes the Condenser to charge in opposite direction. It sets up electric field between the plates.

Radiation mechanism of an antenna-Maxwell equation :

Maxwell's Equations are a set of four vector-differential equations that govern all of electromagnetics (except at the quantum level, in which case we as antenna people don't care so much). They were first presented in a complete form by James Clerk Maxwell back in the 1800s. He didn't come up with them all on his own, but did add the displacement current term to Ampere's law which made them complete.

The four equations (written only in terms of \mathbf{E} and \mathbf{H} , the electric field and the magnetic field), are given below.

$$\nabla \cdot \mathbf{E} = \frac{\rho_v}{\epsilon} \quad (\text{Gauss' Law})$$

$$\nabla \cdot \mathbf{H} = 0 \quad (\text{Gauss' Law for Magnetism})$$

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \quad (\text{Faraday's Law})$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \epsilon \frac{\partial \mathbf{E}}{\partial t} \quad (\text{Ampere's Law})$$

In Gauss' law, ρ_v is the volume electric charge density, \mathbf{J} is the electric current density (in Amps/meter-squared), ϵ is the permittivity and μ is the permeability.

Defination

Antenna gain :- The power transmitted or received by the antenna to the power transmitted or received by a ideal antenna in a same direction.

$$\left[\text{Antenna gain} = \frac{\text{Power transmitted/received by the antenna}}{\text{Power transmitted/received by ideal antenna}} \right]$$

Directive gain :- The ratio of its radiation intensity in that direction to its mean/avg radiation intensity of antenna is known as directive gain (G_D)

$$\left[G_D = \frac{\text{Maximum radiation intensity}}{\text{average radiation intensity}} \right]$$

* (G_D = Directive Gain)

Directivity of an antenna

The ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions.

Effective Aperture (Area) of an antenna

It is a receiving cross section which measures of how effective an antenna is at receiving the power of electromagnetic radiation.

Polarization of an antenna

It is the direction in which the electric field of radio waves oscillates while propagating in a medium.

Input Impedance

The ratio of the voltage to current at a pair of terminals on the ratio of the appropriate components of the electric field to magnetic field at a point is known as input impedance.

Bandwidth :- Bandwidth of an antenna is the range of frequencies within which the performance of the antenna with respect to some characteristic conforms to a specific standard.

Radiation Resistance

The value of resistance that would dissipate the same amount of power as radiated as radio waves by the antenna with the antenna input current passing through it.

Beamwidth :- The angular separation between two identical points on opposite side of the pattern maximum is the beamwidth.

Radiation Pattern :- It refers to the directional dependence of the strength of the radio waves from the antenna or other source. It is also used to represent the emission or reception of wave front by the antenna, specifying its strength.

Efficiency :- The ratio of effective area of aperture to its actual area.

$$\text{Efficiency } (\eta) = \frac{\text{aperture area}}{\text{actual area}}$$

$$\text{or } \eta = \frac{A_e}{A}$$

η = Percentage of physical aperture area which actually receive radio 'RF' energy.

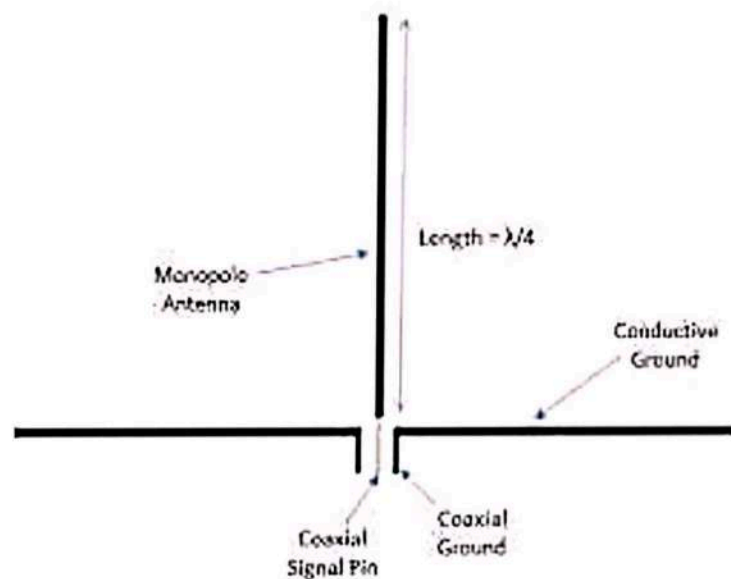
Types of Antenna

There are of following types:

1. Monopole
2. Dipole Antenna
3. Omnidirectional antenna.

1. Monopole Antenna :

- A **monopole antenna** is a class of radio antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a ground plane.



- The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane.
- One side of the antenna feedline is attached to the lower end of the monopole, and the other side is attached to the ground plane, which is often the Earth.
- This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna.
- The monopole is often used as a resonant antenna; the rod functions as an open resonator for radio waves, oscillating with standing waves of voltage and current along its length.

- Therefore the length of the antenna is determined by the wavelength of the radio waves it is used with.
- The most common form is the quarter-wave monopole, in which the antenna is approximately one quarter of the wavelength of the radio waves.
- However in broadcasting monopole antennas $5/8 = 0.625$ wavelength long are also popular, because at this length a monopole radiates a maximum amount of its power in horizontal directions.
- The monopole antenna was invented in 1895 by radio pioneer Guglielmo Marconi; for this reason it is sometimes called the Marconi antenna.
- Common types of monopole antenna are the whip, rubber ducky, helical, random wire, umbrella, inverted-L and T-antenna, inverted-F, mast radiator, and ground plane antennas.
- A monopole has an omnidirectional radiation pattern: it radiates with equal power in all azimuthal directions perpendicular to the antenna.
- However, the radiated power varies with elevation angle, with the radiation dropping off to zero at the zenith of the antenna axis.
- It radiates vertically polarized radio waves.

2. Dipole Antenna :

Half Wave Dipole :

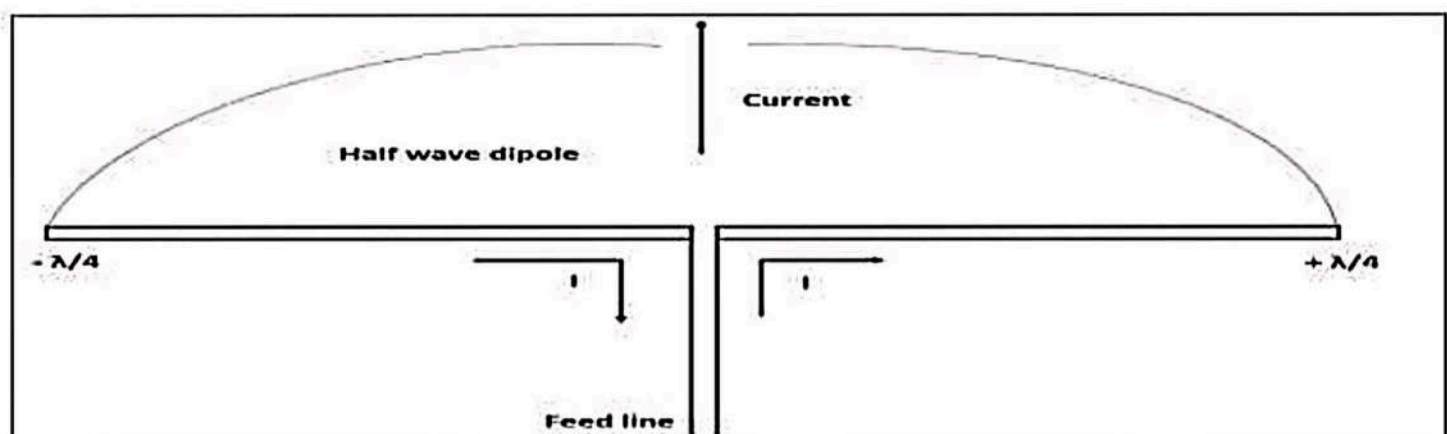
- A folded dipole is an antenna, with two conductors connected on both sides, and folded to form a cylindrical closed shape, to which feed is given at the center. The length of the dipole is half of the wavelength. Hence, it is called as **half wave folded dipole antenna**.

Frequency range

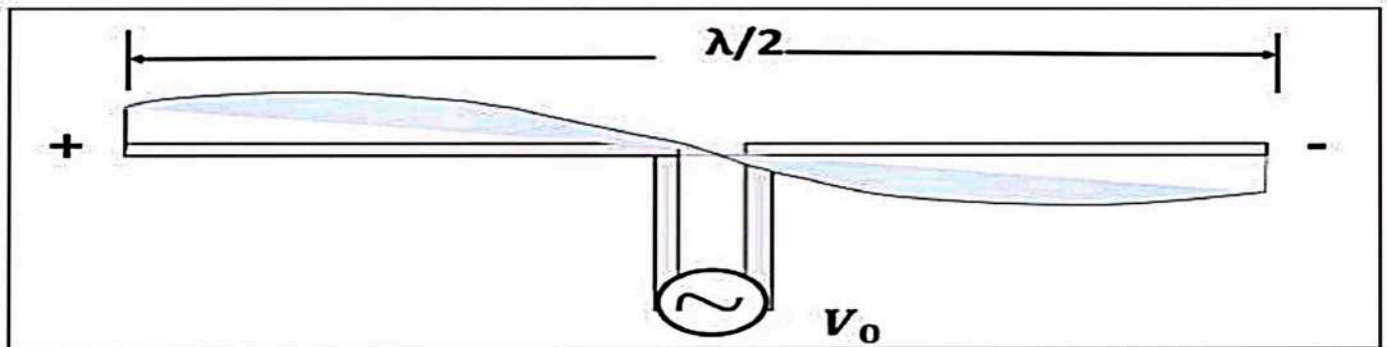
- The range of frequency in which half wave folded dipole operates is around 3KHz to 300GHz. This is mostly used in television receivers.

Construction & Working of Half-wave Folded Dipole

- This antenna is commonly used with the array type antennas to increase the feed resistance. The most commonly used one is with Yagi-Uda antenna. The following figure shows a half-wave folded dipole antenna.



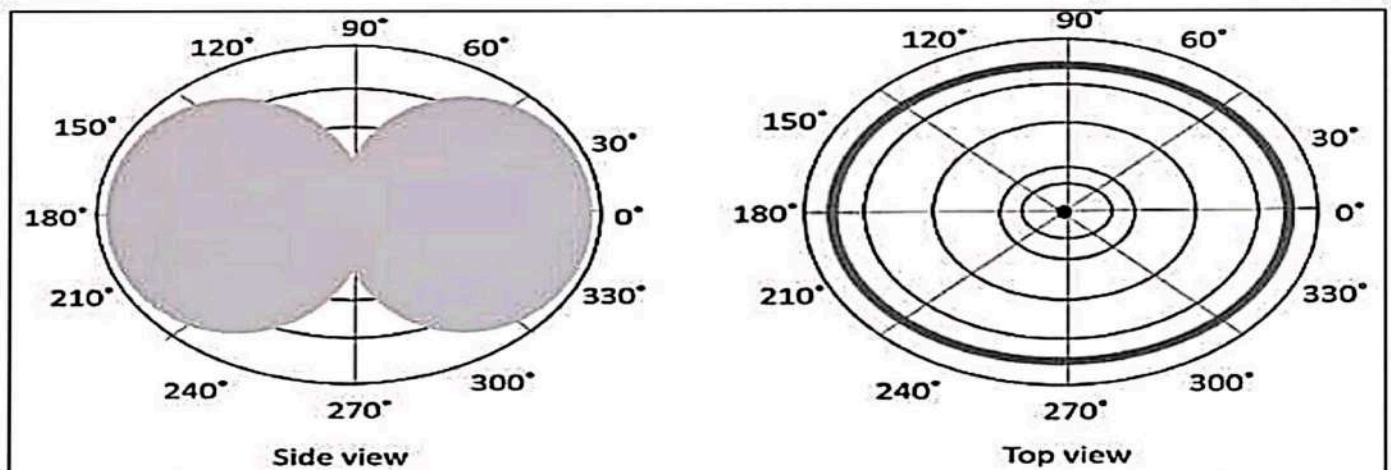
- This antenna uses an extra conducting element (a wire or a rod) when compared with previous dipole antenna. This is continued by placing few conducting elements in parallel, with insulation in-between, in array type of antennas.
- The following figure explains the working of a half-wave folded dipole antenna, when it is provided with excitation.



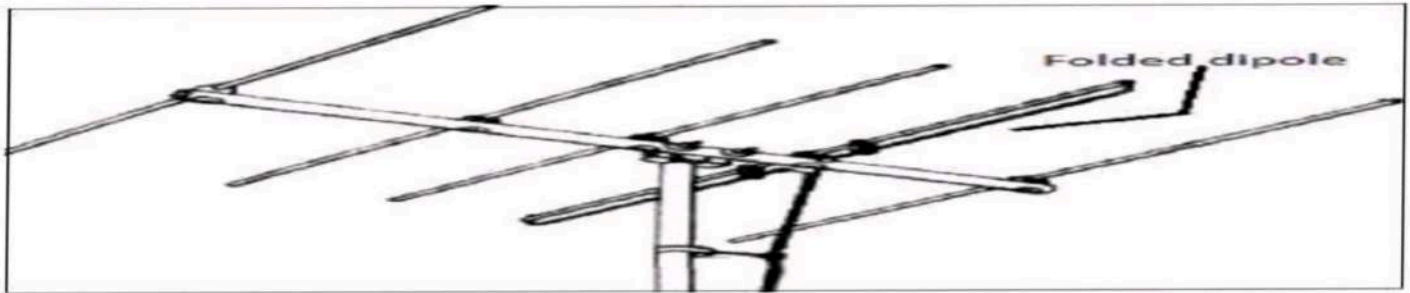
- If the diameter of the main conductor and the folded dipole are same, then there will be four folded (two times of squared one) increase in the feed impedance of the antenna.
- This increase in feed impedance is the main reason for the popular usage of this folded dipole antenna. Due to the twin-lead, the impedance will be around 300Ω .

Radiation Pattern

- The radiation pattern of half-wave folded dipoles is the same as that of the half-wave dipole antennas.
- The following figure shows the radiation pattern of half-wave folded dipole antenna, which is **Omni-directional** pattern.



- Half-wave folded dipole antennas are used where optimum power transfer is needed and where large impedances are needed.
- This folded dipole is the main element in **Yagi-Uda antenna**. The following figure shows a **Yagi-Uda antenna**, which we will study later.
- The main element used here is this folded dipole, to which the antenna feed is given.
- This antenna has been used extensively for television reception over the last few decades.



Advantages

The following are the advantages of half-wave folded dipole antenna –

- Reception of balanced signals.
- Receives a particular signal from a band of frequencies without losing the quality.
- A folded dipole maximizes the signal strength.

Disadvantages

The following are the disadvantages of half-wave folded dipole antenna –

- Displacement and adjustment of antenna is a hassle.
- Outdoor management can be difficult when antenna size increases.

Applications

The following are the applications of half-wave folded dipole antenna –

- Mainly used as a feeder element in Yagi antenna, Parabolic antenna, turnstile antenna, log periodic antenna, phased and reflector arrays, etc.
- Generally used in radio receivers.
- Most commonly used in TV receiver antennas

Full Wave Dipole :

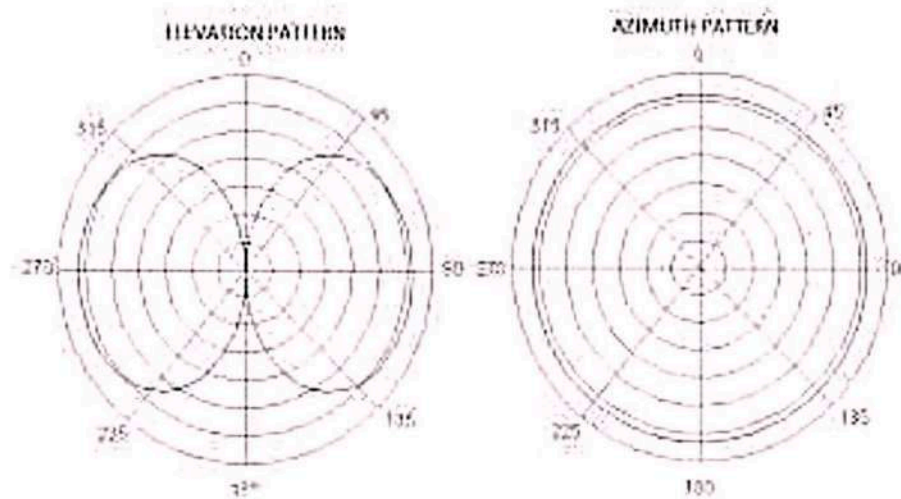
- If the length of the dipole, i.e. the total wire, equals the full wavelength λ , then it is called as **full wave dipole**.

Construction & Working of Full-wave Dipole

- The full-wave dipole with its voltage and current distribution is shown here. Both the positive and negative peaks of the wave induce positive and negative voltages respectively.

3. Omni-Directional Antenna :

- An **omnidirectional antenna** is a class of antenna which radiates equal radio power in all directions perpendicular to an axis (azimuthal directions), with power varying with angle to the axis (elevation angle), declining to zero on the axis.



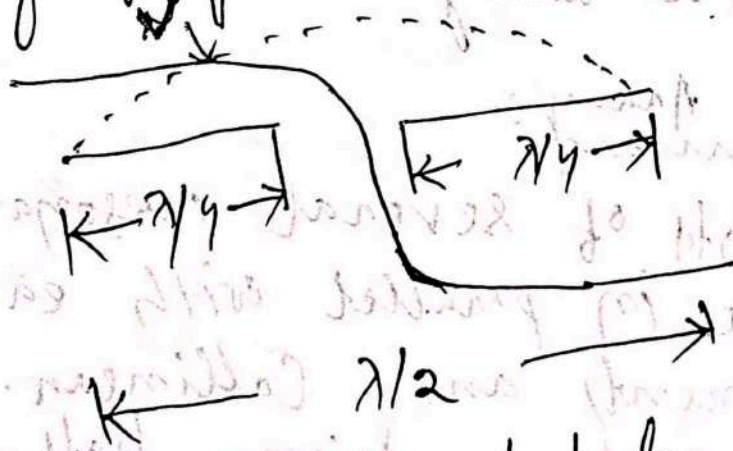
- When graphed in three dimensions this radiation pattern is often described as doughnut-shaped.
- Note that this is different from an isotropic antenna, which radiates equal power in all directions, having a spherical radiation pattern.
- Omnidirectional antennas oriented vertically are widely used for nondirectional antennas on the surface of the Earth because they radiate equally in all horizontal directions, while the power radiated drops off with elevation angle so little radio energy is aimed into the sky or down toward the earth and wasted.
- Omnidirectional antennas are widely used for radio broadcasting antennas, and in mobile devices that use radio such as cell phones, FM radios, walkie-talkies, wireless computer networks, cordless phones, GPS, as well as for base stations that communicate with mobile radios, such as police and taxi dispatchers and aircraft communications.
- Common types of low-gain omnidirectional antennas are the whip antenna, "Rubber Ducky" antenna, ground plane antenna, vertically oriented dipole antenna, discone antenna, mast radiator, horizontal loop antenna (sometimes known colloquially as a 'circular aerial' because of the shape) and the halo antenna.
- Higher-gain omnidirectional antennas can also be built. "Higher gain" in this case means that the antenna radiates less energy at higher and lower elevation angles and more in the horizontal directions.
- High-gain omnidirectional antennas are generally realized using collinear dipole arrays.
- Omnidirectional radiation patterns are produced by the simplest practical antennas, monopole and dipole antennas, consisting of one or two straight rod conductors on a common axis. Antenna gain (G) is defined as antenna efficiency (e) multiplied by antenna directivity (D) which is expressed mathematically as: $G = eD$.
- A useful relationship between omnidirectional radiation pattern directivity (D) in decibels and half-power beamwidth (HPBW) based on the assumption of a $\sin(b\theta)/b\theta$ pattern shape is:

$$D \approx 10 \log_{10} \left(\frac{101.5}{\text{HPBW} - 0.00272 \text{HPBW}^2} \right) \text{ dB.}$$

DIPOLE ARRAY (Antenna Array) antenna

→ When two or more antenna elements are combined to form a single antenna, the arrangement is called an antenna array or Dipole array antenna.

→ An antenna array is a radiation system consisting of grouped radiators or elements.



→ The antenna is connected to the transmission line. The voltage & current distinguish ~~at~~ at $\lambda/4$ as open. At the center of half wave dipole and increasing $200\ \Omega$ at either end in order to achieve

the power transfer the antenna must be connected to 72Ω transmission line. The source of loading effect there.

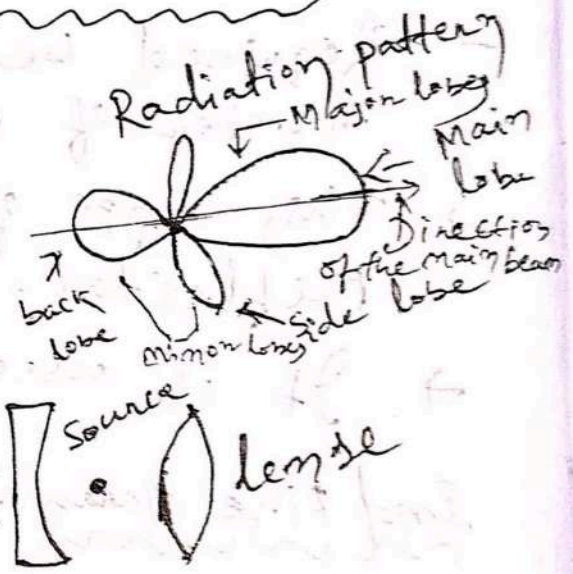
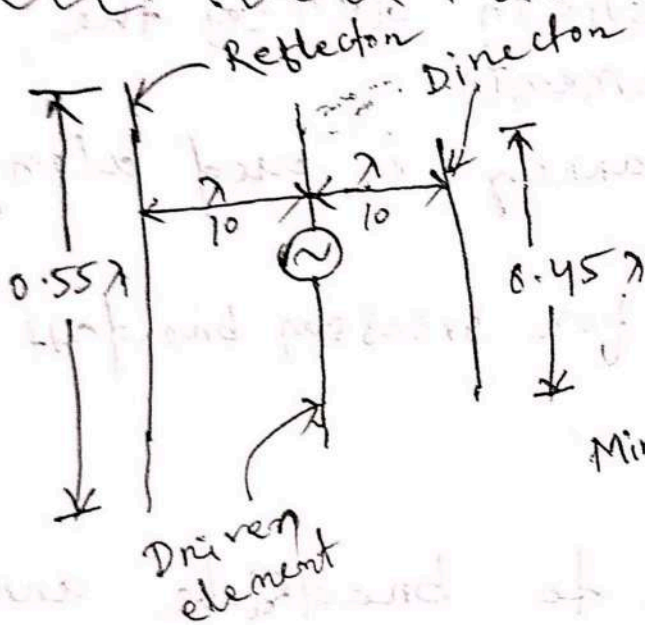
Advantages:

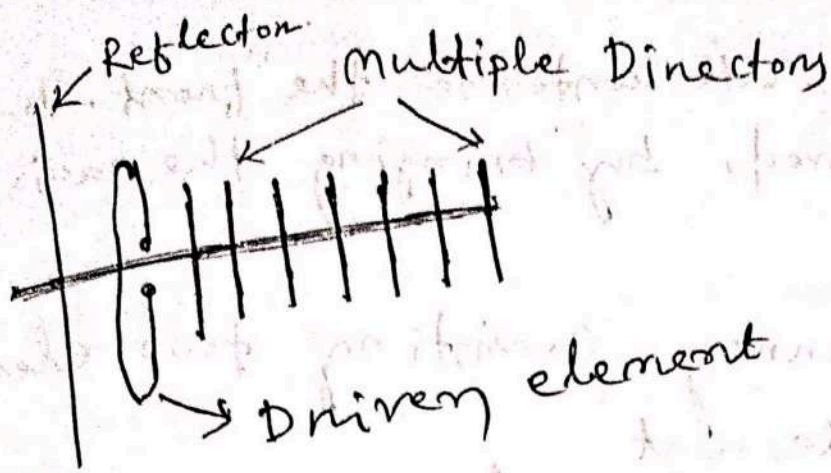
- It has higher i/p impedance
- Greater bandwidth.
- Easy and cost of construction
- Impedance matching is good.

Application: -

It is used for TV broadcasting.

Yagi Antenna (Yagi-Uda Antenna)





- The Yagi antenna or Yagi-Uda antenna is one of the most successful RF antennas.
- It is the common kind of TV antenna to be found on the roof top of houses.
- It is used at freq. range betⁿ 30 MHz and 3 GHz which becomes to the VHF & UHF bands.
- Its name derives as two Japanese inventors are Hidetsugu Yagi and Shintaro Uda.
- The Yagi-Uda antenna is an array consisting of a driven element and one or more parasitic elements arranged close together.
- Since it is relatively unidirectional, as per radiation pattern shows and has a moderate gain in the vicinity of 7 dB.
- It is used as a high freq. antenna. It can also be used at higher frequencies, such as TV receiving antenna.

Here in Yagi-Uda antenna the "front-to-back" ratio is improved, by bringing the radiator closer.

It is an array consisting of two elements. They are

- ① Driven element
- ② Parasitic element

Driven Element → It is radiating element connected to the array.

It will load the driven element more and reduce its input impedance.

(It is also driven element) or It is a resonant half wave dipole usually of metallic rod at the freq. of operation.

Parasitic Element

Any element not connected ~~to it~~ called a parasitic element.

Parasitic elements are passive elements which are not directly connected to the transmission line but electrically coupled. These are close together.

Reflector - It is an element it acts as a mirror for antenna radiation.

It receives energy through induction field of a driven element rather than the by direct connection to the transmission line. It is longer than driven element.

The separation betⁿ reflector and driven element is 0.1λ and it is 5% longer than driven element.

Director :- It is a parasitic element depends on its distance and turning and it acts as an conver mirror. It receives energy to increase the radiation in its own direction. It is shorter than driven element.

Application :-

- (1) High freq. transmitting antenna
- (2) VHF TV receiving antenna
- (3) Good gain
- (4) Beamwidth per unit area of array
- (5) Good unidirectional radiation pattern.

Features :- It is very compact.

- The construction enables antenna to be mounted easily to vertical or other places with standard mechanical fitting.
- It allows ready for simplifying construction.
- Front to back ratio is improved.
- It is also called as super gain antenna.

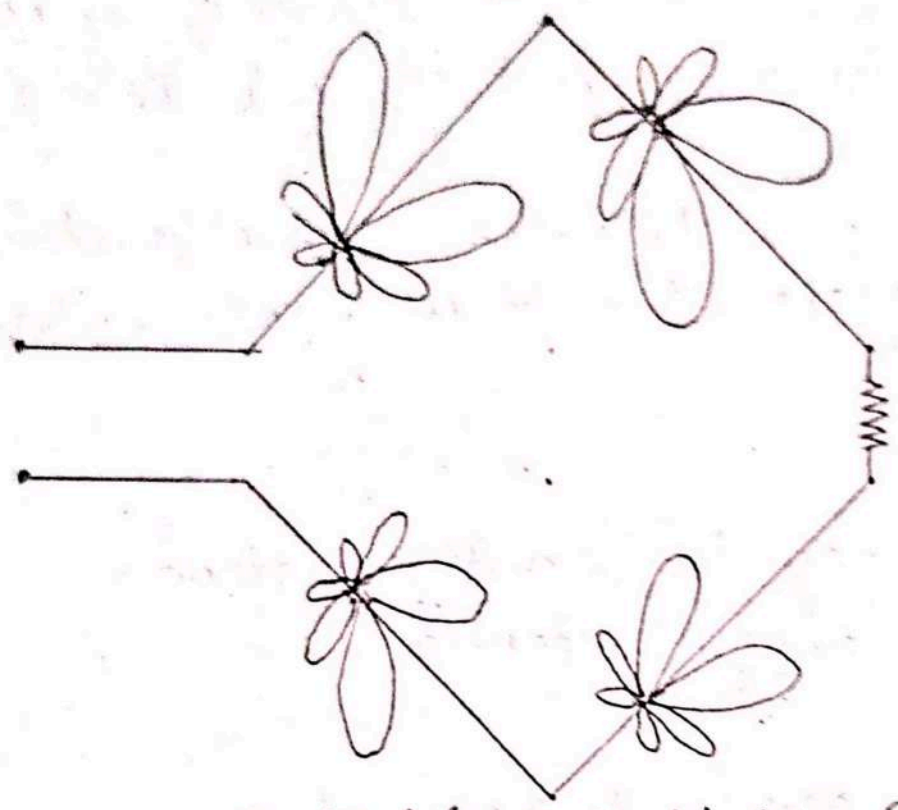
Advantages

- High gain achieve
- High directivity if achieve.
- Easy of handling & maintainance
- Less amount of power is wasted
- Broaden coverage at freq.

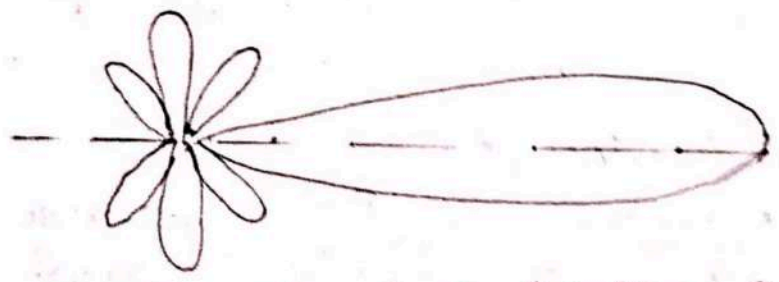
Disadvantages

- For high gain levels the antenna gain become very long.
- Gain limited to amount. 20 dB

* Rhombus Antenna -

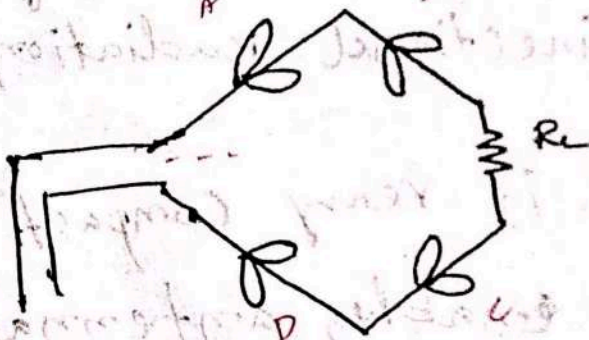


Individual radiation Pattern



Resultant radiation Pattern

Rhombus Antenna :-



It is an equilateral parallelogram, with two opposite acute angles.

- It is an equilateral parallelogram with two opposite acute angles.
- It is an antenna which is shape of rhombus type. It is usually terminated in a resistance. It is made up of four non-resonant elements, each is several wavelengths long.
- It is also called as diamond shape layout of antenna. It is a array for interconnected long wire antenna. It is also called as double 'V' antenna. It needs $600\ \Omega$ to $800\ \Omega$ termination resistance to minimize reflection loss. It has requirement for high frequency, transmission and ^{reception} must have wide bandwidth. The power gain of the antenna range 15 dB to 60 dB. and the range of freq. is 3-30 MHz.
- The radiation from each wire as shown as above fig. by the main lobe.
- The lobes A, B, C and D of individual radiation and when combined gives one main lobe of radiation directed along the diagonal of the rhombus.
- The total directivity of the antenna is the sum of directivity of individual elements. The length of the equal radiations vary from 2 to 8λ and the radiation angle ' ϕ ' varies from 40 to 75° .

The 4 wires on legs rhombic antenna when terminated by a resistance of value equal to char impedance of the system, give a non-resonant current distribution.

Advantages

- Vertical radiation is low
- Highly directional
- High gain bandwidth
- good range variation
- Better power gain.

Disadvantages :-

- Large space
- Half power is wasted if terminated resistor.

Application :-

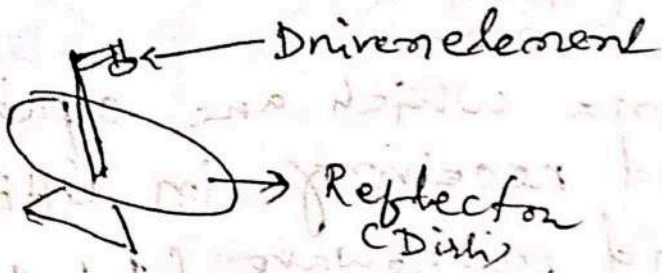
- It is used in point-to-point communication
- High freq. transmission & reception
- Broadband antenna.

Dish Antenna

A parabolic antenna is an antenna that uses a parabolic reflector a curved surface with the cross-section shape of a parabola to direct the radio waves.

The most common form is shaped like a dish & is popularly called a dish antenna or parabolic antenna.

The dish antenna consists of active element & driven element & passive is reflector element.



The driven element used for dish antenna may be a antenna which is used in such a way that it aimed to the center as reflecting dish. The reflector has diameter at 0.6 to 1m (approximate), where,

$$v = f \lambda$$

(v = velocity)

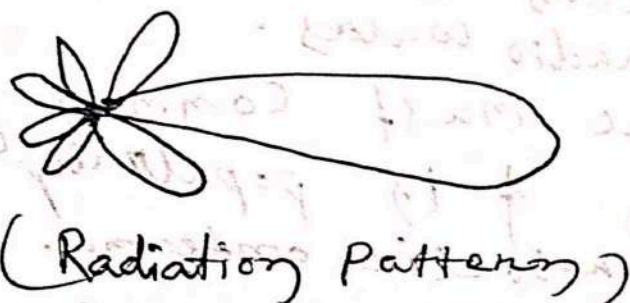
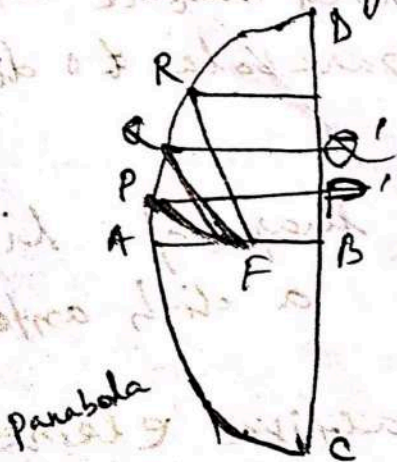
$$f = \frac{v}{\lambda}$$

(λ = wavelength in meter)
(f = frequency)

- In this antenna usually for Radar,
- Radio Astronomy, Space Comm^m, Broadband
- Trans-receiver of satellite Comm^m,
- Microwave links.

In this antenna provide very high gain of microwave freq. (300Hz to 300GHz) but only with sharp bandwidth.

It is an antenna use a reflective disk in a shape of parabola which is use to the received beam on a single point.



→ The geometric of parabolic reflectors in transmitting mode

AB = Axis of ~~the~~ the parabola

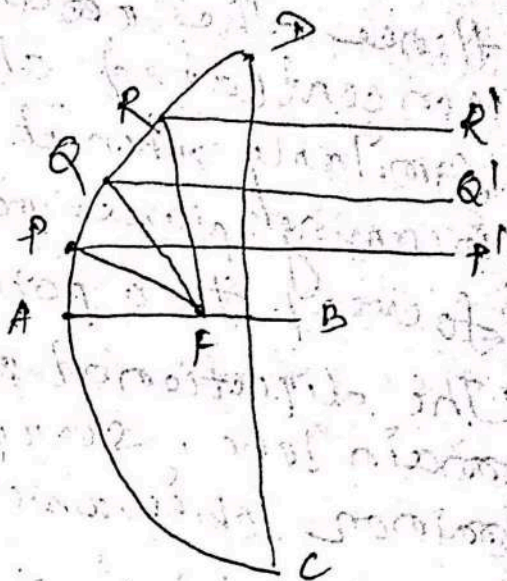
AF = Focal length

CD = Mouth diameter

A = Vertex

F = Focus

CAD = parabola



From parabola definition

$$FP + PP' = FQ + QQ' = FR + RR' \text{ constant } K$$

→ The ratio of the focal length to the mouth diameter AF/CD is called the aperture

→ The equation of parabola is given by

$$y^2 = 4px \quad \& \quad x^2 = 4py$$

→ A parabolic antenna is an antenna which uses a parabolic reflector, a curve surface with cross sectional shape of a parabola to direct radio waves.

→ A practical reflector having the properties of parabola will be a three dimensional bowl shape or curved surface obtained by revolving the parabola about the axis AB.

→ The resulting geometric is known as parabolic which is often called as microwave dish or parabolic reflector

operation -

→ If a feed antenna is placed at the focus, all the waves incident on the reflector and they are reflected back, forming a plane wave front.

→ By the time the reflected waves reach the directrix all of them will be in phase, irrespective of the point on the parabola from which they are reflected.

→ Hence the radiation is very high and is concentrated along the axis of the parabola. Similarly when it is used for reception all the incoming plane wave parallel to the axis will be focused to a point at the focal point.

→ The directional pattern of a very sharp main lobe, surrounded by a number of minor lobes which are much smaller.

→ The power gain wrt an isotropic antenna is given by $A = \eta \left(\frac{\pi D}{\lambda} \right)^2$, where $\eta =$ Antenna Efficiency.

$D =$ Mouth Diameter of the parabolic reflector

$\lambda =$ Wavelength in meter

Beam width of parabolic antenna is

$$\theta = \frac{70\lambda}{D} = \frac{70c}{fD}$$

$$Ac\lambda = c/f$$

Advantages

- High gain (30 dB to 40 dB)
- High directivity

Disadvantages

→ Requires a feed system ^{replace} and parabolic Reflector & driven element

→ Cost is more of the antenna

→ Big size

Horn Antenna :-

- It is an antenna per microwave horn is antenna that consist of flowing metal waveguide shaped like a horn to direct radio wave in beam.
- It consist of a short length of rectangular or cylindrical metal tube closed at one end, conical or pyramidal horn on the other end.
- When a wave guide is terminated by a horn such as any of those

operation :- The radio waves are usually introduced in to the body of the antenna which then radiates out from the horn at open end in narrow beam.

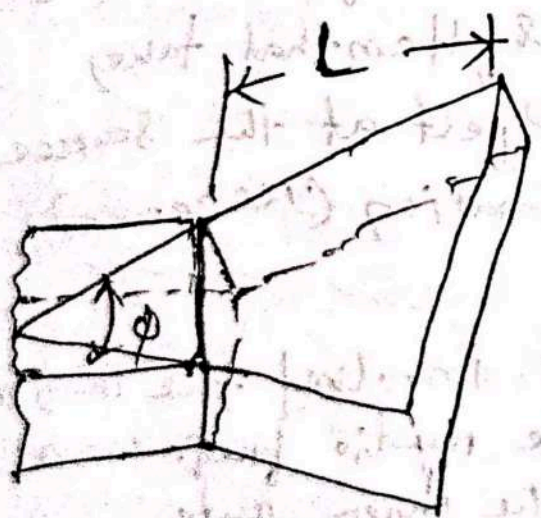
- It is used in transmission purpose this type of antenna use to transmit radio wave from wave guide and it is used as a UHF & microwave freq. response.
- They can used as feed antenna for radar gun automatic door openings & microwave radio meters.
- It is an antenna can have the shape of square, rectangle, cone or a pyramid. and another is sectoral horn type.
- The sectoral horn is flared only in one plane. The flaring can be along the electric field or magnetic field.
- If the direction of the electric field, it is called the sectoral E-plane horn.
- If the magnetic field, it is called sectoral H-plane horn.

- The Pyramidal horn is flared in both planes.
- The Conical horn consists of a cone that is truncated in a piece of circular waveguide to produce a circularly polarized beam. The angle of cone is 50° . The length of the cone denoted the antenna gain.

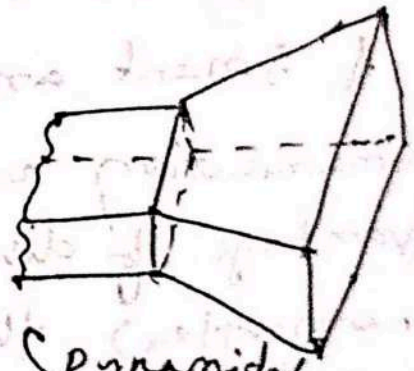
Advantages

- No resonant elements are used.
- Wide range of freq.
- improve directivity of radiation pattern
- wide band width
- Gain of antenna is 25 dB.
- low VSWR

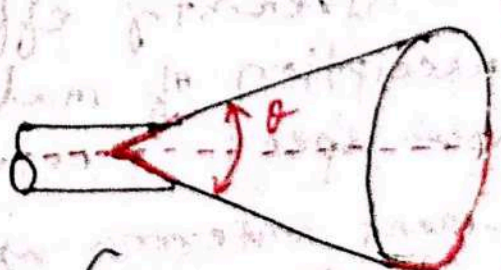
Fig 1 -



(Sectoral Horn Antenna)



(Pyramidal horn antenna)



(Circular or Conical horn antenna)

Smart Antenna

→ A Smart antenna system combine a multiple antenna element with signal processing capability to optimise the radiation and reception pattern automatically in response to the signal environment.

→ A smart antenna also known as adaptive array antennas, digital antenna arrays, multiple antennas and recently (MIMO) multi input multi output, are antenna arrays with smart signal processing algorithms used to identify spatial signals such as the direction of arrival (DOA) of the signal.

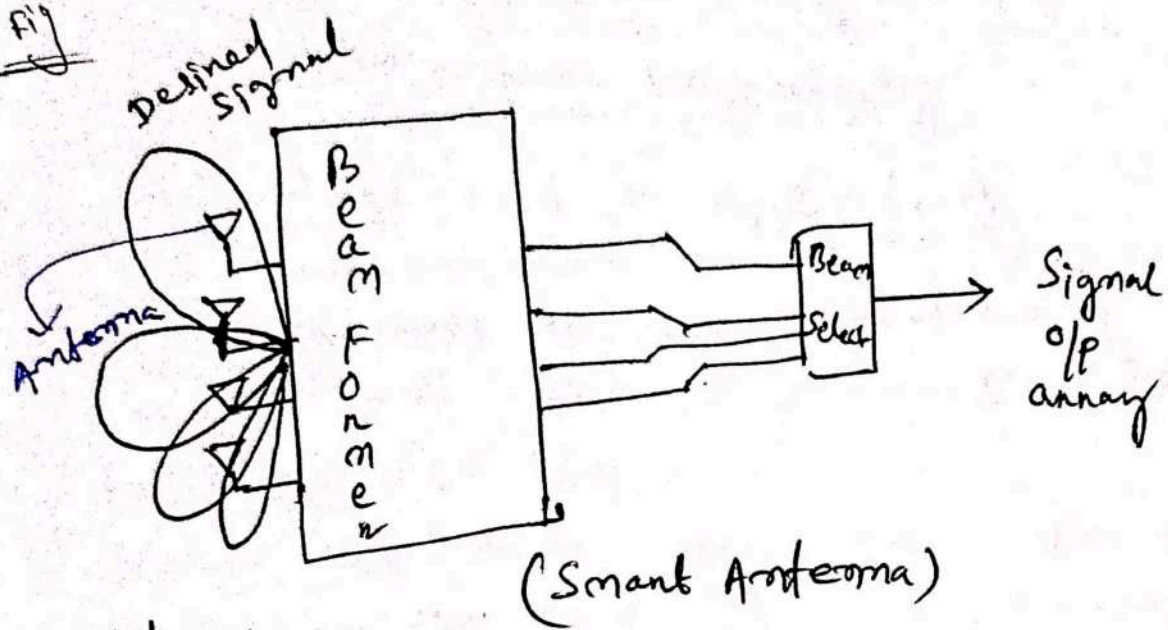
→ A smart antenna is a digital wireless communication antenna system that take advantage of diversity effect at the source (transmitter), the destination (receiver) or both (Tx and Rx).

→ The diversity effect involved the transmission and reception of multiple radio freq. wave to increase speed & reduce the error rate.

→ Smart antenna as three categories. They are

- (1) SIMO
- (2) MISO
- (3) MIMO

Fig



Advantages

- ~~Higher gain for desired signal in the direction of interest~~
- Increase no. of users
- Increased range
- Security
- Reduced interference
- Increased beam width

Disadvantages

- Complex circuit
- More expensive
- Large size
- Location.

Application

- Radar Astronomy, acoustic signal processing, track.
- Radio telescope
- 3rd Comm^m system :- cellular, W-CDMA, UMTS, LTE

TRANSMISSION LINES

Define Transmission Line

→ It is the impedance matching circuit design to delivery RF power from transmitter to the antenna and maximum signal from the antenna to the receiver.

Application

- Transfer energy from one circuit to another circuit.
- It can be used Ckt elements like, inductor, capacitor and so on.
- used impedance matching device.
- Used as ~~imp~~ TV to TV antenna ^{as stubs}.
- Used Twisted pair & Co-axial cable as Computer n/w such Ethernet & internet
- used Telephone & power transmission.

Fundamental of Transmission line

There are two types of transmission lines.

- ① Parallel line (Balanced)
- ② Co-axial line (Unbalanced)

Other types of Transmission Line

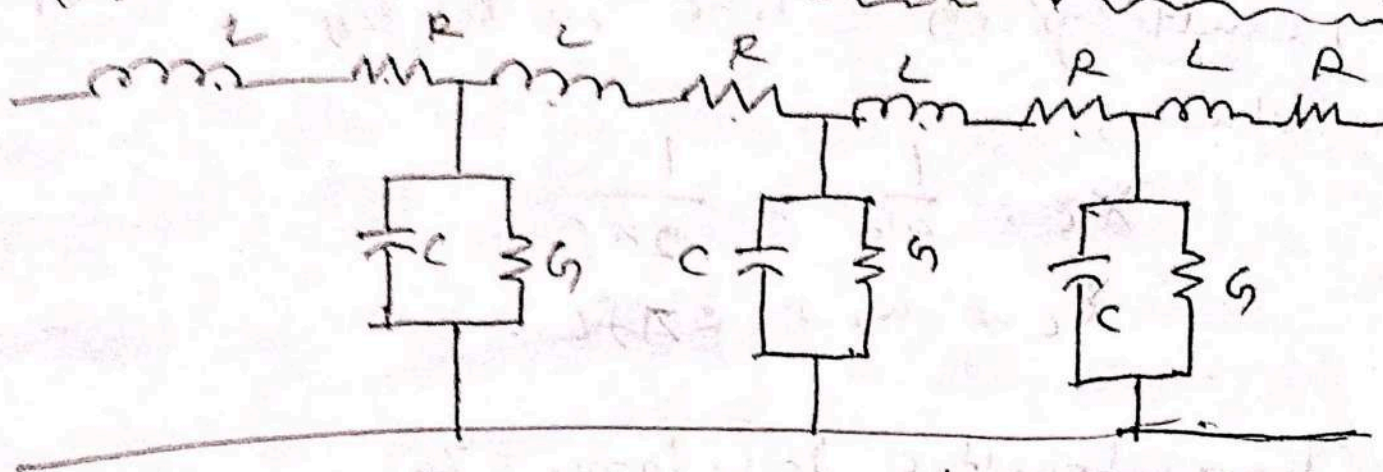
There are

- ① Two wire parallel line.
- ② Twisted pair lines.
- ③ Optical fiber
- ④ wave guide
- ⑤ RF Lines.
- ⑥ Telephone wires.

Equivalent Circuit of Transmission Line

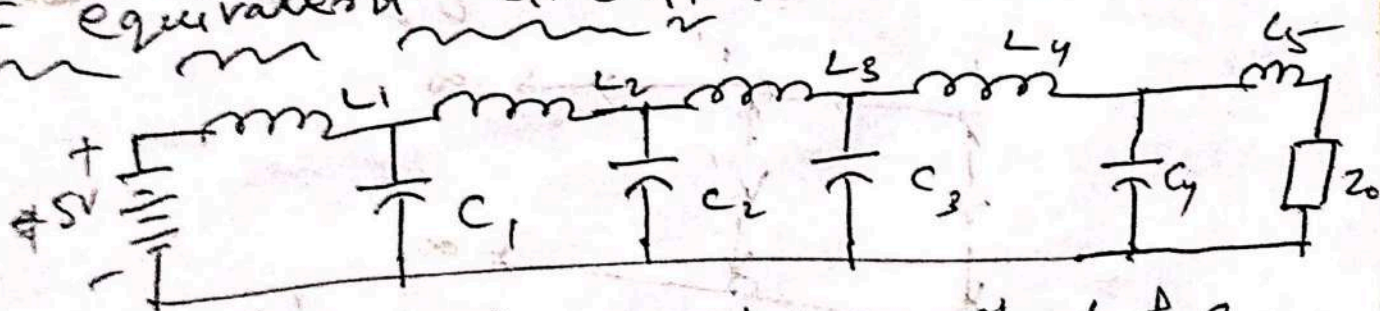
- It contains the following components, such as,
 - ① Inductance
 - ② Capacitance
 - ③ Resistance
 - ④ Conductance.
- Since each conductor of the line has a certain length and diameter, it must have resistance (R), inductance (L)
- Since there are two wires close to each other.
- Therefore it must be capacitance (C) betⁿ them.
- Finally the wires are separated by a medium called the dielectric.
- It can't be perfect in the insulation & hence current links through it.
- This linkage current represent by shunt conductance (G).

General Equivalent Circuit of Transmission Line



- It consists of cascaded sections of Series resistance (R), Series inductance (L), Shunt capacitance (C) & Shunt conductance (G).
- It represents a unit length of the transmission line.
- That is R, L, C & G all is measured per unit length.
- Because as per meter measured they have periodically along the line.

RF equivalent circuit :-



- In this circuit contains of L & C component.
- At RF (Radio frequency) the inductive reactance is much larger than the resistor.
- Then capacitive susceptance is also much higher than the shunt conductance.

→ Hence both R & G may be neglected resulting in a line i.e. lossless.

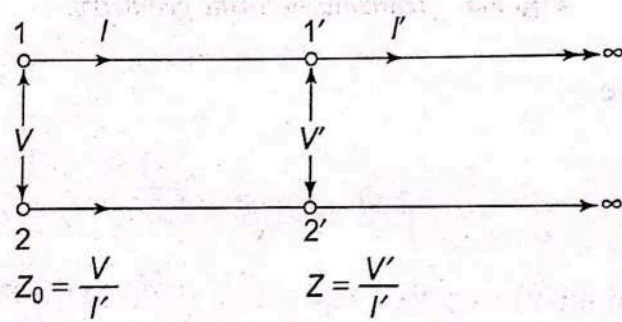
Where,

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$X_L = \omega L = 2\pi f L.$$

Characteristic Impedance (Z_0)

- It is ^{defined as} the impedance measured at the ip of the line when its length is infinite (∞) therefore the termination at the far end has no effect.
- The description and calculation, the ip impedance under certain standard simple & easy. So the condition is reference is called Char's impedance of line.
- So the Char's circuit fig is given below.



Method of Calculation :-

$$Z_0 = Z_{in} = Z_{out}$$

$$\therefore Z_0 = \frac{V}{I'} = \frac{V'}{I'}$$

- The Char^d impedance (Z_0) is measured at the i/p of the transmission line.
- If the o/p is terminated at the far end at this condition ' Z_0 ' is considered purely resistive.
- It likes bilten circuit considering 'LC' circuit with it series and shunt elements.

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

where, Z = Series impedance per section

$$Z = R + j\omega L \text{ (}\Omega/m\text{)}$$

(Series impedance / unit length)

Y = Shunt admittance / section

$$Y = G + j\omega C$$

By substituting the value of Y & Z in eqⁿ (1)

$$\begin{aligned} Z_0 &= \sqrt{\frac{Z}{Y}} \\ &= \sqrt{\frac{R + j\omega L}{G + j\omega C}} \end{aligned}$$

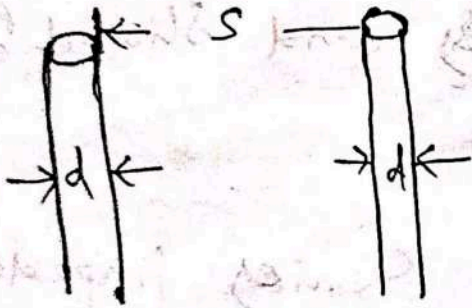
→ A
At RF of the value of R & G are in significant, so it can be reduced to or ignored. (R & G)

$$\therefore Z_0 = \sqrt{\frac{j\omega L}{j\omega C}}$$
$$= \sqrt{\frac{L}{C}} \text{ (}\Omega\text{)} \quad (\text{As R \& G neglected})$$

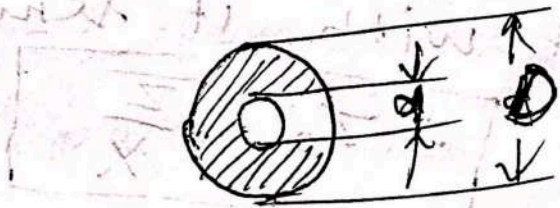
Where, 'L' measure in Henry and 'C' measure in Farade.

Transmission line

Transmission Line Geometry



(Parallel line)



(Co-axial line)

→ For parallel line;

$$\left[Z_0 = 276 \log \frac{2S}{d} \right]$$

→ For Co-axial line;

$$\left(Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d} \right)$$

Where,

k is Dielectric Constant of insulation.

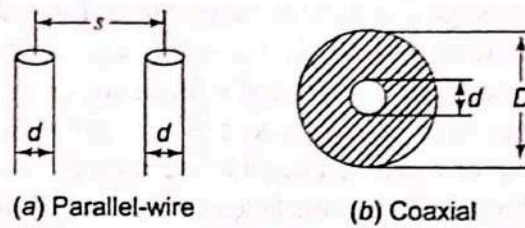


Fig. 9.5 Transmission-line geometry.

For the parallel-wire line, we have

$$Z_0 = 276 \log \frac{2s}{d} \Omega \quad (9.4)$$

For the coaxial line, this is

$$Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d} \Omega \quad (9.5)$$

where k = dielectric constant of the insulation.

Note that the figure 138 is equal to $1207\pi/e$, where $120\pi = 377 \Omega$ is the impedance of free space, and e is the base of the natural logarithm system; 276 is 2×138 .

Simple Numerical Problems:

Q.1 A Co-axial cable has a $75\ \Omega$ Char^s impedance and a nominal capacitance of $69\ \text{pF/m}$.

What is its inductance per meter? If the diameter of the inner conductor is $0.584\ \text{mm}$ and the dielectric constant of the insulation is 2.23 , what is the outer conductor diameter?

Solution :-

We know that the Char^s impedance

$$Z_0 = \sqrt{\frac{L}{C}}$$

$$\begin{aligned} L &= Z_0^2 \cdot C \\ &= 75^2 \times 69 \times 10^{-12} \\ &= 3.88 \times 10^{-7} \\ &= 0.388\ \mu\text{H/m} \end{aligned}$$

$$\therefore Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d}$$

$$\Rightarrow \log \frac{D}{d} = \frac{Z_0}{\frac{138}{\sqrt{k}}} = \frac{75}{\frac{138}{\sqrt{2.23}}} = 0.81$$

$$\therefore D = d \times \text{antilog } 0.81$$

$$= 0.584 \times 6.457$$

$$= 3.77\ \text{mm}$$

$$= 3.77\ \text{mm}$$

(Ans)

Q.2

A Co-axial cable having an inner diameter of 0.025 mm and using an insulator with a dielectric constant of 2.56 is to have a Char's impedance of 2000 Ω , what must be the outer conductor diameter?

Solⁿ →

$$\log \frac{D}{d} = \frac{Z_0}{138/\sqrt{\epsilon_r}} = \frac{2,000}{138/\sqrt{2.56}}$$
$$= 2,000 \times \frac{1.6}{138} = 23.1884$$

$$\therefore D = d \times \text{antilog } 23.1884$$
$$= 0.025 \times 10^{23} \times 1.543$$
$$= 3.86 \times 10^{21} \text{ mm}$$
$$= 3.86 \times 10^{15} \text{ km}$$
$$= \frac{3.86 \times 10^{15}}{9.44 \times 10^{12}} = 409 \text{ (light years)}$$

Losses in Transmission Lines

There are three types of losses observed in transmission mode.

(a) Radiation loss.

(b) Conductor heating.

(c) Dielectric heating.

(a) Radiation Loss

→ When the transmission line act as antenna the radiation loss is occurring due to separation of conductors.

→ Radiation losses are applied more to parallel-wire lines than to Co-axial lines.

(b) Conductor Heating Loss ($I^2 R_{\text{con}}$)

It's directly proportional to current and there are inversely proportional to char^l impedance.

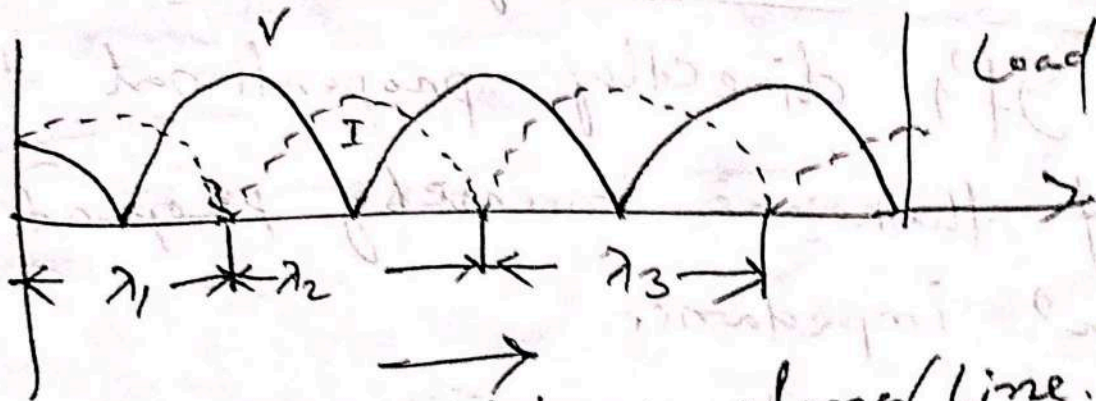
$\propto I^2$
It's also $\propto \frac{1}{\sqrt{f}}$ increase with freq., this time because of the skin effect.

© Dielectric heating loss

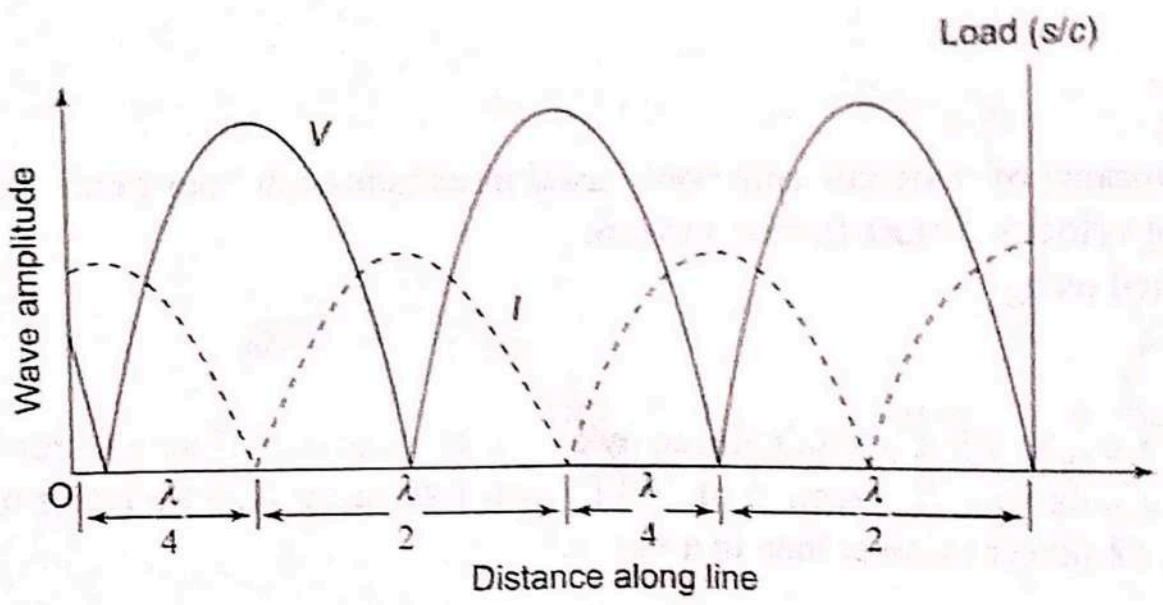
Dielectric heating is directly proportional to the voltage across the dielectric & hence inversely proportional to the char^d impedance. It also gradually increase frequency for air dielectric heating remain negligible.

Standing waves

A voltage and current wave whose value depend on load impedance & the applied power to a transmission line is called Standing wave.



Where, $V =$ voltage, $I =$ current, $\lambda =$ wavelength
When $Z_0 = Z_L$ then load absorb all power
 $Z_0 \neq Z_L =$ The load partly observed the power



SWR (Standing Wave Ratio)

It is defined as the ratio of maximum current to minimum current along a transmission line is called the Standing wave.

The SWR is a measure of the mismatch betⁿ the load and the line.

When the load is perfectly matched, the SWR is equal to unity (1)

When the line is terminated in a purely resistive load, the standing wave ratio is given by

$$[SWR = Z_0/R_L]$$

Where, R_L = Load Resistance.

Z_0 = Impedance char.

(3.7) Impedance Matching

It is require for max^m transfer of signal from source to load by employing quarter wave length line the 'z' matching is done.

It is due to the quarter wave length line provide for unique opportunity for impedance transmission at high frequency and Computable with transmission line.

For impedance (z), matching the load impedance

(Z_L) and Char^d impedance (Z_0)
* The maximum power transfer between source & load.

$$\therefore Z_S = \frac{Z_0}{Z_L}$$

$$R_L = R_S$$
$$X_L = -X_S$$

The matching can be done by varying Char^d impedance (Z_0) at keep constant load impedance (Z_L) for maximum signal transmission.

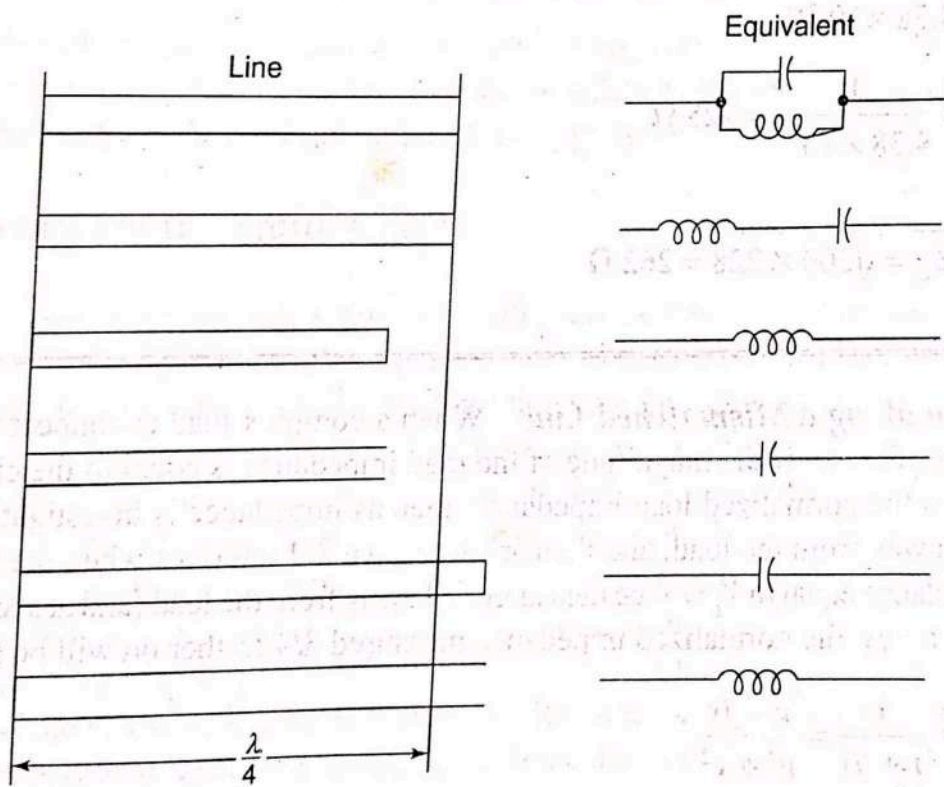


Fig. 9.10 Transmission-line sections and their LC equivalents.

Quarter wave length

The distance betⁿ anti current node & voltage node is known as quarter wave length.

Operation

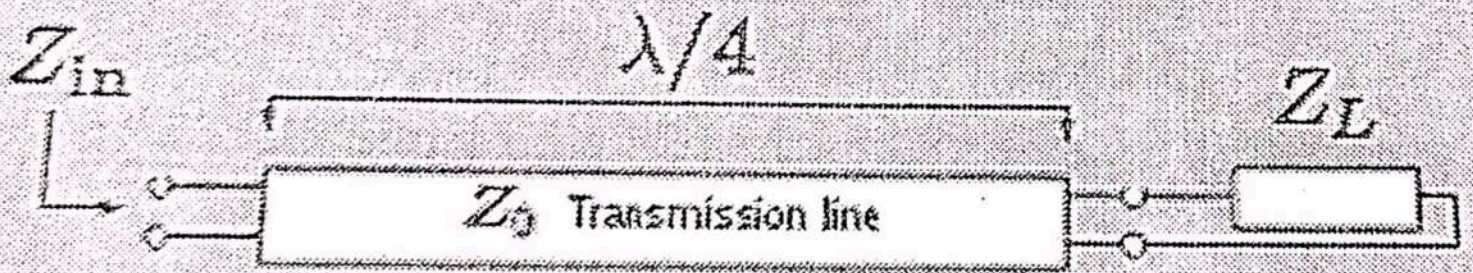
Quarter wave length are also have important impedance transforming properties used for radio frequency.

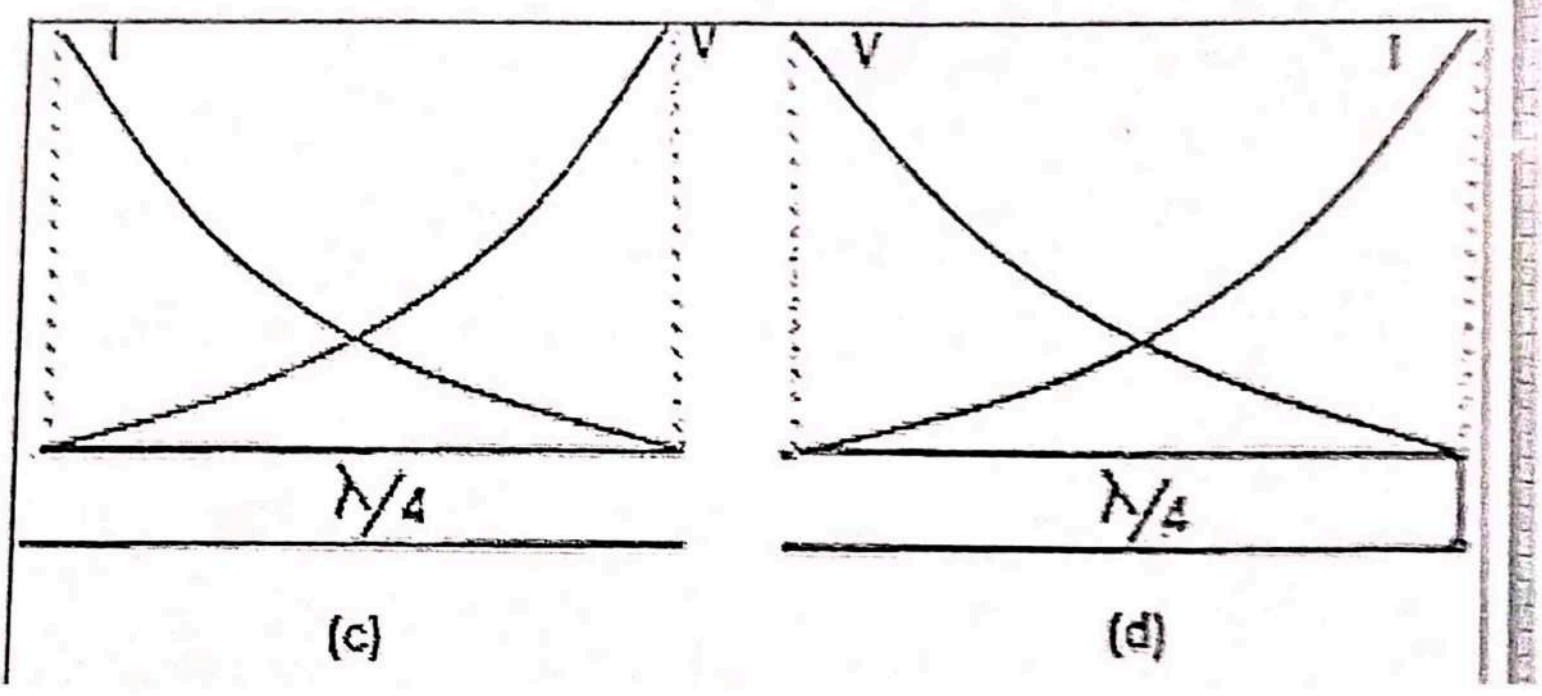
Considering a piece of transmission line of length l , the load impedance (Z_L) and char^{act} impedance ' Z_0 '.

When ' l ' equal to quarter of a line and the line is lossless then the impedance looking to the load then the impedance Z_S when looking toward the load is given

$$\text{by } \boxed{Z_S = \frac{Z_0^2}{Z_L}}$$

This relationship is called reflective impedance.





Half wave length

The distance / length betⁿ the two node is called $\lambda/2$ (half wave length)

Half wave length line

The half wave length line reflects it load impedance directly.

A half wave length line has the property that the i/p impedance must be equal to the impedance of the load placed at the far end of the half-wave line. i.e. $Z_S = Z_L$

From the knowledge of frequency and wavelength the velocity of the wave along the line can be calculate.

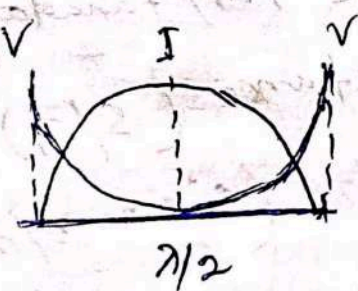


fig (a)

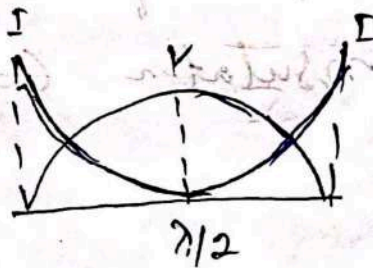


fig (b)

(Half wave length line)

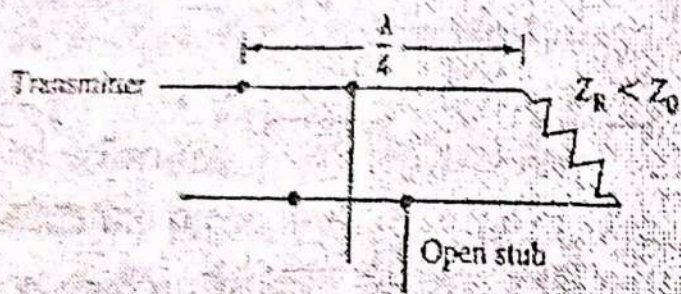
Stubs matching -

It is a short circuited transmission line and more obtained uses very high frequency. It has a pure reactance.

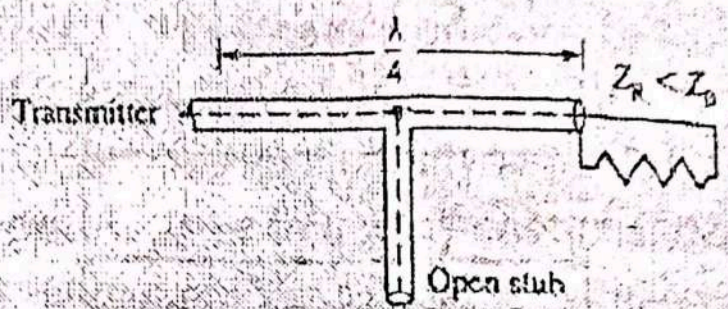
It is used to cancel out reactance of transmission line.

It is used for impedance matching there are basically two ways

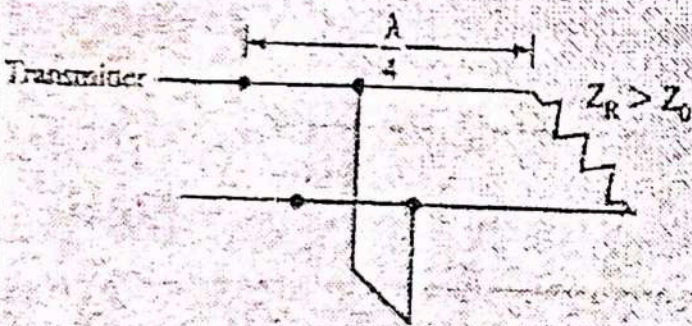
- ① single stub
- ② double stub



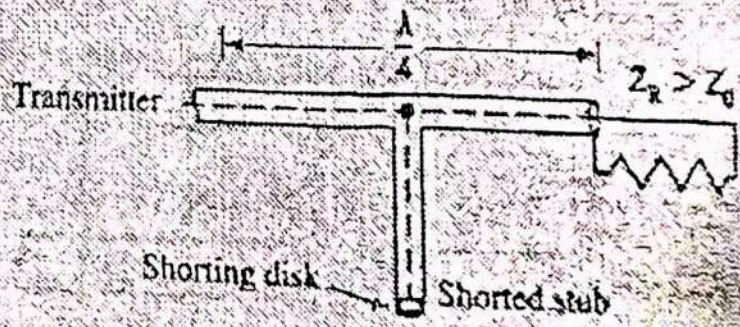
(a)



(b)



(c)



(d)

Single Stub matching

- A short circuited section of line;
- Here open end is connected to main transmission line.
- It's particular distance from the load end.
- Here input conductance is equal to Y_{in} impedance of line.
- The stub length is adjusted to provide a susceptance which is equal in value.
- But opposite in sign to the i/p susceptance of the main line.
- So, that total susceptance at point alternation is zero.

The combination of stub and line will be conductance.

This is equal to the char^d conductance of the line.

* The main length of high frequency transmission line will be matched.

→ A short circuited stub of length 'L' is placed at a distance.

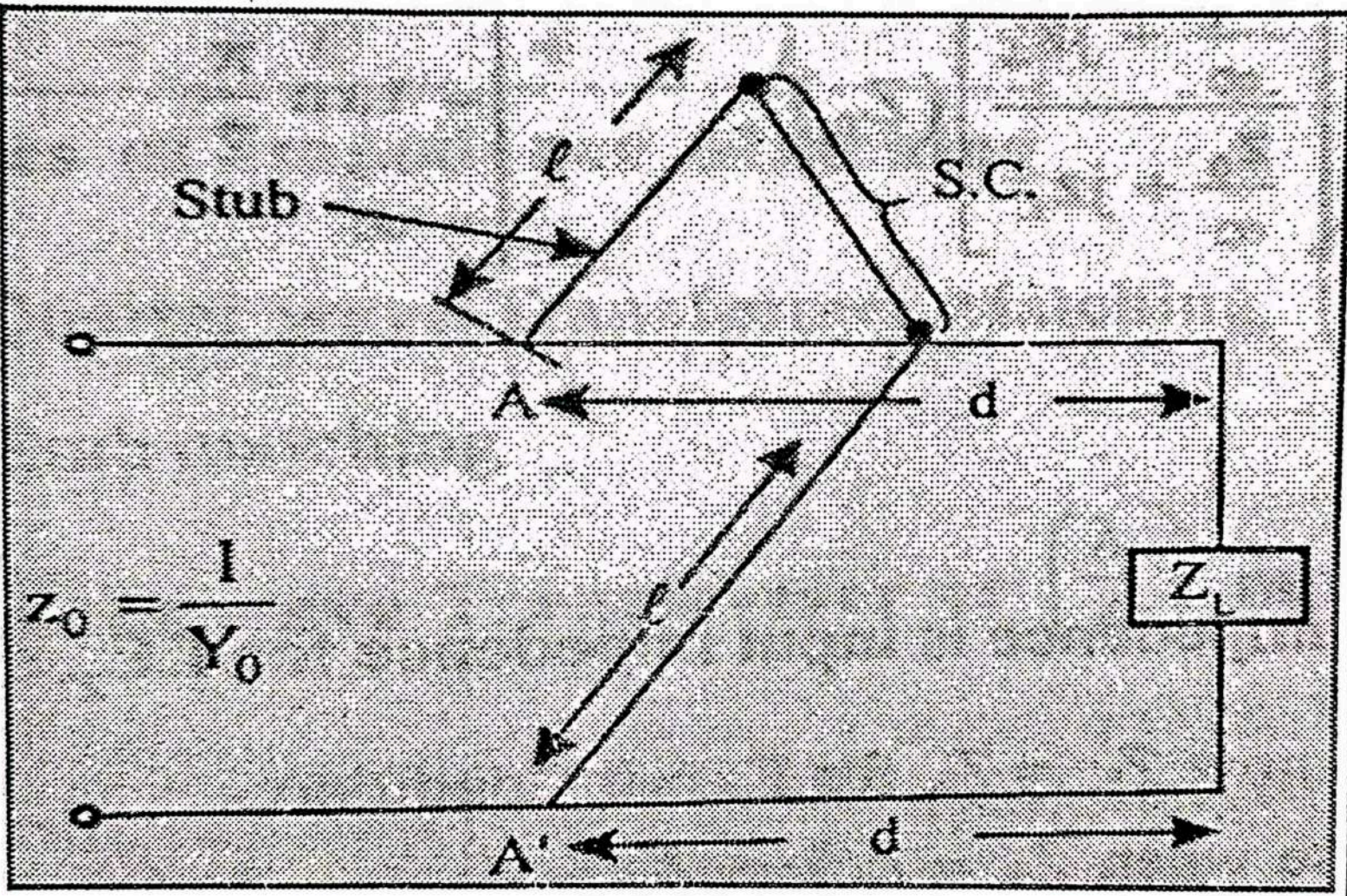
→ 'L' from the end impedance!

$$\therefore \boxed{Z_L \neq Z_0}$$

→ At microwave frequency $\boxed{Z_0 = R_0}$, a pure reactance at a length 'L' from the load.

→ The impedance $\boxed{R_L + jX_L}$ is such that;

$$\therefore \boxed{R_L = R_0}$$

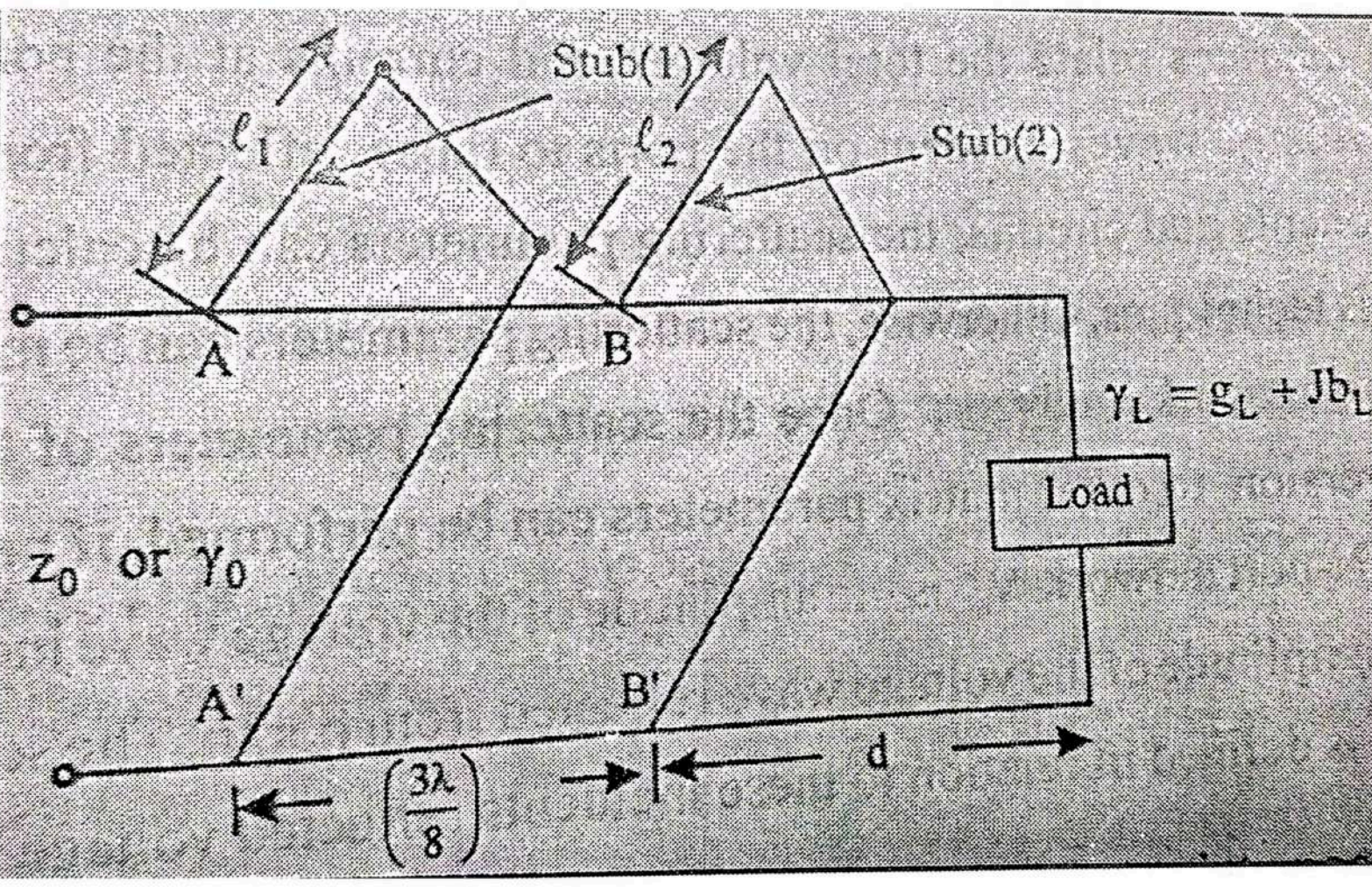


Demerits -

The range of impedance which can be transformed is limited.
It becomes essential to the position and length and stubs
It is use full for a fixed frequency.

Double Stub matching

- In double stub matching two stubs, having length l_1 and l_2 .
- Those are placed at a fixed position AA' & BB'
- The distance between AA' & BB' is $3\lambda/8$.
- The stub nearer to the load is adjusted.
- As a result to make the admittance at point AA' is equal to Character conductance of transmission line ($Y \cong 1$)
- In the absence of 2nd stub at BB' . the stub at AA' is adjusted to produce the zero susceptance at AA' .
- So, in this way matching is done.
- Therefore, position are fixed but their lengths are independently adjustable.
- It has provides wide range of impedance matching.



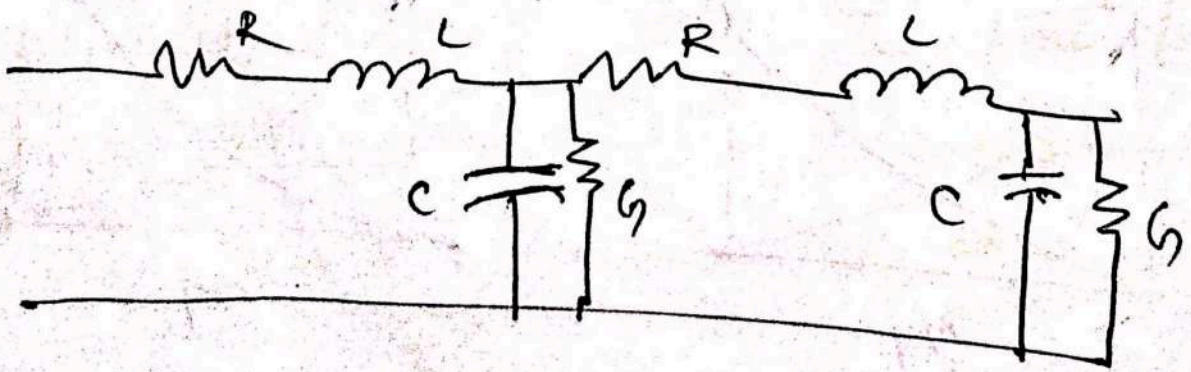
8) Primary Constant of transmission line

→ The parameters that describe the char^s of transmission line, which are terms of electrical properties of line.

→ The primary constants are relevant to transmission line and they are names as

- ① R - Load Resistance (Ω/m) (ohm/meter)
- ② L - Load Inductance (H/m) (Henry/meter)
- ③ C - Load Capacitance (F/m) (Faraday/meter)
- ④ G - Insulator Conductance (S/m) (Siemens/meter)

These primary constants are distributed per unit length in transmission line as shown in fig below



(Primary constant of R-L-C & G)

Secondary Constant

The Secondary Constant of transmission line are,

- (a) Propagation Constant
- (b) Characteristic Impedance (Z_0)

The reflection Co-efficient is also known as secondary constant.

Propagation Constant (γ)

It's represent that in which manner the propagation take place along the transmission.

The real part of the propagation constant is the attenuation constant i.e. α .

→ It causes the decreases of signal amplifier amplitude along the transmission line.

The unit of attenuation constant is dB/meter.

$$\gamma = \sqrt{ZY}$$

i.e. $\gamma = \alpha + j\beta$

α = Real part

$$\beta = \frac{2\pi}{\lambda}$$

→ The propagation constant is used to decide how much power we need to put in a line of a given length, so that usually amount of power should be coming out i.e. to the load.

Relation Between Primary and Secondary Constants

Primary Parameters $\rightarrow R, L, C \text{ \& } G$

Secondary Parameters $\rightarrow \alpha, \beta, \gamma \text{ \& } Z_0$

Case - 1 (Lossless Transmission Line)

A line is said to be lossless when a dielectric medium betⁿ them is lossless & conductance is very high.

So, $R = G = 0$ (Perfect Conductor Line)

$$\text{(Char. Impedance)} Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}} = \sqrt{\frac{0 + j\omega L}{0 + j\omega C}} = \sqrt{\frac{L}{C}}$$

$$\text{(Propagation Constant)} \gamma = \sqrt{(R + j\omega L) \times (G + j\omega C)}$$
$$= j\omega \sqrt{LC} \quad (\because \gamma = \alpha + j\beta)$$

$$\alpha = 0$$

$$\beta = \omega \sqrt{LC}$$

$$\text{(Phase velocity)} V_p = f\lambda = f(2\pi/\beta) = \omega/\beta$$
$$= \omega/\omega\sqrt{LC}$$
$$= 1/\sqrt{LC}$$

Case - 2 (Distortionless Transmission Line)

A line is said to be distortionless when Attenuation Constant (α) is independent of frequency & Phase Constant (β) is proportional to frequency.

α to be independent of freq. when $Z_0 = R_0$
 $\Rightarrow R/L = G/C$

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}} = \sqrt{\frac{R \left(1 + \frac{j\omega L}{R}\right)}{G \left(1 + \frac{j\omega C}{G}\right)}} \\ \Rightarrow \sqrt{\frac{R}{G} \frac{\left(1 + \frac{j\omega \left(\frac{L}{G}\right)}{1 + \frac{j\omega \left(\frac{C}{G}\right)}\right)}{1 + \frac{j\omega \left(\frac{C}{G}\right)}\right)} = \sqrt{\frac{R}{G}} \sqrt{\frac{L}{C}}$$

$$Y = \sqrt{(R + j\omega L)(G + j\omega C)} = \sqrt{R \left(1 + \frac{j\omega L}{R}\right) \cdot G \left(1 + \frac{j\omega C}{G}\right)}$$

$$= \sqrt{RG \left(1 + \frac{j\omega L}{R}\right) \left(1 + \frac{j\omega C}{G}\right)} \left[\frac{R}{L} = \frac{G}{C} \Rightarrow \frac{L}{R} = \frac{C}{G} \right]$$

$$Y = \sqrt{RG \left(1 + \frac{j\omega L}{R}\right)^2} = \sqrt{RG} \left(1 + \frac{j\omega L}{R}\right) \\ = \sqrt{RG} + \sqrt{RG} \cdot \frac{j\omega L}{R} = \sqrt{RG} + \sqrt{\frac{G}{R}} j\omega L \\ = \sqrt{RG} + j\omega L \sqrt{\frac{G}{R}} \equiv \alpha + j\beta$$

So, $\alpha = \sqrt{RG}$ & $\beta = \omega L \sqrt{\frac{G}{R}}$

Phase wave velocity, $v_p = \frac{f \lambda}{\beta}$

$$= \frac{f (2\pi/\beta)}$$

$$\lambda/v = (2\pi/\beta) \Rightarrow \omega/\beta = \omega/v \Rightarrow v = \omega/\omega \sqrt{RG}$$

$$= 1/\sqrt{RG}$$

Transmission Line Equation

It's having four parameters i.e. series resistance (R), series inductance (L), shunt capacitance (C) and shunt conductance (G)

If R, L, C & G is primary constants of transmission line then,

The series impedance & shunt admittance per unit length of the line is given by,

$$Z = R + j\omega L \quad \text{--- (i)}$$

$$Y = G + j\omega C \quad \text{--- (ii)}$$

The line voltage & current per unit length decrease as Z increase.

$$\frac{dV}{dz} = -(R + j\omega L) \times I \quad \text{--- (iii)}$$

$$\frac{dI}{dz} = -(G + j\omega C) \times V \quad \text{--- (iv)}$$

Now, Differentiating eqn no. (iii) & (iv) w.r.t dz we have,

$$\frac{d^2V}{dz^2} = \gamma^2 V \quad \text{--- (v)}$$

$$\frac{d^2I}{dz^2} = \gamma^2 I \quad \text{--- (vi)}$$

These are voltage & current respectively
propagation on the line,

$$\text{where } \gamma = \sqrt{ZY} = \sqrt{(R + j\omega L)(G + j\omega C)}$$

→ where γ is called propagation constant (vii)
in complex quantity, write
→ Hence we can write,

$$\gamma = \alpha + j\beta$$

where α = Attenuation constant and
the real part of the eqⁿ (vii)
and β

then β = Phase constant and it
is Imaginary part.

The solution of eqⁿ (v) and (vi)
give the voltage & current at
any point z and it is given by,

$$\begin{aligned} V(z) &= V_s e^{-\gamma z} + V_r e^{-\gamma z} \\ I(z) &= I_s e^{-\gamma z} + I_r e^{-\gamma z} \end{aligned}$$

Here, V_s = Sending voltage Amplitude
 I_s = Sending current Amplitude
 V_r = Reflected voltage Amplitude
 I_r = Reflected current Amplitude.

3.1. Aspect ratio, Rectangular switching, flickere, Horizontal Resolution, video bandwidth, interlaced scanning, composite video signal, Synchronization pulses:-

Aspect ratio :- The ratio of the width to the height of an image (or) screen is called Aspect ratio. It is commonly expressed as two numbers separated by colon as in 16:9.

Rectangular switching :- Rectilinear scanning :- The scanning of picture in rectangular shape (or) pattern in parallel lines followed by the electron beam on a television screen. There are two scanning procedures taking place simultaneously. One moving the beam horizontally from left to right at a fast rate and the other moving the beam vertically downwards at a slower rate.

Flicker :- Flicker means an unsteady movement of a light causing rapid variations in brightness.

Horizontal Resolution :- The horizontal resolution of a television system is the ability of the scanning system to resolve the horizontal details i.e. changes in brightness levels of elements along a horizontal scanning line.

Video bandwidth :- Video bandwidth (or) video frequency bandwidth is the range of frequencies between 0 and the highest frequency used to transmit a live television image.

Interlaced Scanning :-

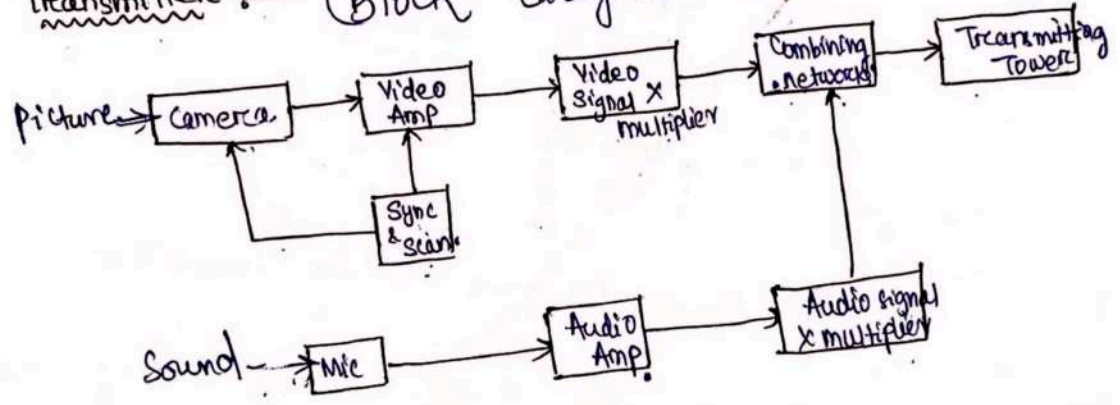
Interlaced Scanning is a display signal type in which one-half of the horizontal pixel rows are refreshed in one cycle and the other half in the next, i.e. two complete scans are required to display the screen image.

Composite video signal :-

It is formed by the electrical signal corresponding to the picture information in the lines scanned in the TV camera pickup tube and the synchronizing signals introduced in it.

Synchronization pulses :- These are the pulses generated by sync pulse generator which serve the purpose of locking line and to correct frequency at the receiver. It is a pulse used to achieve (or) maintain synchronism.

TV Transmitter :- (Block diagram and its function) :-

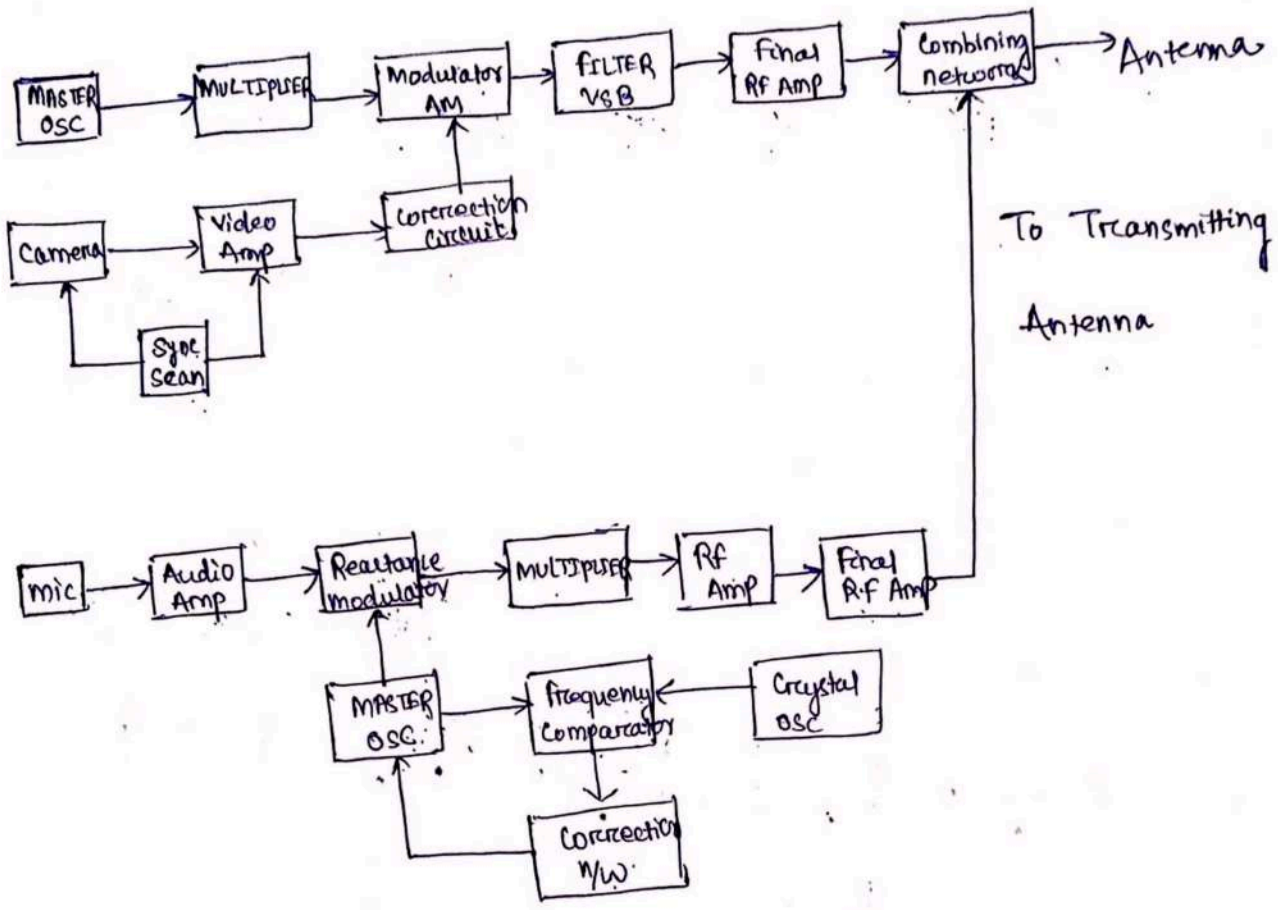


Basic Television Transmitter

The block diagram divided into two sections one that generates an electronic signal (video signal) corresponding to the actual picture and then uses this video signal to modulate an RF carrier so as to applied to the transmitting antenna for transmission.

Other that generates an electronic signal (audio signal) containing sound information and then uses this signal to modulate another AF carrier and then applied to the transmitting antenna for transmission.

However, only one antenna is used for transmission of the video as well as audio signals. 10/09



Complete Block diagram of TV Transmitter

Master Oscillator :- It generates an RF carrier frequency in both video and audio section.

AM modulator :- To modulate video signals, AM modulator is employed.

FM modulator :- To modulate audio signals, FM modulator is employed.

Video Amplifier and Audio Amplifier :- Video and Audio signals have to be amplified to the desired degree before they modulate their respective RF carrier. This function is performed

by Amplifiers.

Syn scan (Synchronizing circuit) - Synchronizing scanning circuits are used to make the electron beam scan the actual picture to produce the corresponding video signal.

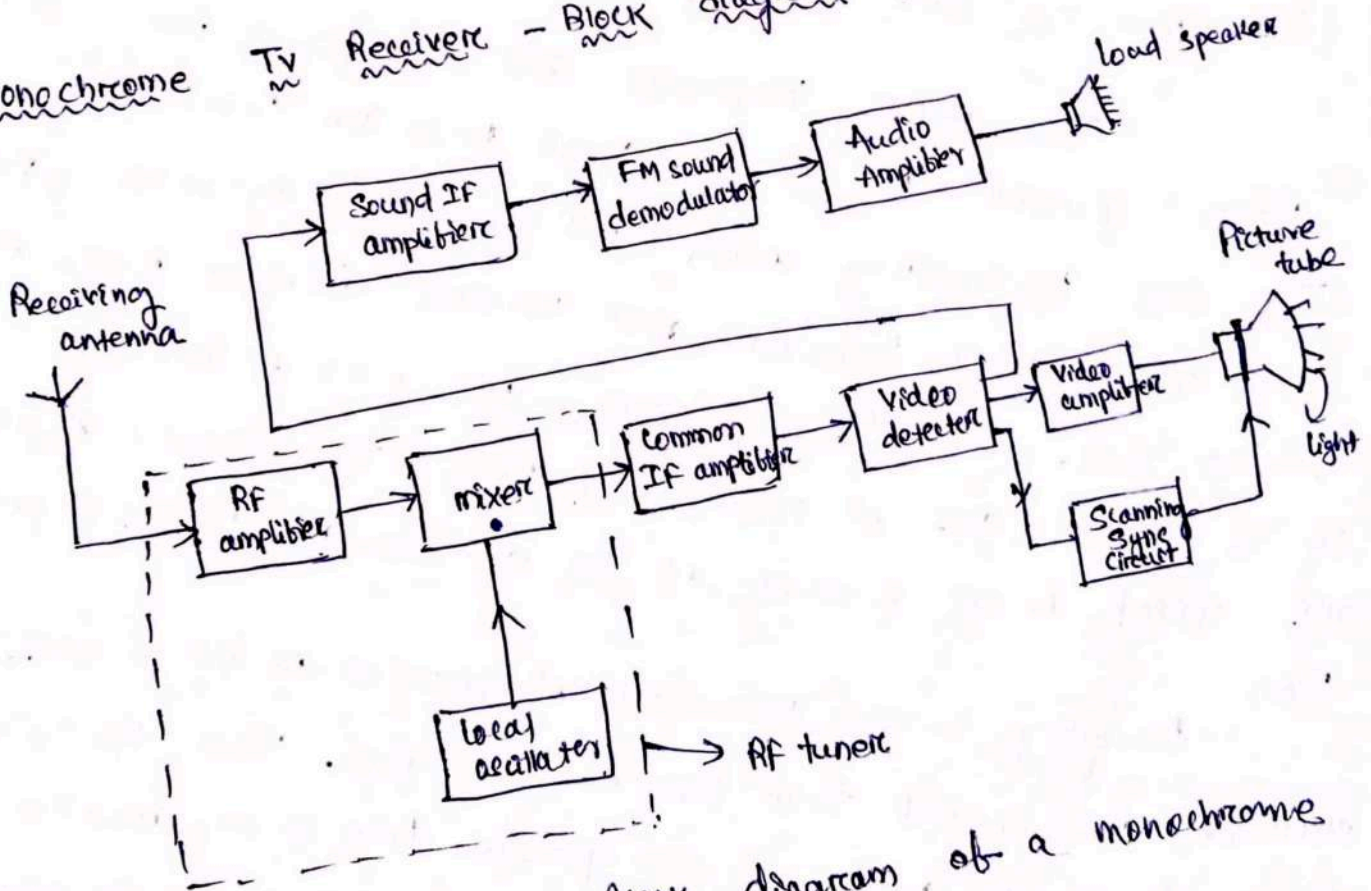
Combining Network :- Combining network combine all modulated signals in some appropriate network before they are applied to transmitting aerial system.

Camera :- Camera viewing the scene. Video signal is generated by a television camera viewing the scene to be televised.

Micro :- Audio signal is produced by a microphone. Microphone picking up sound.

RF amplifier :- It drives the antenna of a transmitter. It converts low radio frequency signal to higher frequency signal.

Monochrome TV Receiver - Block diagram and function of each :-



Elementary block diagram of a monochrome TV receiver.

(40)

The receiving antenna intercepts radiated RF signals and the tuner selects the desired channel frequency band.

The antenna provides RF picture and sound signals for the RF amplifier stage. The RF amplifier stage is then coupled into the mixer stage. The mixer is connected to the local oscillator. The RF audio and video signals are heterodyned into intermediate frequency by the mixer and local oscillator.

The RF amplifier, mixer and local oscillator stages are combinedly called as the RF tuner. The output signal from the tuner circuit is amplified by using a common IF amplifier. Video and ^{audio} signal components are separated by a detector. The sound signals are detected from FM waves, amplified and then fed into the loud speaker, which reproduce the sound.

The video components are first passed into a detector which separates the picture signal from the synchronising pulses. The line synchronising pulses and the frame synchronising pulses are fed into the horizontal and vertical deflector plates of the picture tube. The blanking pulses are given to the control grid of the electron gun of the picture tube. The picture signals are applied to the filament of the electron gun of the picture tube.

According to the variations of potential in the picture, electrons are emitted from the electron gun. Thus, the intensity of the fluorescent screen of the picture tube is in accordance with the variation of potential in the picture and the picture is reproduced.

3.4 Color TV signals (Luminance ⁽⁴¹⁾ signal & chrominance signal, (I & Q, U & V signals))

Luminance signal :- Luminance refers to brightness. The luminance signal is obtained by adding the primary R, G and B color signals in the proportion red 30%, green 59% and blue 11% taking into account the difference in sensitivity of the human eye.

$$Y = 0.30R + 0.59G + 0.11B$$

where Y represents the luminance signal.

and R, G & B are red, green and blue signals voltages.

Chrominance signal :-

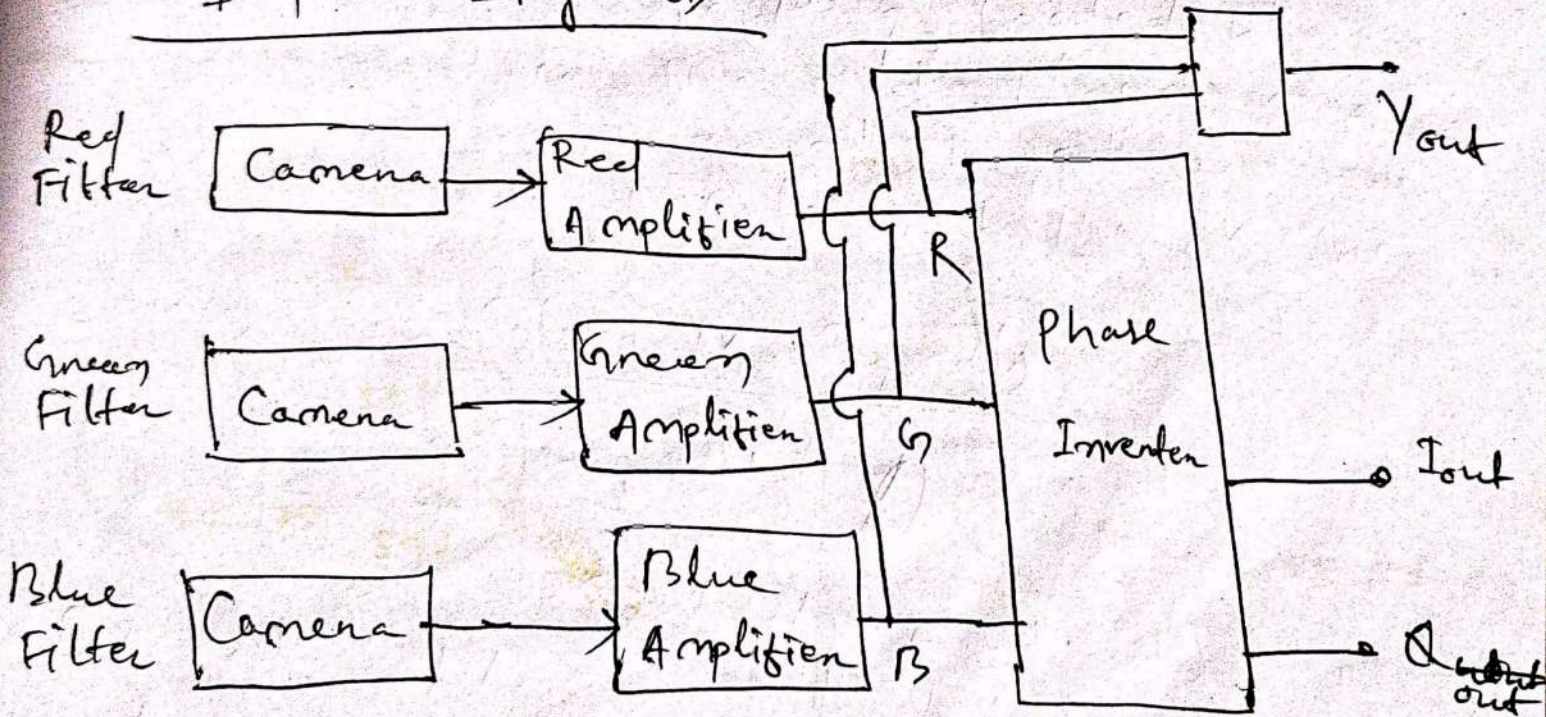
Chrominance means color. Chrominance is the signal used in video systems to convey the color information of the picture.

Chrominance is usually represented as two color difference

components.

$$U = B' - Y \quad \text{and} \quad V = R' - Y$$

I & Q Signals



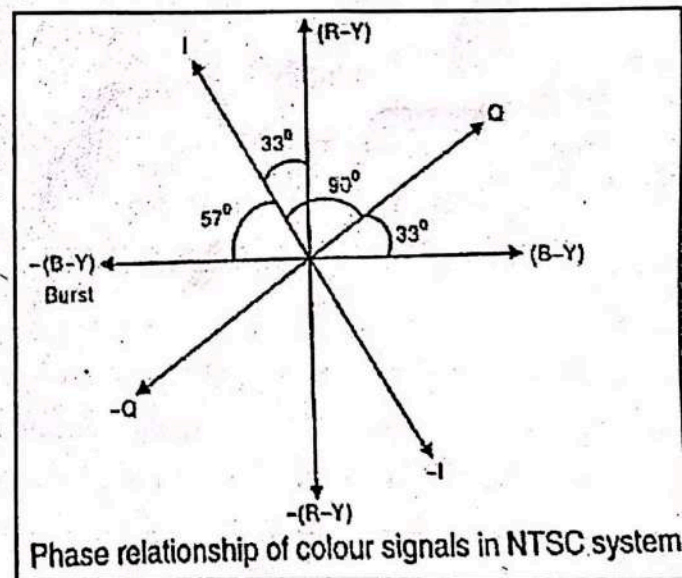
'I' stands for In phase

'Q' stands for Quadrature phase.

These two signals are use in colour TV.

❖ I and Q SIGNAL: -

- > The I and Q signals are derived from colour difference signal that are $(R - Y)$ and $(B - Y)$.
- > The "I" Signal lies in the vision of $+ 33^\circ$ counter clockwise to $+(R - Y)$. The "Q" Signal lies in the vision of $+ 33^\circ$ counter clockwise to $+(B - Y)$.
- > The I and Q signals are always right angle to each other.
- > For I signal, the bandwidth extends to 0.5 MHz on the upper side and 1.5 MHz on the lower side.
- > Thus the Band Width of 2 MHz used for I signal.
- > Similarly Q signal has a channel bandwidth of 1 MHz (± 0.5 MHz).
- > Therefore the Total Band Width required for the I and Q signal is 2MHz.



3.5 Types of Televisions by technology (only comparison based on application):

15/09

(i) CATHODE-RAY TUBE TVs :-

CRT TVs consist of a vacuum with an electron gun that produces an electron beam and a phosphorescent screen into which the electron beam is modulated to create images. Cathode-ray tube technology for televisions, expanding the resolution of screens to 600 (or) more lines of pixels each direction and a frame refresh rate of sixty times a second. (60Hz).

(ii) Plasma display Panels :-

Plasma display panels TVs became the first flat screen alternative to CRT technology. Plasma displays are designed as a cellular grid with pixels that contain plasma, an ionized gas that responds to electric fields. The plasma layer is flanked by electrodes, with glass panels in the front and rear. Plasma TVs use similar phosphor screens as cathode-ray tube TVs, making the color depths similar in both technologies. However, plasma screen technology has considerable faster frame response over CRT 'refreshing up to 600 times a second (600Hz).

(iii) Digital light processing (DLP) :-

DLPs use an optical semiconductor chip with over 1 million mirrors that process digital signals by tilting to varying degrees, reflecting light in different directions to create an image. The resulting smooth viewing experience has several advantages over CRT and plasma TVs, including longer lifespans, lighter weight

and 3D projection compatibility.

(43)

46/09

ged

(iv) Liquid Crystal Display (LCD) :-

LCD technology uses a unique state of matter called liquid crystals. In this state, molecules are fluid but retain a specific crystal such that they are all oriented the same way.

For LCDs, each pixel of the display contains several precisely oriented liquid crystal molecules that are aligned between two electrodes and two polarizing filters.

When the screen is inert, no light can pass through. But when an electric field is applied, the liquid crystals rotate to a degree dependent on the voltage applied, which lets a corresponding amount of light pass through the screen at that pixel. So, by applying different voltages to different pixels across the screen, an image can be viewed.

LCD technology allowing screen sizes ranging from small watches to TVs. LCD screens are flat and light weight having high resolution.

(v) Organic light-emitting Diode Display (OLED) :-

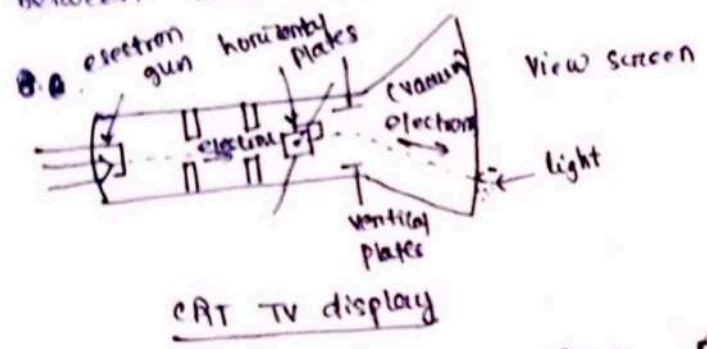
An OLED display contains an organic compound that emits light in response to electricity. The organic compound which can be small molecules (or) polymers, is situated between two electrodes, at least one of which is transparent for viewing the fluorescent compound clearly.

Unlike LCDs, no backlighting is required since the compound itself is light-emitting, so OLEDs can display deeper blacks and than LCD screens and generally display greater contrast ratios in ambient light. They can also be even thinner and lighter than LCDs because filter layers are not required. OLED technology allows for much faster than LCDs. OLED TVs use 40% less power than LCD.

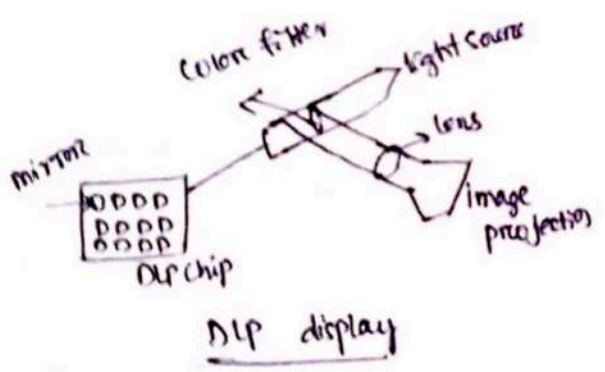
like LEDs, OLEDs can also suffer from the same blurred motion effect when response times are slow. Unlike LED TVs, OLED TVs are quite pricey, ranging into the thousands of dollars.

(vi) Quantum light-emitting diode: — (QLED)

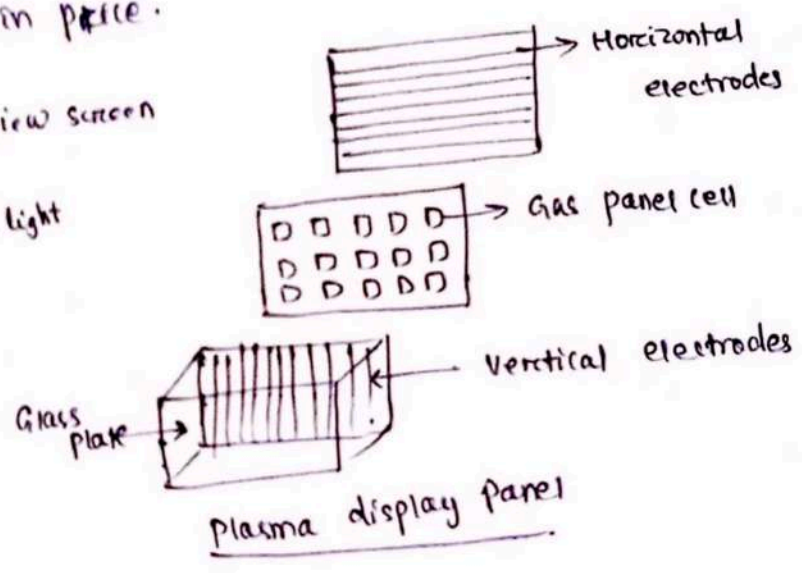
Quantum light-emitting diode displays are the next generation of LED displays. Tiny nanoparticles called quantum dots are embedded in the LED display, which dramatically improves color and brightness. OLEDs still have better contrast ratios over QLEDs, but QLED screens can be larger, last longer, and are not susceptible to burn-in. QLEDs TVs are more affordable than OLED TVs, ranging between LEDs and OLEDs in price.



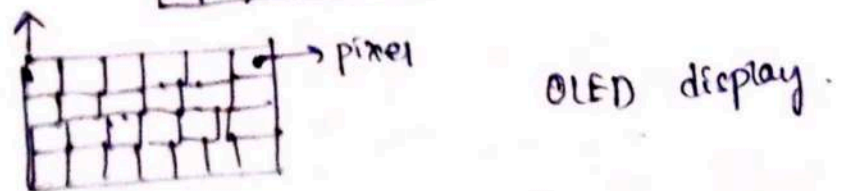
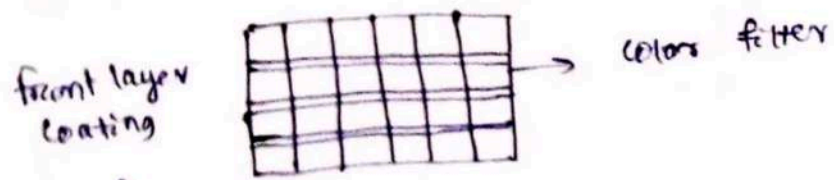
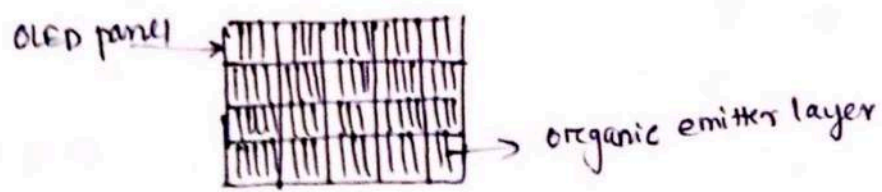
CRT TV display



DLP display



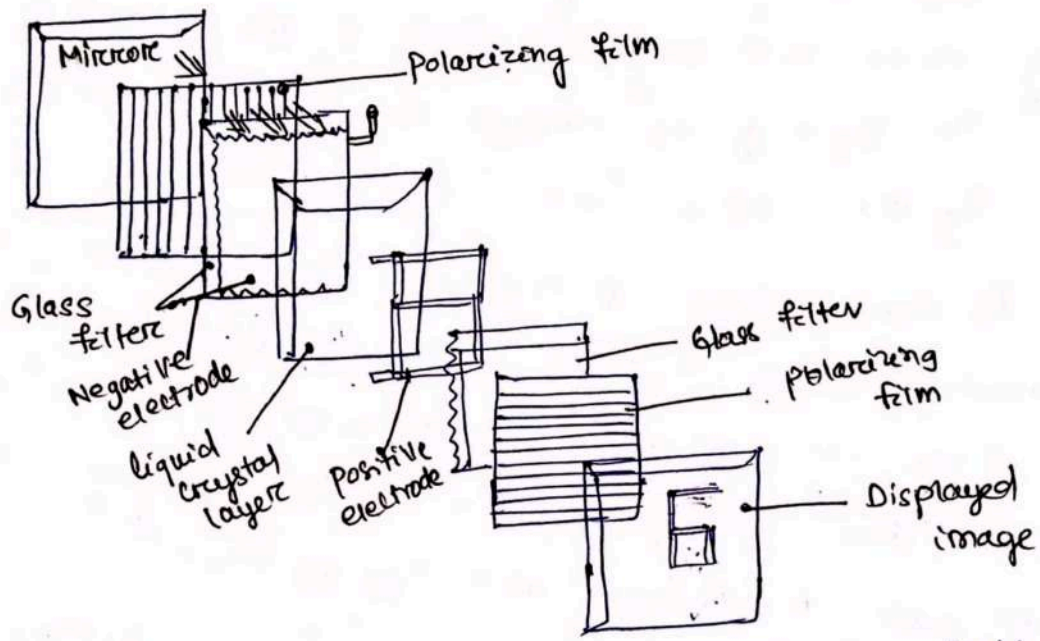
Plasma display panel



3.6. The principle of operation - LCD display, large screen display:

21/09

LCD display:— LCD display is a combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. LCD crystal display is composed of several layers which include two polarized panel filters and electrodes.



The LCD works on the principle of blocking light. While constructing the LCD's, a reflected mirror is arranged at the back. An electrode plane is made of indium - tin oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device.

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So, little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.

46) For making an LCD screen, a reflective mirror has to be set up on the back. An electrode plane made up of indium-tin oxide is kept on top and a glass with a polarizing film is also added on the bottom side. The entire area of the LCD has to be covered by a common electrode and above it should be the liquid crystal substance.

Next comes another piece of glass with an electrode in the shape of the rectangle on the bottom and on top, another polarizing film and they are kept at 90° . When there is no current, the light passes through the front; at the LCD it will be reflected by the mirror and bounced back.

As the electrode is connected to a temporary battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. Thus that particular rectangular area appears blank.

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Large screen display:—

Large screen display means plasma. The central element in a fluorescent light is a plasma, a gas made up of free flowing ions and electrons.

Under normal conditions, a gas is mainly made up of uncharged particles where individual gas atoms have equal numbers of protons and electrons which balance each other so that the atom has a net zero charge.

If many free electrons are introduced into the gas by establishing an electronic voltage across it, the free electrons collide with atoms knocking loose other electrons.

(19) With a missing electron, an atom loses balance to become an ion with a net positive charge.

In the plasma, electric current flows through it, negatively charged area. So in rush, particles are constantly hit into each other.

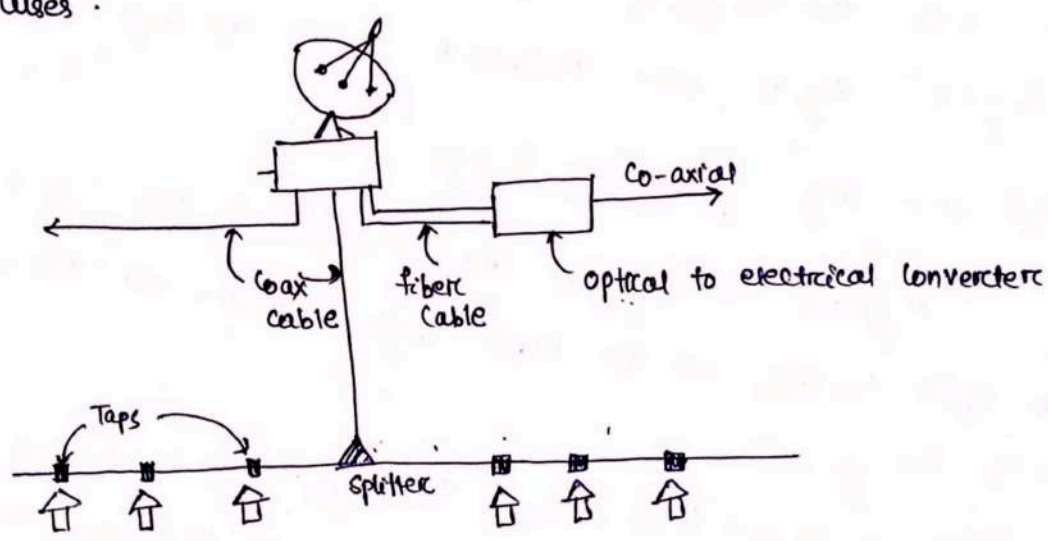
These collisions excite gas atoms in the plasma, causing them to release photons of energy in the form of ultraviolet light.

The ultraviolet photons cause the release of visible light photons that illuminate the display.

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8.7. CATV systems and Types & networks :-

CATV systems stands for cable television system. It is a system of delivering television programming to consumers via radio frequency signals transmitted through co-axial cables (or) through light pulses.



Cable TV networks

TV network companies beam their TV shows via satellite. Cable operators install control centres for cable network for aggregation of TV channels received from different satellites. One has to then program his/her cable ready television sets to receive the cable channels.

There are three types of CATV system :-

- (i) twisted pair
- (ii) Fiber optic cable
- (iii) Co-axial cable.

(42) 25/09

Digital TV Technology - Digital TV signals, Transmission of digital TV signals & Digital TV Receiver video programme processor unit?

The digitization of TV signals can take two forms. In composite coding, the composite NTSC, PAL (or) SECAM signals are quantized, the resulting digitized signals are referred to as 'digitized video'. PAL signals can be digitally coded and decoded satisfactorily, and there are no difficulties in sampling PAL at multiples of line (or) color subcarrier frequencies.

SECAM presents some problems as the color signals are not available simultaneously.

In component coding, the luminance and chroma signals (Y, U, V) (or) the Red, Green and Blue (R, G, B) from the camera rather than the composite video are separately digitized, when the digitized signals are referred to as all digital video.

26/09

Transmission of Digital TV signals:-

Digital TV signals are transmitted via copper cables, fibre optic cables, or for over digital microwave radio or satellites relay links.

The digital transmission technique can be bit-parallel (or) bit serial. Bit parallel transmission is usually employed for interconnections of digital hardware within a studio complex.

Bit-serial transmission is used for video transmitting digital video over longer distances. Telecommunication networks are rapidly adapting to all digital environment and in order to optimally utilize the transmission capabilities, the digital networks are highly structured in architecture.

A digital TV signal transmits in "packets" of compressed data. The data uses a combination of 0's and 1's. Digital TV converts the picture into a stream of 0's and 1's. (49)

Digital TV Receiver :-

A digital TV receiver is a set-top box that permits the reception of digital television. outputs digital surround sound, processes and renders internet and interactive TV services.

A digital satellite receiver takes this compressed digital TV signal and converts it into an analog format that a typical television set can output. When this signal transmission reaches the subscribers, the digital satellite receiver extracts individual channels and feeds it to the television set.

Video Programme Processor Unit :-

The video processing unit (VPU) is a multi standard video codec (encoder / decoder) capable of simultaneously handling multiple streams by time multiplexing. |29/09

It is a specialised processor which takes video stream as input and has the capability to perform highly complex processes on the input stream. Because processing an video stream means performing calculation on each pixel value of multiple frames of the video, which is a huge amount of data which is not possible without a VPU. VPU contain accelerators which speed up the calculation and few compressors which extract the path of the data.

Microwave Engineering

Advantage and its application

Microwaves are very short waves. Microwaves are EM waves whose freq. range from 300 MHz (100cm) to 300 GHz (0.1cm).

It is also called define their wavelength. Micro in the sense tiny, in wave length λ is very short.

It is used for point-to-point comm.

Advantages of Microwave

The microwave spectrum has large bandwidth and hence large amount of information can be transmitted using it. (VHF, UHF)

In this technology helps to manage crowded spectrum with the use of high selective receive modulation (SSB, PSK, ~~QPSK~~) and spread spectrum technique, data compression etc.

Other advantages are

- Greater directivity
- Small size of antenna
- Low power consumption
- Effect of fading
- Transparency property of microwave.

Application :-

There are many application represents,
Like Industrial, Scientific, medical & domestic
Others application of microwave

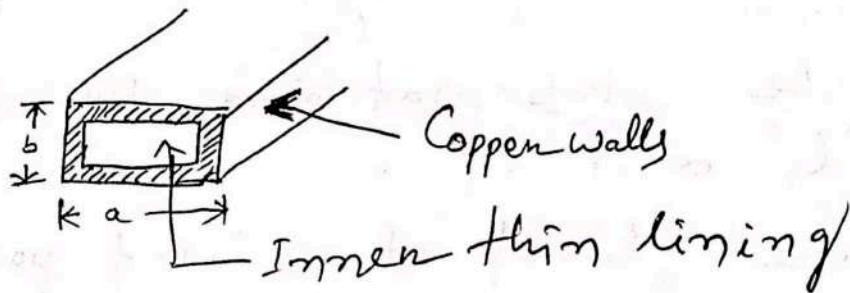
- Telecommunication
- Remote Sensing
- Heating
- Commercial & Industrial application
- Medical Science.

Microwave waveguides

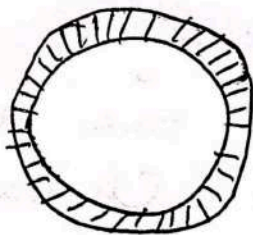
A hollow metallic tube of uniform cross-section for transmitting electromagnetic waves (or) microwave signals wave by successive reflection from the inner walls of the tube is called 'microwave waveguide'.

Types of wave guide

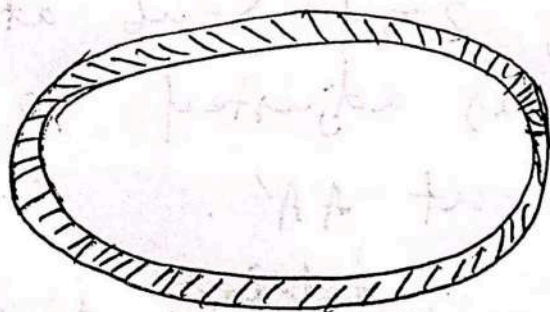
(1) Rectangular wave guide



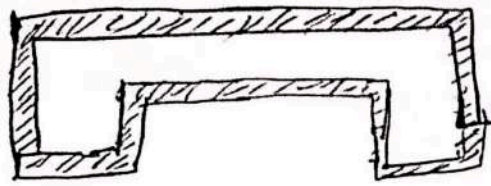
(2) Circular wave guide



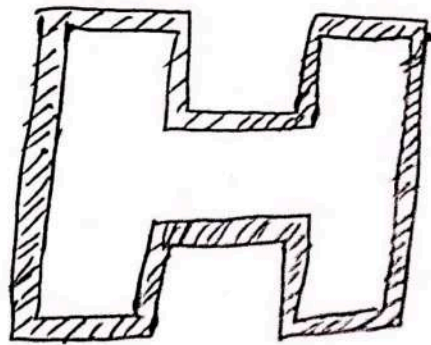
(3) Elliptical waveguide



④ Single RIDGED wave guide



⑤ Double Ridged wave guide



OR

Microwave wave guide

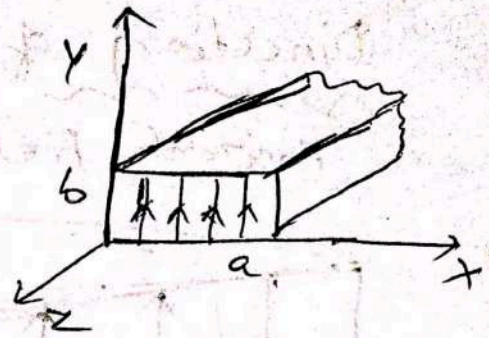
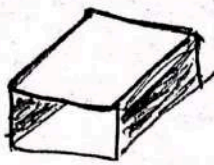
- A wave guide is a structure that guide wave such as, EM waves with minimal loss of energy by restriction on only to one dimension or two.
- A wave guide is the type of transmission line which carries microwave freq. from source to load. The energy is in the form of electric field & magnetic field which are perpendicular to each other the electric field & magnetic field inside.
- The wave guide is also perpendicular to the direction of propagation as the energy is in the form of electric or magnetic field.
- Therefore, it is capable to handle the high power of micro wave length of freq. wave guide is used for airborn radar, satellite comm, ground radar, navigation etc.

Types of wave guide

There are two types of the wave guide

- (1) Rectangular wave guide
- (2) Circular wave guide

Rectangular wave guide



→ The rectangular wave guide is designed from conducting material in rectangular shape which is hollow from the center and fully polished from interior. The outer surface is insulating material or paint for avoid dust and rust. It has many application used.

A lot of components such as isolators, detectors, attenuator, coupler & slotted lines,

A rectangular wave guide cannot propagate below some certain freq. This freq. is called cut-off freq.

A rectangular wave guide support TM & TE modes but not TEM wave because we cannot define a unique voltage since there is only one conductor in a rectangular waveguide.

where,

a = inside width (m)

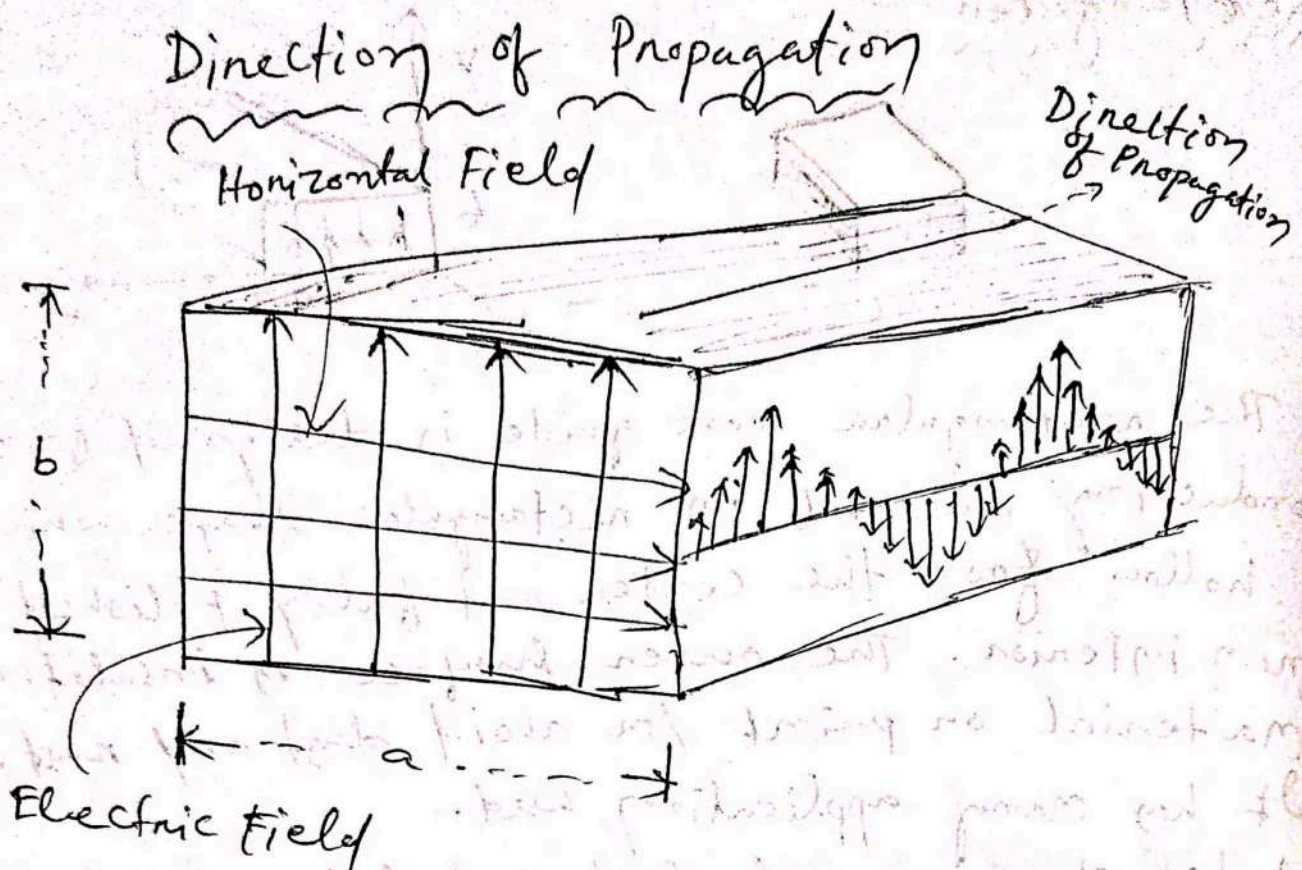
b = longest dimension

m = inside height

N = number of $1/2$ wave length.

$$(f_c)_{mn} = \frac{1}{2\pi\sqrt{\mu\epsilon}} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

$$(\lambda_c)_{mn} = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$$



A rectangular waveguide where two dimensions show. one is the broad dimension of the end is the narrow dimension.

The broad dimension is denoted by 'a' and the narrow is by 'b' in the wave guide the electric-field and the magnetic-field carry the signal from source to load.

In this case electric field and the magnetic field is perpendicular to each other at the same time.

These fields are perpendicular to the direction of propagation. Inside side the wave guide horizontal field is perpendicular to 'a' and vertical field is perpendicular to 'b' according to the freq. both horizontal and vertical field change its amplitude & direction.

Advantages of Rectangular Waveguide :-

- Easy Manufacture
- No inner conductor
- No supporting dielectric
- Power handling Capacity is more.

Propagation of EM wave through wave guide TE & TM modes

The EM wave in a (metal pipe) wave guide may be imagined as, travelling down the guide in a zig-zag path being repeatedly reflected betⁿ opposite wall at the guide.

The signal through wave guide is propagated by different modes.
Wave guide modes

There are two modes

(1) TE mode.

(2) TM mode

→ TE mode are four types

↳ TE₁₀ mode (1), TE₁₁ mode (2), TE₂₀ mode (3), TE₀₁ mode (4)

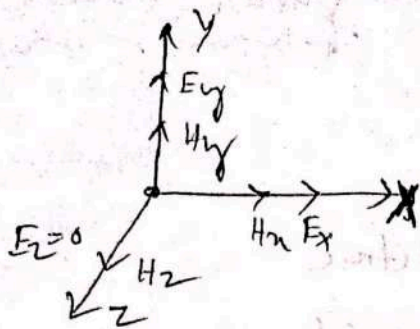
→ TM mode are two types

↳ TM₁₁ mode (1), TM₂₁ mode (2)

TE modes

The TE stands for transverse electric mode. When the electric field of the signal is perpendicular to the direction of propagation through wave guide, it is called the TE mode.

So $E_z = 0$, but $H_z \neq 0$

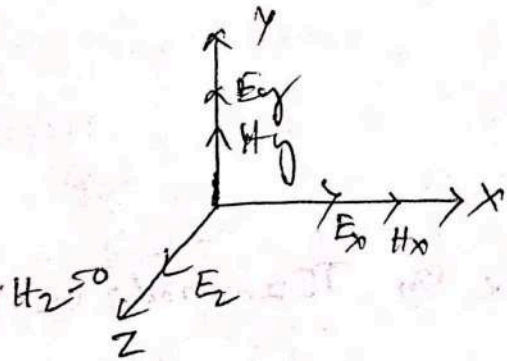


(So no electric field Component (E_z) along propagating/direction (in z direction))

TM Mode

The TM stands for Transverse magnetic mode. When the propagation takes place through wave guide in TM mode, the magnetic field is perpendicular to the direction of propagation and electric field is in the direction of propagation and electric field is in the direction of propagation. It is called TM mode.

So $H_z = 0$, $E_z \neq 0$

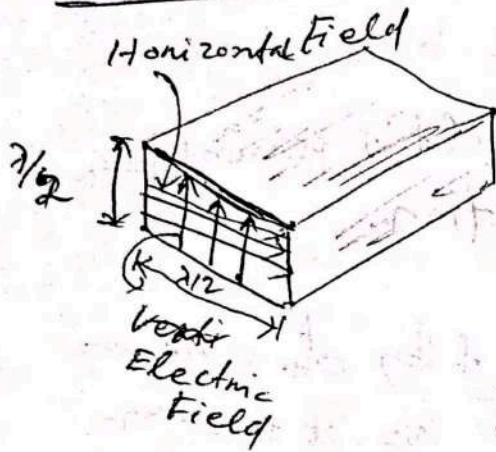


(So no magnetic field Component (H_z) along propagating/direction (in z direction))

TE mode

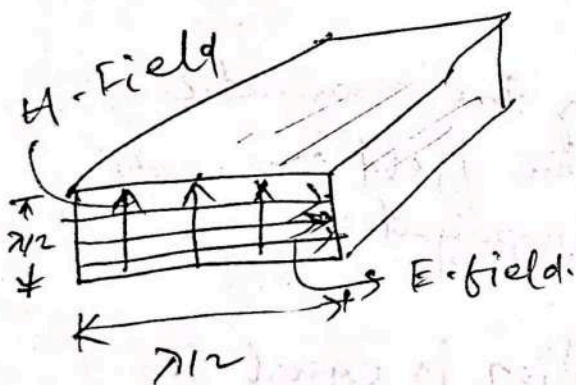
The TE mode is sub divided into four modes

(1) TE₁₀ mode



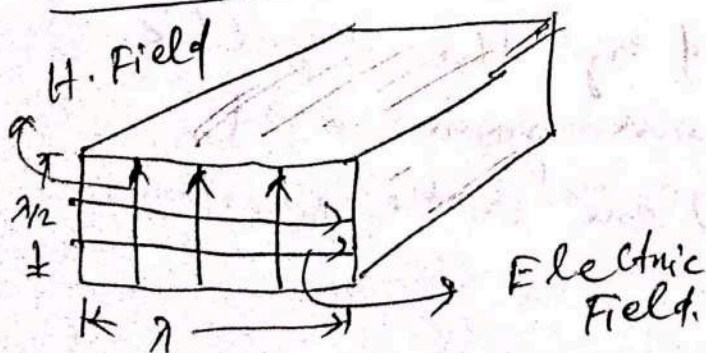
The TE₁₀ means that during propagation through wave guide the electric field is perpendicular to the direction of propagation. It is equal to $\lambda/2$ across the broad dimension & magnetic field is less than $\lambda/2$ (half wavelength)

(2) TE₁₁ mode



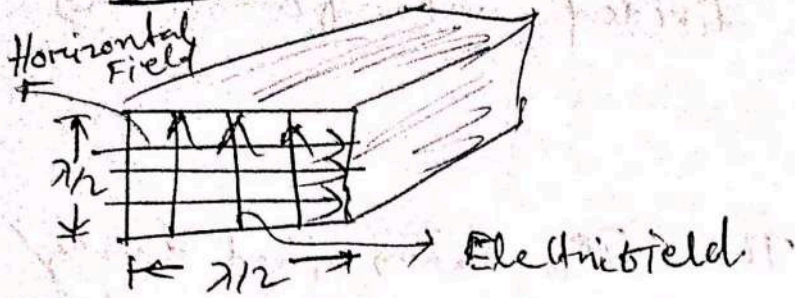
The TE₁₁ means that during propagation through wave guide the electric field & magnetic field is perpendicular to the direction of propagation. It is $\lambda/2$ across the broad dimension and the magnetic field is also $\lambda/2$ across the narrow dimension.

(3) TE₂₀ mode



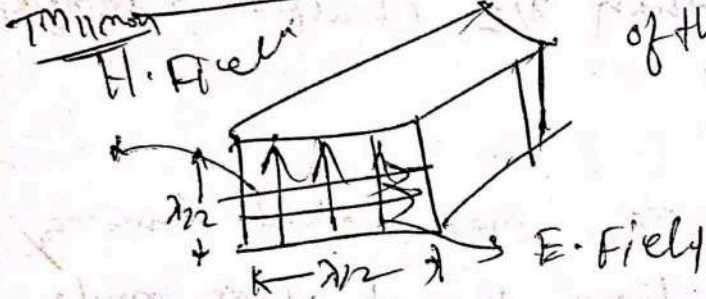
It is less than the λ of the magnetic field. The TE₂₀ mode means that the electric field is perpendicular to the direction of propagation

TE₀₁ mode



The TE₀₁ means that electric field is perpendicular to the direction of propagation.

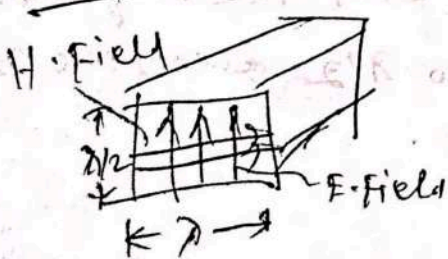
TM mode



Both (a) & (b) dimension of the waveguide are equal to $\lambda/2$ of the freq.

The signal is carried by the magnetic field components and electric field components are in the direction of propagation.

TM₂₁ mode

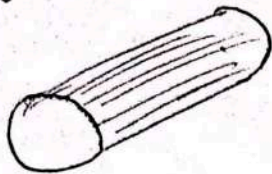


(a) Dimension is equal to complete wave length of freq.

(b) dimension is equal to half wave length of freq.

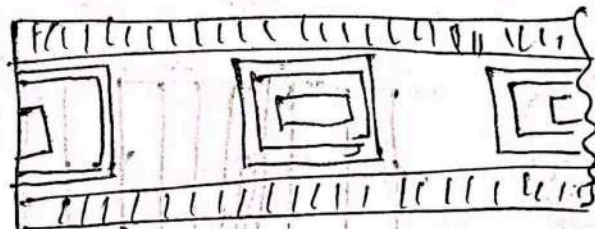
The signal is carried by the magnetic field component through wave guide. And electric field components are in the direction of propagation.

Circular wave guide

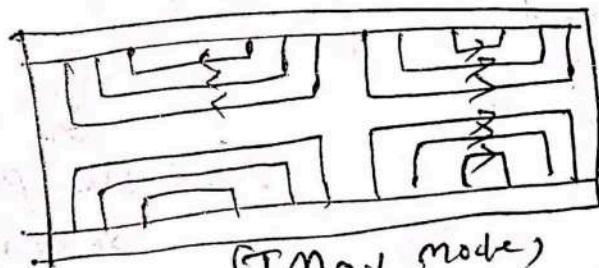
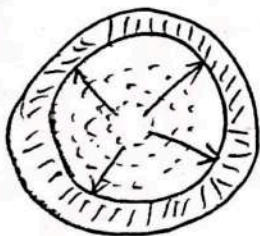


It is designed from a conducting pipe which is hollow from the center & polished from interior portion.

It is similar to rectangular wave guide except its geometry. It is made up independent of the cross section shape and dimensions of the guide.



(TE₁₁ mode)



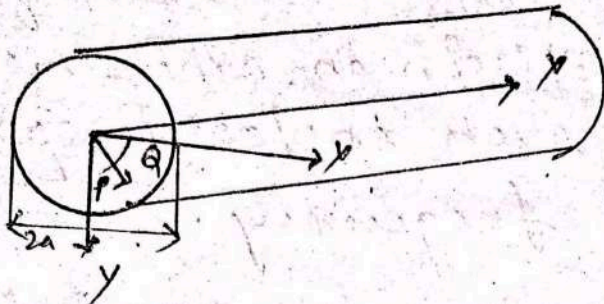
(TM₀₁ mode)

All the parameters and definitions involved for rectangular wave guides apply to circular wave guides with the minor modification that modes are tabbed.

This must be different because of the different geometry and it is given by

$$\lambda_0 = \frac{2\pi r}{k_n}$$

where, r = radius (internal) of wave guide.
 k_n = solⁿ wt a base funⁿ, eqⁿ and circle with a radius 'r' giving.



$$A_c = \pi a^2$$

Cross-section view of circular wave guide

Advantage -

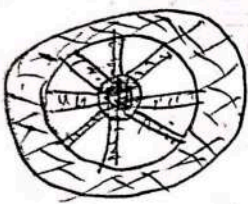
- It is easy to manufacture circular wave than rectangular wave guide.
- The coupling of circular wave guide is easier than rectangular wave guide.
- It became significant if longer distance wave guide transmission is considered.

Disadvantage -

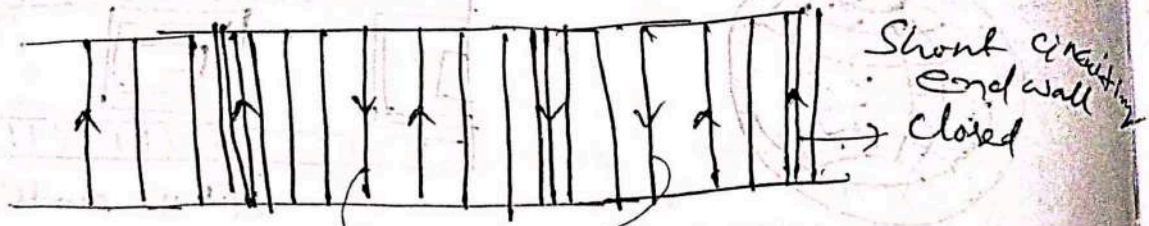
- The main disadvantage associated with a circular wave guide is that its cross section will be much bigger in area than that of rectangular wave guide used to carry same signal.

Cavity Resonator

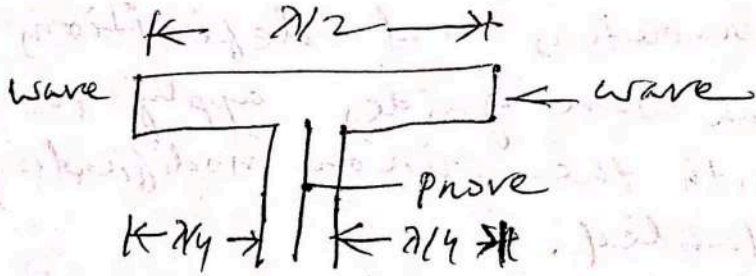
It is a piece of wave guide closed off at both ends with metallic plates where the propagation in the longitudinal direction took place in the wave guide.



Resonant Cavity Resonant.



Suitable positions for Second wall



If conducting end walls are placed in the wave guide then standing wave on oscillation will take place if a source is coupled betⁿ the walls. The reflected signal then reinforced the i/p signal at the probe & the result is back

Signal will be bounced back.

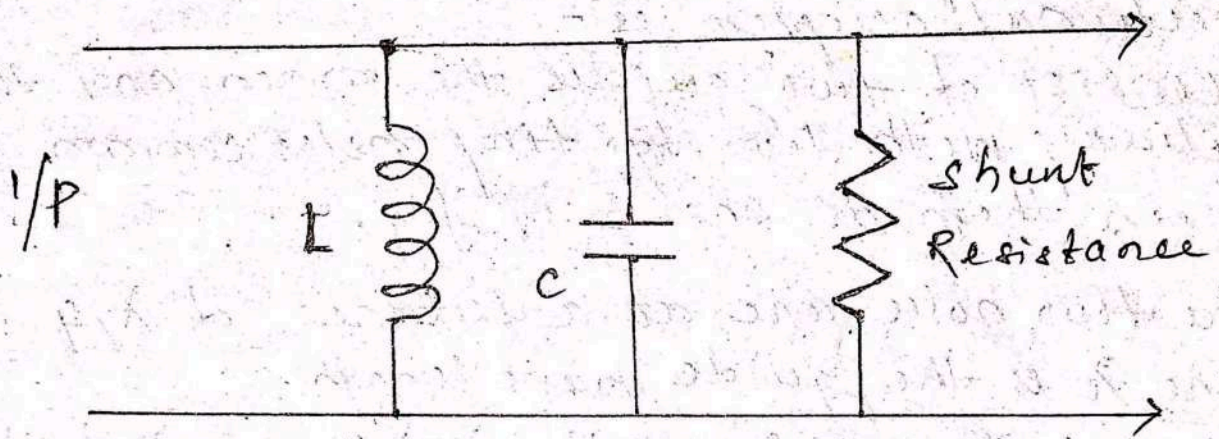
They are oscillation to be produce by reflected signal inside the power. The freq. at oscillation is called the resonant freq. is given by

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

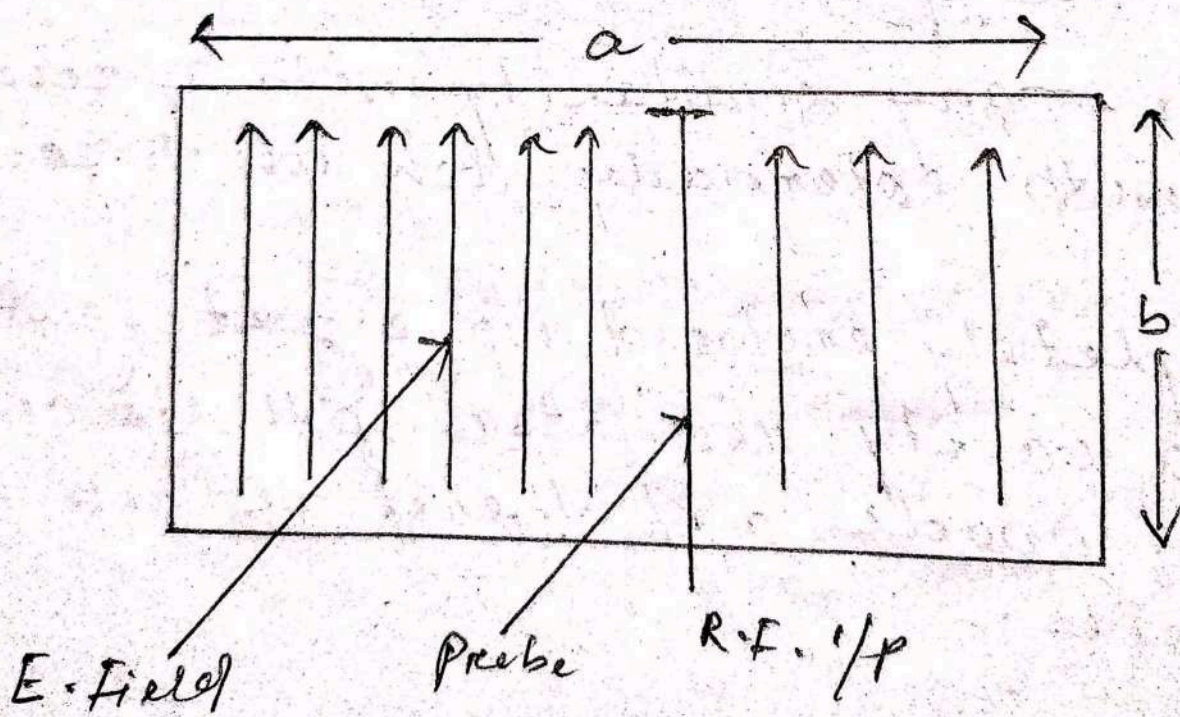
Parallel Resonant Circuit

When the microwave signal freq. is made equal to resonant freq. of the wave guide.

It is used for microwave freq. resulting device.



L-C equivalent ckt of Cavity resonator



→ This is due to when a pulsed energy is fed to the structures of cavity and the cavity is maintained in sinusoidal oscillation due to fly wheel effect and the pulsed energy which contains harmonics which is fed to cavity therefore there is oscillation takes place at harmonics frequencies.

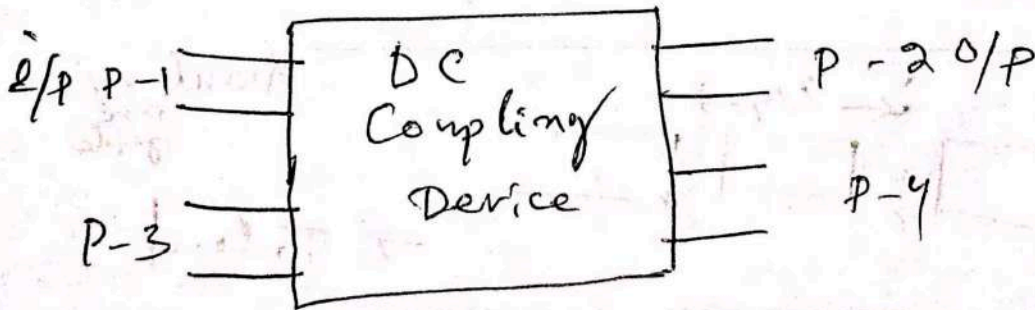
→ The result which is in the form of shapes are come out are in odd shapes which ensure that various oscillating frequencies are not harmonically related.

Application -

- It is used as a cavity meter for micro-wave frequency measuring device.
- This used in filter ckt or used in co-junction with mixers.
- It is used as a cavity wave meter for measuring of microwave frequency.

Directional Coupler

It is four pole wave guide function to which the i/p one port direct to other port for its o/p without reflection.



Here Two wave guide is;

- (1) Probe wave guide
- (2) SWS

All the ports are terminated and there char^s impedance & there is no reflection betⁿ P_1 & P_2 Similarly there is no transmission betⁿ P_1 & P_3 & P_2 & P_4 .

Because of Coupling the opp ports are P_3 & P_4 the coupling function is derived from the

$$C_{dB} = 10 \log_{10} \left(\frac{P_1}{P_4} \right)$$

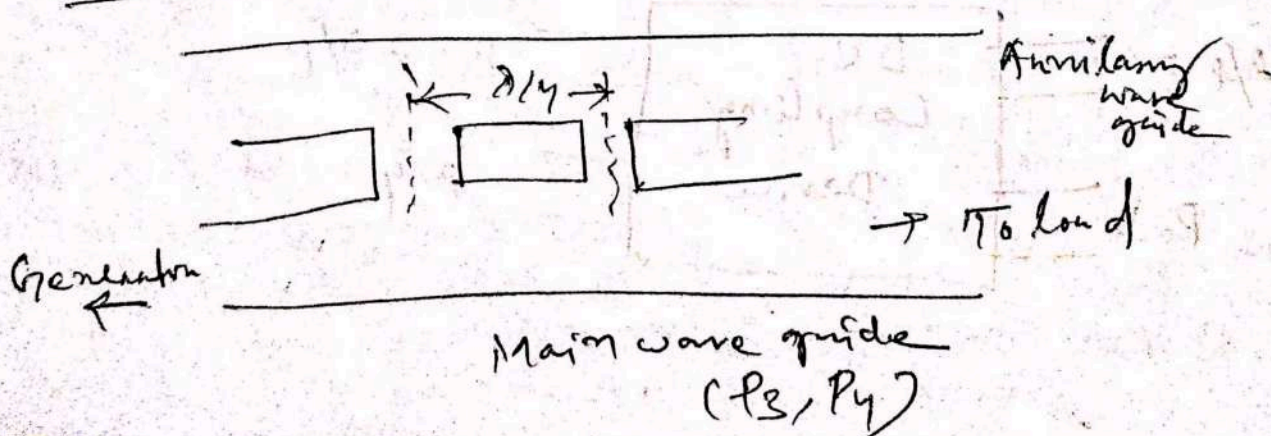
It is expressed in dB, how much incident power on signal is sample. How much incident power is same direction

$$D_{dB} = 10 \log_{10} \left(\frac{P_4}{P_3} \right)$$

It $P_3 = 0 \Rightarrow D = \infty$

But the practical value of 'D' is betⁿ 30 to 40 dB. The directional Coupler are available in different types like one hole, two hole.

Two hole directional coupler



It should be two hole directional coupler which consist of auxiliary wave guide (P_1, P_2) and main wave guide (P_3, P_4). The generator and load are shown in fig. In wave circuit an antenna used at the primary wave to detect the signal which is directly proportional to the reflect signal of the main wave guide. The signal energy is stored in P_1 & P_2 passed to the hole which are placed at $\lambda/4$ apart.

After passing the hole the signals are entered into secondary wave guide where it is added in the main wave guide and results a signal with same phase to pass in the forward direction towards the load. If the signal are reached from P_3 to be canceled out & will be in out of phase.

$$\text{Coupling factor } (C)_{dB} = 10 \log_{10} P_1/P_4$$

$$\text{Directivity } (D)_{dB} = 10 \log_{10} P_4/P_3$$

ISOLATORS

It is a microwave device that absorb the reflected energy in one direction and it provide less less transmission in other direction.

That means if isolators are components from reflection of other component.

These are a type of isolator i.e finite isolator.

Construction

It consist of two rectangular wave guide at the two ends i.e the beginning and at the end.

A circular wave guide in middle portion of the two rectangular wave guides are connected.

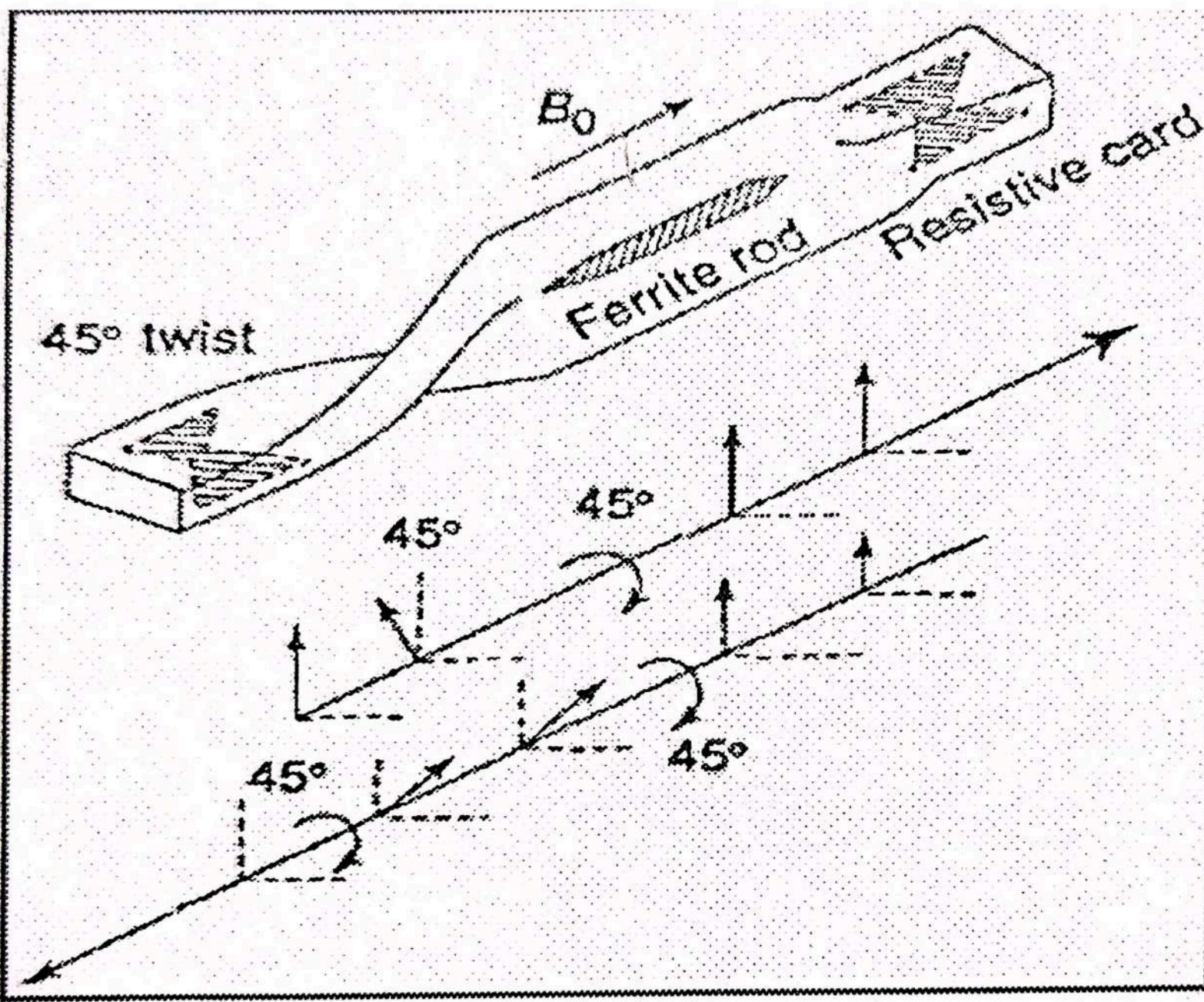
So both rectangular and circular wave guide are operate in TE_{10} dominate mode i.e Transverse electric dominate mode. (i.e port 1 & port 2)

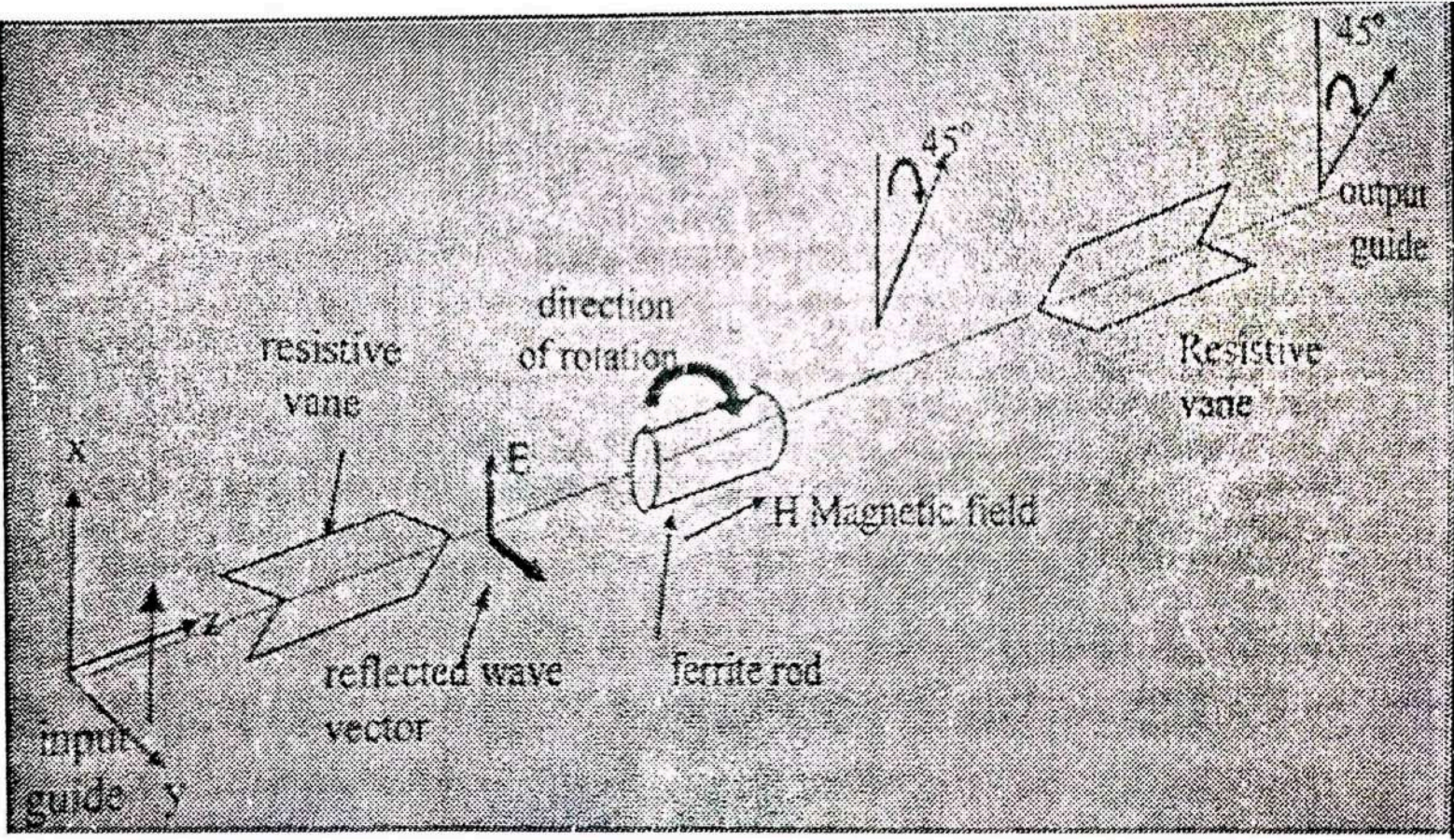
A thin "pencil" of ferrite is coated inside the circular wave guide supported by poly foam and the surrounded by permanent magnet.

Both ferrite rod and permanent magnet exhibit repulsive magnetic field due to which the signals pass where it is rotated in 45° .

All the device are in one axis
i.e. Z axis.

This rotation is known as Faraday's rotation.





operation

When a signal enters in the ip wave guide at that time electric field is perpendicular to 1st resistive core, which is in x-axis. = Core

Then the signal is passed through the ferrite rod and 2nd resistive varn which polarizes to 45° due to Faraday rotation.

Hence the change in field is observed.

The change in field allow the signal to pass through 2nd resistive varn and pass field towards η without any change.

That means the transmission without any attenuation of the signals.

So, the reflected signal will be 45° changed towards left & to pass through ferrite rod. As a result will be again 45° change means the signal will be parallel to its resistive vane.

Now, signal passing from parallel resistive vane, it will be observed by that vane. Therefore, the reflection signal will not interfere with incident signal.

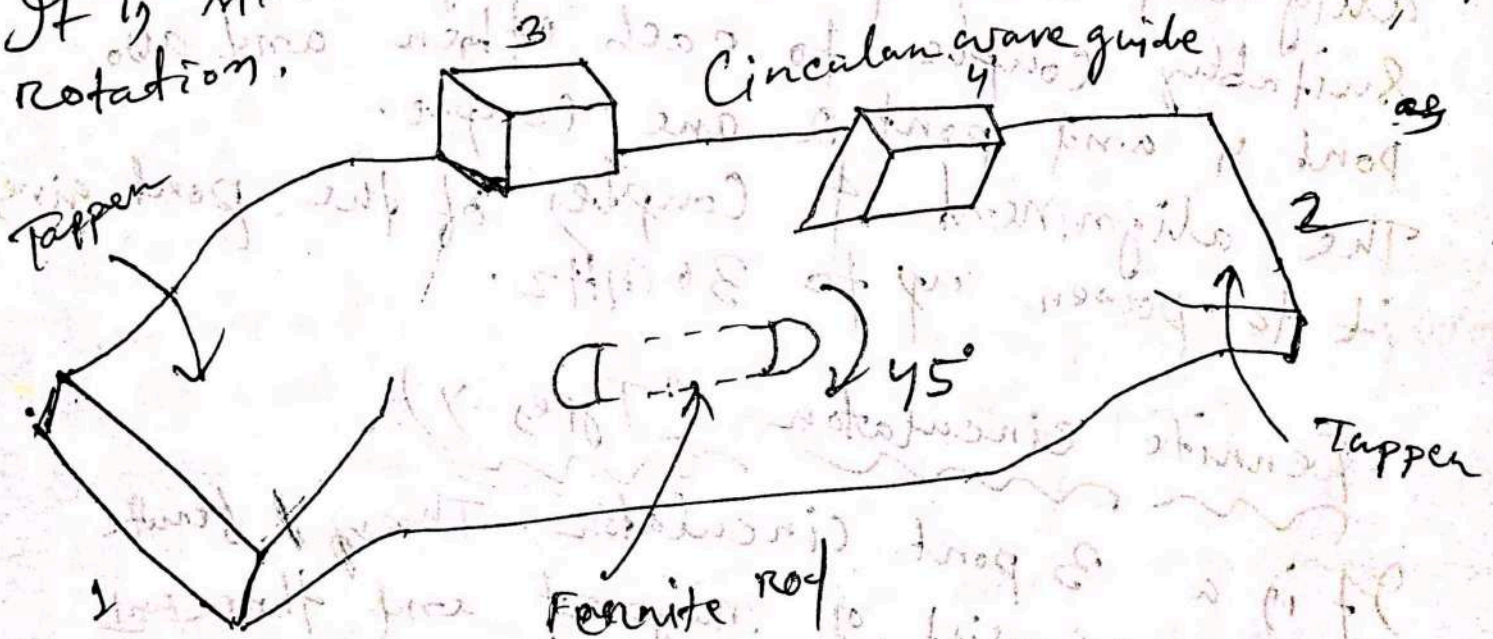
Circulator :-

It is a microwave device used to Isolate its input and output.

It ensures Isolation of transmitter and receiver connected to same antenna.

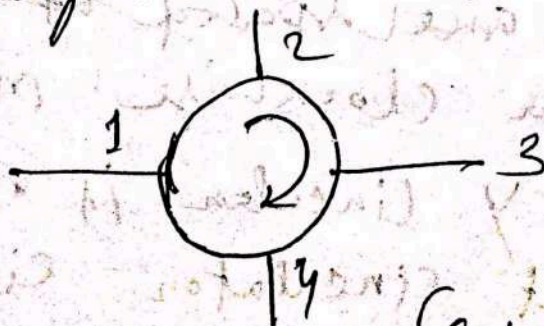
Construction :-

The diagram on fig shows that the Construction of a four port Faraday Rotation, Circular. In this each ports is connected to the next port in a clockwise manner. It is similar to Isolator in respect of Faraday rotation.



Magnet omitted for simplicity

(Faraday Rotation of 4-port Circular)



(Schematic Diagram)

Operation

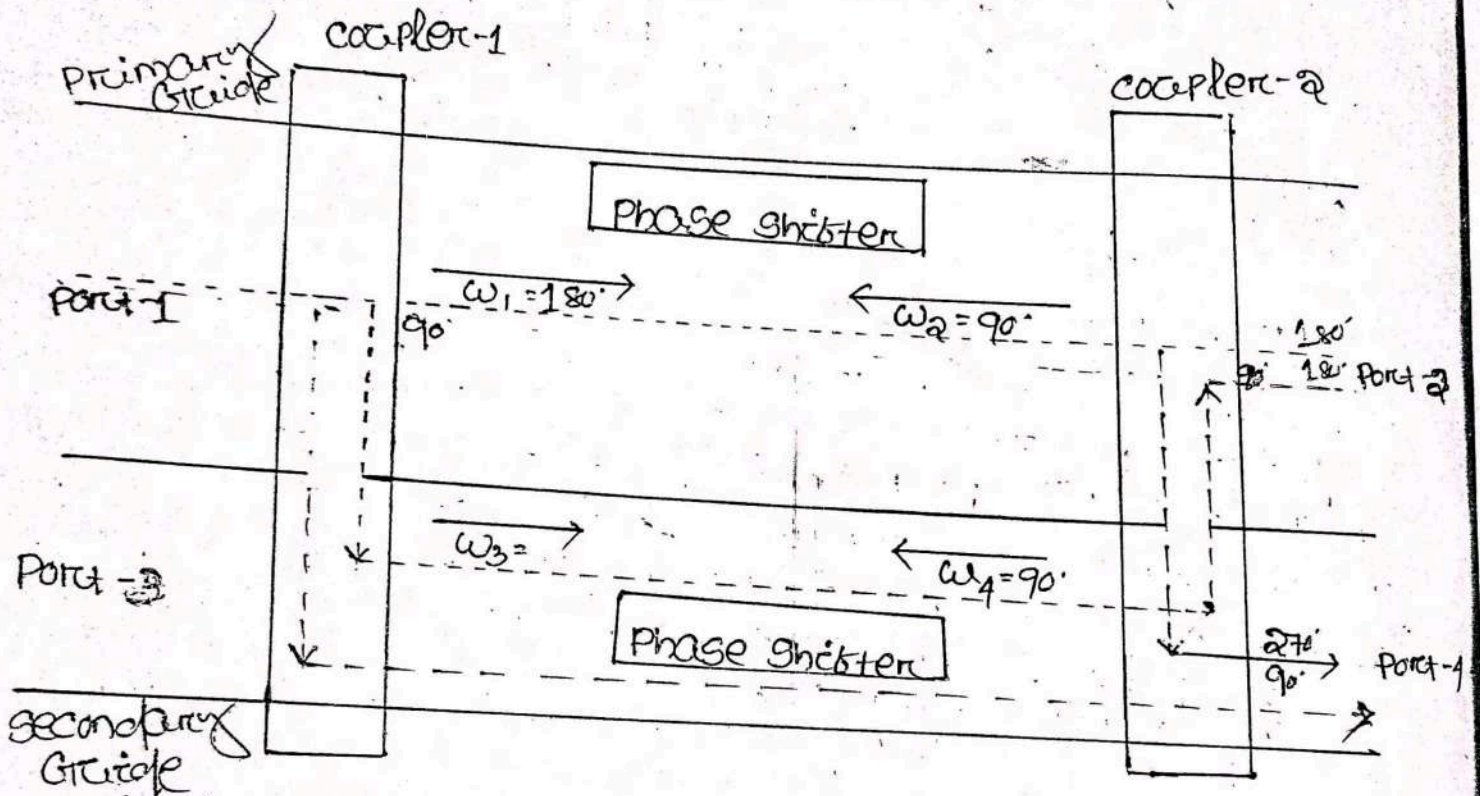
The power enters to the circular on port 1 and is converted to TE mode when it passes through circular wave guide.

After that it passes through port 3 without any attenuation and not being effected. and then it is rotated at 45° and passes through port 4 and finally to port 2 to get desired output.

Here the port 1 and port 3 are suitably aligned and port 3 and port 4 are suitably coupled to each other and also port 4 and port 2 are coupled.

The alignment of couples of the ports give it its power up to 30 MHz.

* Each of two 3dB couplers in circulator introduces a phase shift of 90° .



- * When a wave is incident to Port 1 the wave is split into two components by coupler 1.
- * The wave in the primary guide arrives at Port 2 with a relative phase change of 180° .
- * The second wave propagates through the two couplers and the secondary guide and arrives at Port 2 with a relative phase shift 180° .
- * The wave travels through coupler 1 & secondary guide, and it arrives at Port 4 with phase shift of 90° .
- * As two waves reaching Port 4 are out of phase by 180° , power transmission from Port 1 to Port 4 is 0.

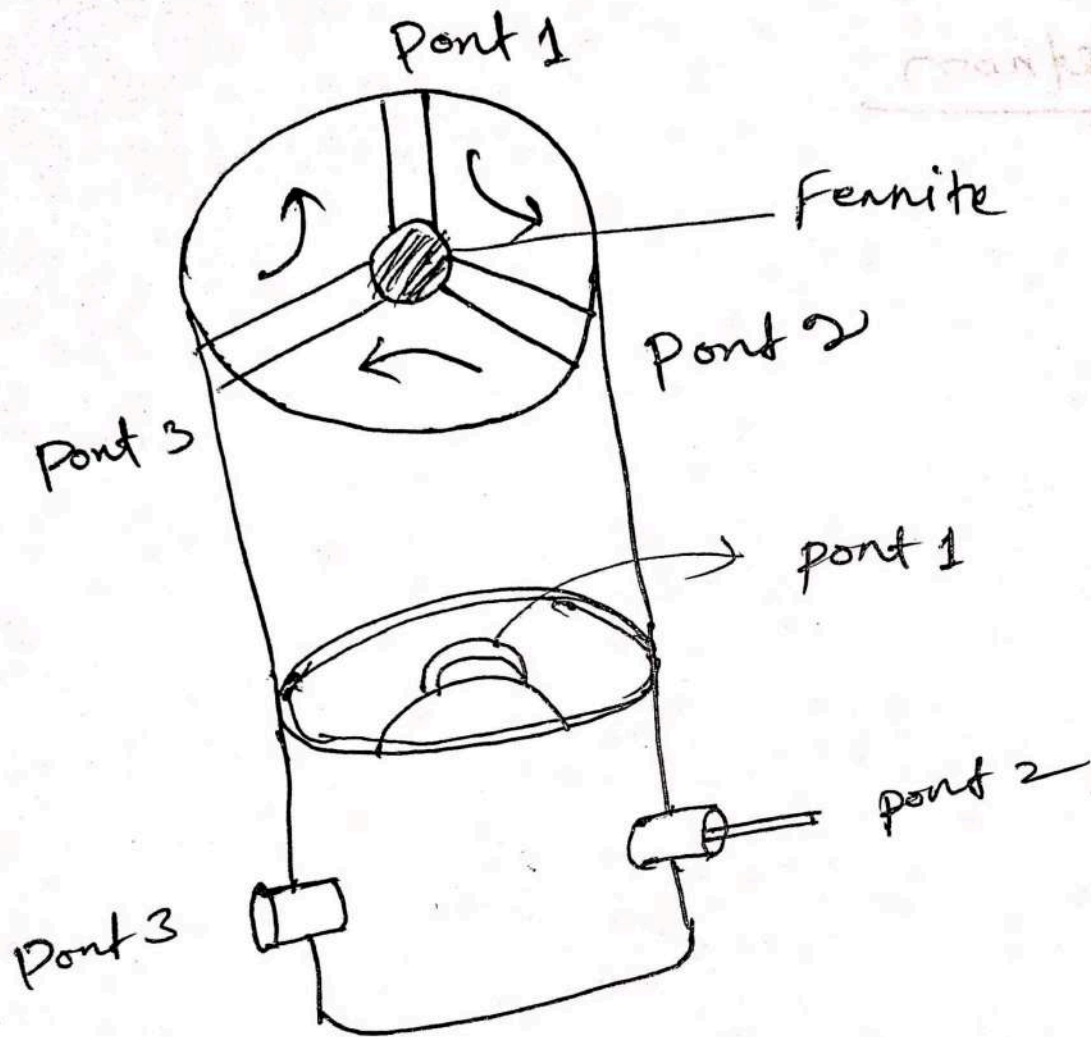
Ferrite circulator (Type-Y)

It is a 3 port circulator. The ferrite circulator consist of magnet and three ports having 3 conductor and ferrite.

Conductor are spaced at 120° apart.

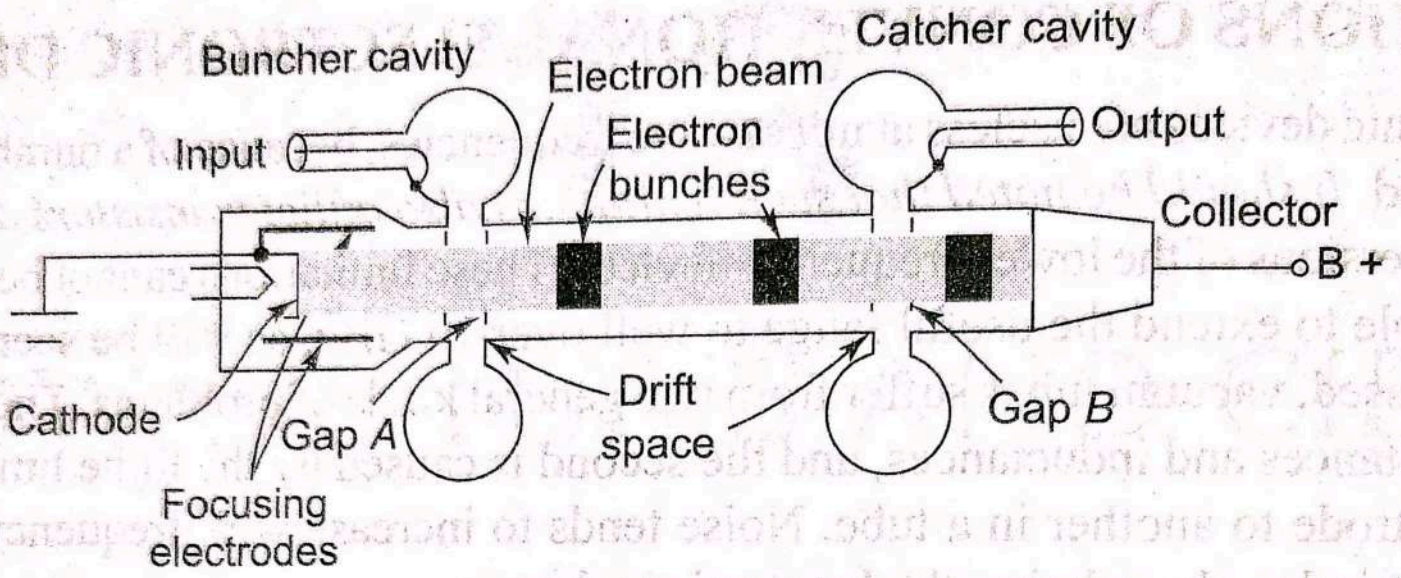
The signals are spaced at center to the port in a clockwise manner.

The funⁿ of Y circulator is similar to the four port circulator circuit.



TWO CAVITY KLYSTRON

- The two cavity klystron is widely used amplifier operated by the principle of velocity and current modulation.
- It consists of a vacuum tube having electrode inside it.
- The input cavity at which applied as buncher cavity and output is taken as catcher cavity.



Operation -

In the above fig. at buncher cavity the electrons are generated and hence are passed forward the right. The microwave signal is given at the input through buncher cavity. The emitted electron from the cathode passed through the focusing anode with a narrow beam.

Those narrow beams of electrons when pass through bunches cavity produce frequency of oscillation

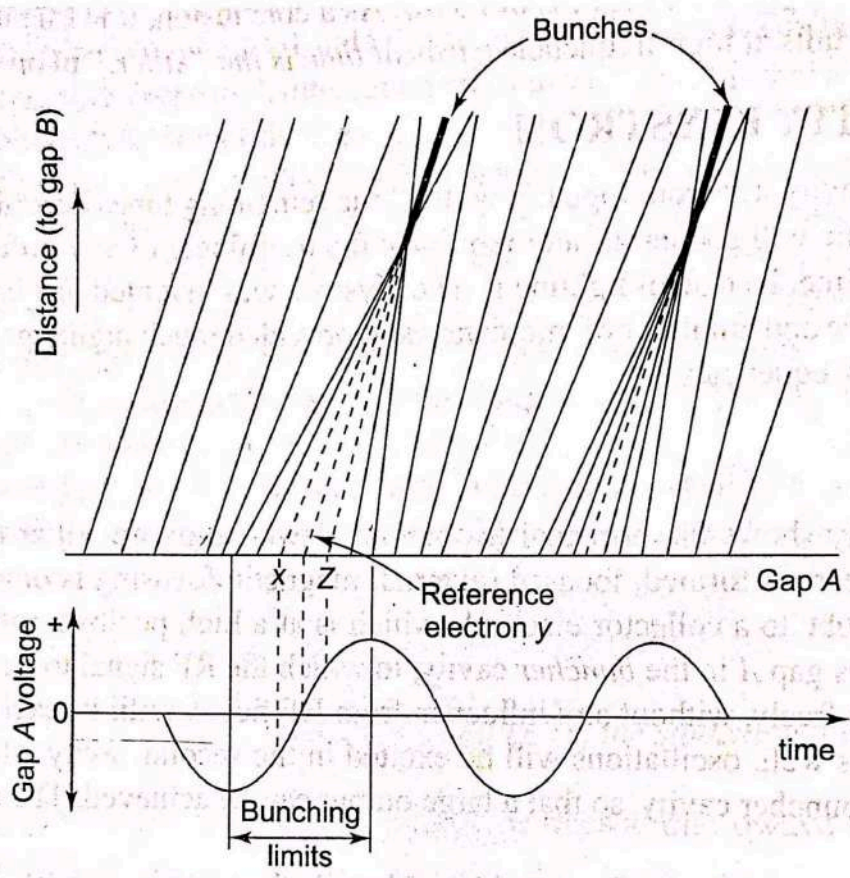
$$f = \frac{1}{2\pi LC}$$

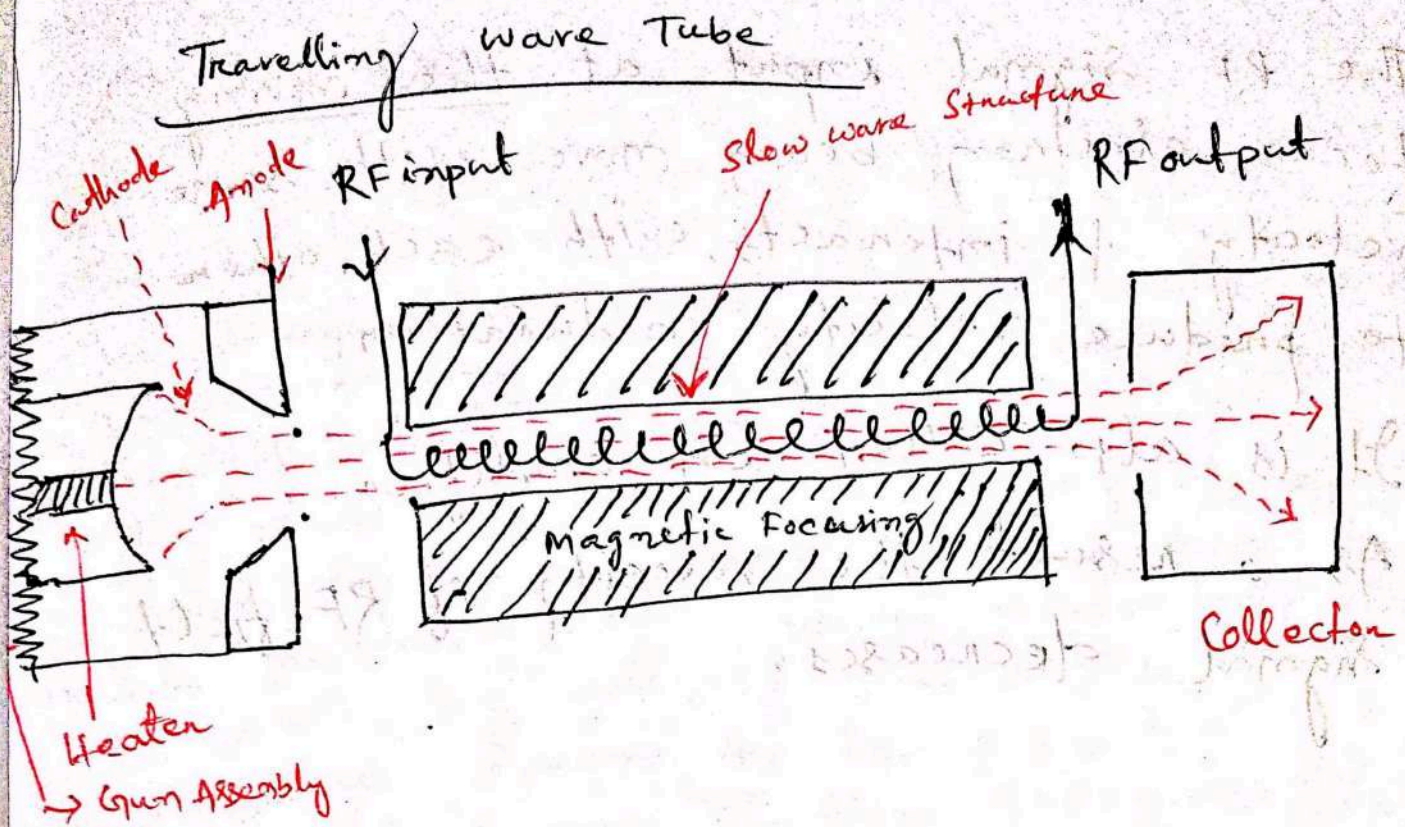
The microwave signal given at the input becomes speed up during the half cycle and slow down during -ve half cycle.

The speeding & slowing process of electron is called velocity modulation.

The bunch electrons then affected by cathode cavity when it is interact with the electron and results amplification of the microwave signals at the opp of the cathode cavity. It means the more amplification energy is executed. From cathode cavity an electron after releasing the energy are attracted towards the +ve side by complete the path.

It is called gain amplifier.





Construction

- It is a linear beam tube used as a microwave amplifier.
- Unlike the klystron however that a device in which the interaction between the beam & the RF-field is continuous.
- It is a positive plate which attracts the electron.

operation

The above diagram is TWT (Travelling wave guide) as the left side, it consists of a gun assembly of heater, cathode and anode.

The electron produce of the gun assembly are passed accelerated electron are focus by the magnetic focusing structure and attracted by the +ve plate.

The moving electrons speed is not greater than light velocity but less than the light speed.

But the RF signal which is given at one end of helix path which speed is equal to light velocity.

For interaction the RF signal (or RF field) and the moving focused electron should move in same velocity and then they can interact at output side and velocity modulation or bunching can be produced.

For getting the equal velocity of electron beam for the RF field, the RF signal is passed through this helical slow wave structure path. As a result the velocity of RF field signal decreases. The decreasing is done by the structure in such way that to reach the same velocity of electron beam. So that interaction will take place means Bunching is occurred and output is taken other end of the helix.

So when bunching electron interacts with RF signal, electrons release the energy and RF signal is amplified means more energy is available and it is extracted at the output path. So due to speeded bunch electrons interaction with RF signal, Amplification occurs.

So TWT is called an Amplifier.

Slow wave structure

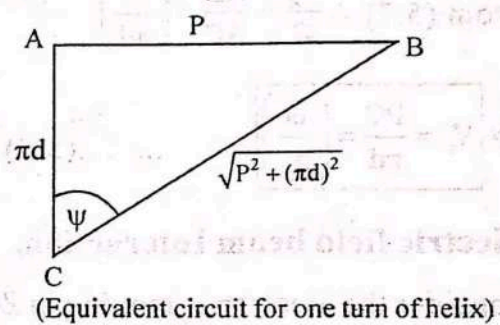
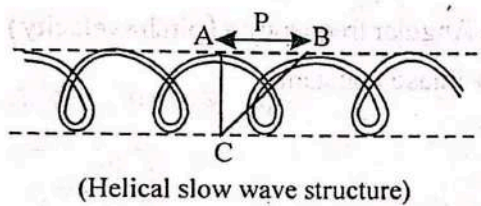


Fig. 5.11

Slow wave structures are special circuits used in microwave tubes to reduce the wave velocity in a certain direction so that the electron beam and the signal wave can interact.

4.9. Principle of operation of cyclotron :- [11] 22

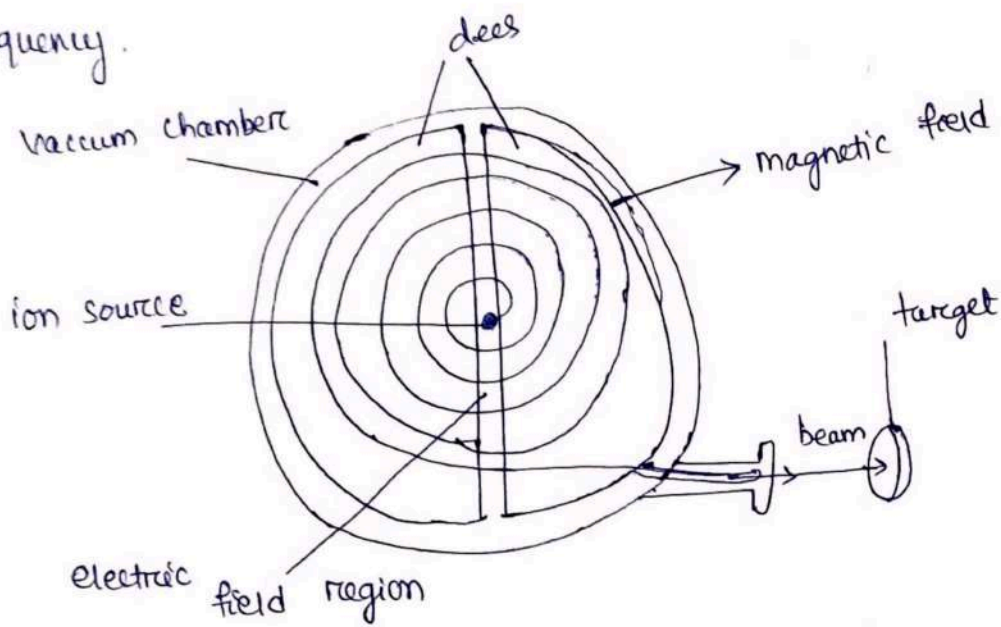
Cyclotron is a device used to accelerate charged particles to high energies. Cyclotron works on the principle that a charged particle moving normal to a magnetic field experiences magnetic Lorentz force due to which the particle moves in a circular path.

Working principle of cyclotron :-

* A cyclotron accelerates a charged particle beam using a high frequency alternating voltage which is applied between two hollow "D"-shaped sheet metal electrodes known as "dees" inside a vacuum chamber.

* The dees are placed face to face with a narrow gap between them, creating a cylindrical space within them for particles to move. Particles are injected into the center of this space.

- * Dees are located between the poles of electro magnet which applies a static magnetic field B perpendicular to the electrode plane.
- * The magnetic field causes the path of the particle to bend in a circle due to the Lorentz force perpendicular to their direction of motion.
- * An alternating voltage of several thousand volts are applied between the dees. The voltage creates an oscillating electric field in the gap between the dees that accelerates the particles.
- * The frequency of the voltage is set so that particles make one circuit during a single cycle of the voltage. To achieve this condition, the frequency must be set to particle's cyclotron frequency.



[12] 11

4-10. Operation of Tunnel diode :-

The Tunnel diode is a negative resistance semiconductor P-N junction diode. The negative resistance is created by the tunnel effect of electrons in the P-N junction. The doping of both P-n regions of the tunnel diode is very high.

Operation :-

Tunnel diodes are the junction diodes having a dynamic -ve resistance at certain operating conditions which can be used in oscillators (or) low power amplifiers.

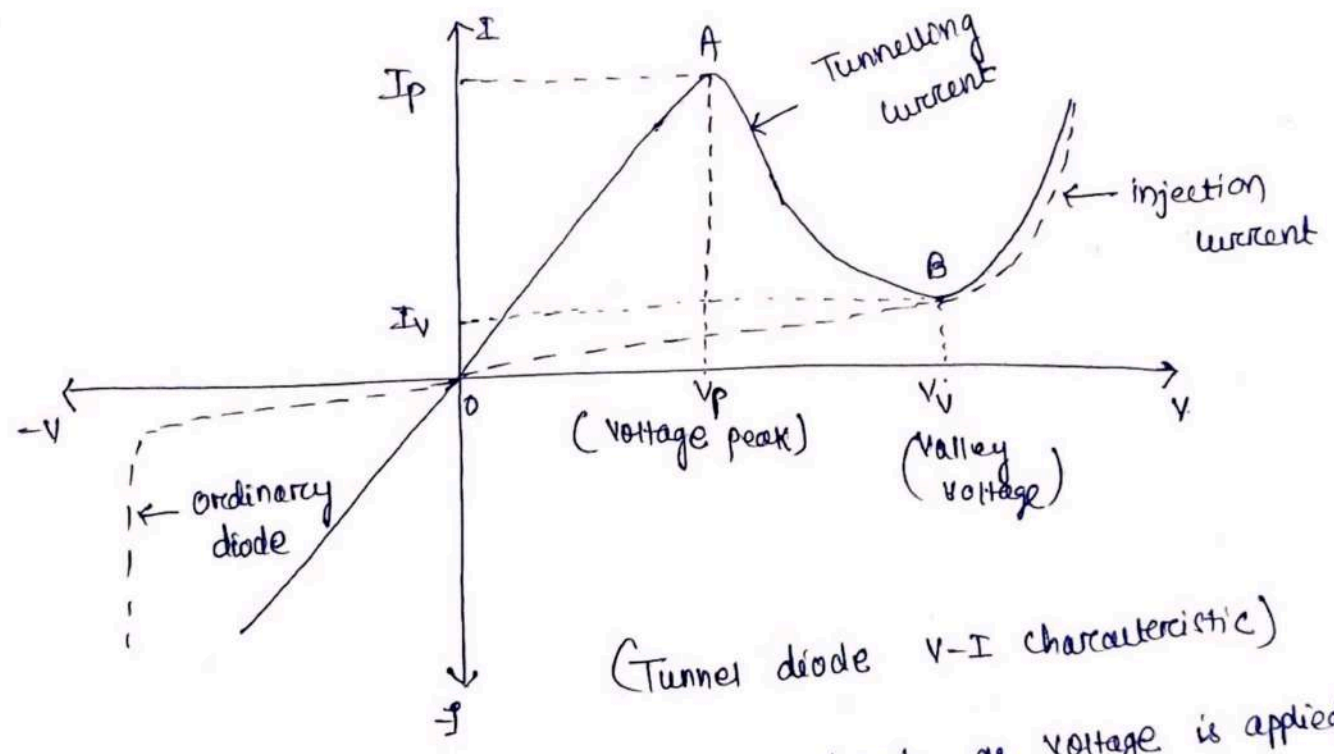
A negative resistance is one in which the current decreases as the voltage increases a specific point.

The tunnel diode are very heavily doped i.e 1000 times more than in ordinary diode.

This heavily doping results in a junction which has a depletion layer that is so thin as to prevent tunnelling to occur.

The tunnel diode is associated with the quantum tunnelling phenomena. The tunnelling time across the device is very short.

A current - voltage characteristics is shown below.



* At first forward current rises sharply as voltage is applied where it would have risen slowly for an ordinary diode.

* Reverse current is also much larger.

* Intersecting portion of the characteristics begins at point A on the curve i.e voltage peak (\$V_p\$).

- * As the forward bias is increased, the forward current drops and continues to drop until point B is reached i.e. valley voltage (V_v).
- * At 'B', the current starts to increase once again and increases rapidly as bias is increased further.

Tunnel diode applications :-

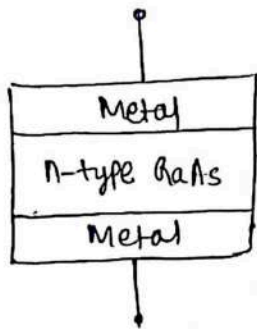
* Tunnel diode can be used as a switch, amplifier and oscillator.

* Tunnel diode acts as logic memory storage device.

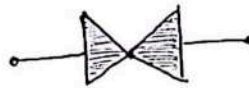
Operation of Gunn Diode :-

A Gunn diode also known as Transferred electron device (TED) is a form of diode used in high frequency electronics. It consists only N-doped semiconductor material.

Gunn diode is a unique component it does not contain a PN junction. Even though it is called as a diode.

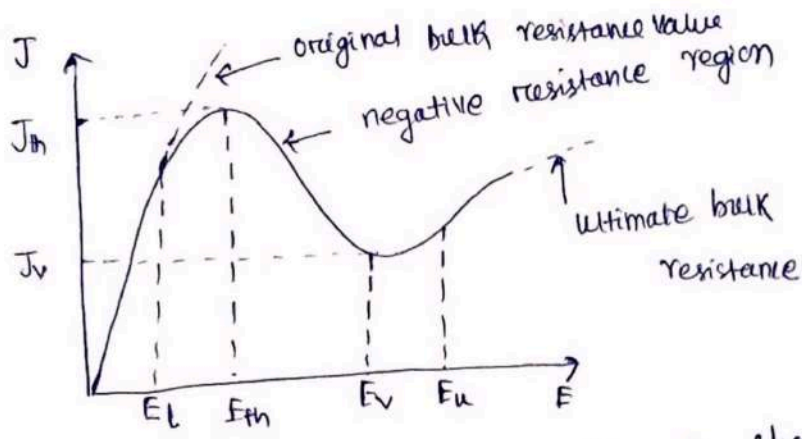


Symbol



Operation :-

Gunn diode is a negative conductance device useful for Power generation (or) amplification which can work from microwave frequency range to millimeter wave region.



Electric field versus current characteristics

- * Under equilibrium condition, the electrons densities in the lower and upper valleys remains the same.
- * When the applied electric field is lower than the electric field of the lower valley ($E < E_L$), no electrons will transfer to upper valley.
- * When the applied field is higher than that of the electric field of the lower valley and lower than that of the electric field of the upper valley ($E_L < E < E_u$), electron will begin to transfer to upper valley.
- * When the applied field is higher than that of the electric field of upper valley ($E_u < E$ (or) $E > E_u$) all electrons will transfer to upper valley.
- * The transferred electron mechanism, the conduction of electrons of some semiconductors is shifted from a state of high mobility to a state of low mobility by the influence of strong electric field. This process is known as "Gunn effect".

BROADBAND COMMUNICATION

- Broadband communication is a type of telecommunication that supplies multiple channels of data in single communication platform using some form of wave or frequency division multiplexing.
- In telecommunication broadband is widely bandwidth data transmission technique with an ability to simultaneously transfer multiple signal and traffic.
- The medium can be co-axial, optical fiber, twisted pair as well as wireless broadband.

Components -

→ The components that effect the broadband telecommunication industry can be classified as two types

- (i) Switched Component
- (ii) Dedicated component

→ The switched components are also known as circuit switching or Telephone calls are connected on the public switch Telephone Network (PSTN)

→ It is composed of three phase which are

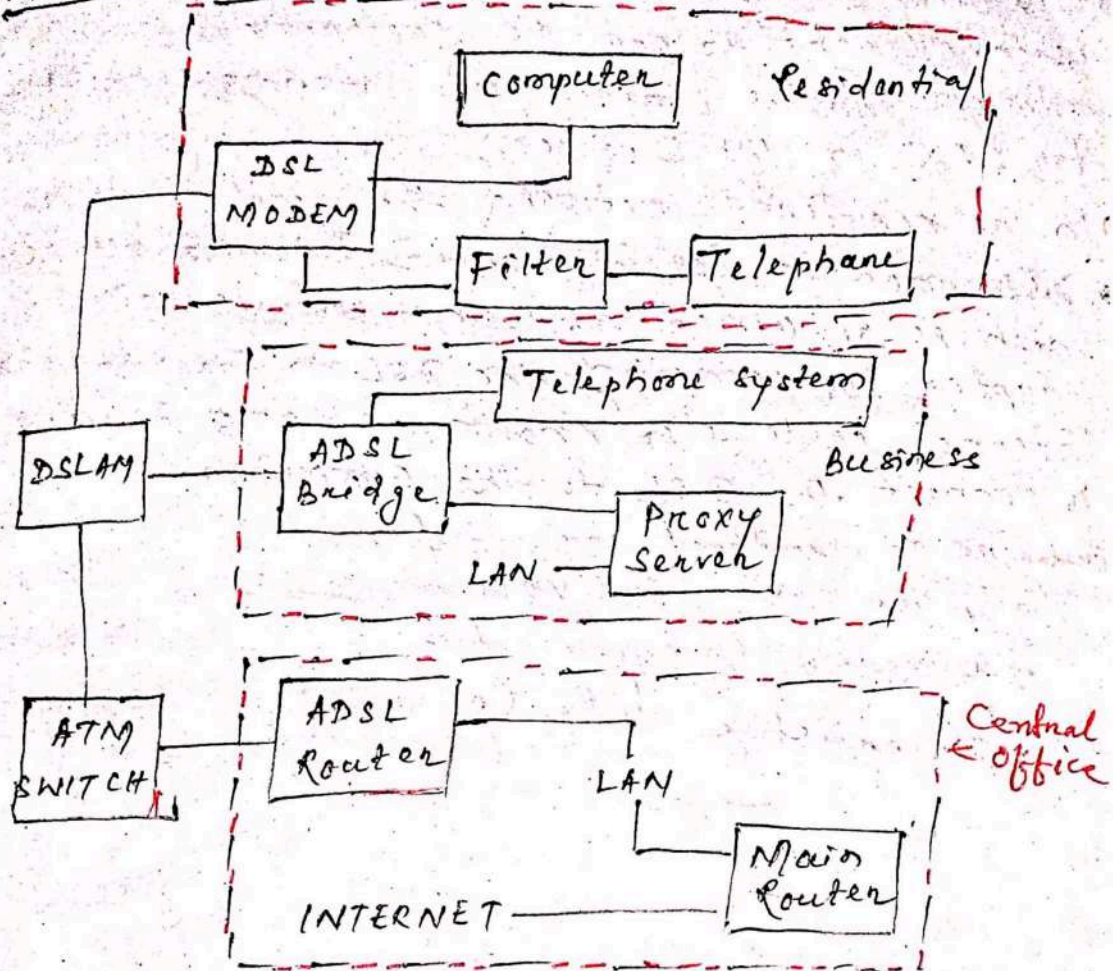
- (i) Call setup
- (ii) Call Transmission
- (iii) Call Termination.

→ The dedicated components are the private lines for business that needs 24 hrs a day to access with the dedicated components the user has permanent access with no dial up.

→ The elements of data communication consist of

- (i) Transmitter
- (ii) Receiver
- (iii) Transmission medium
- (iv) Communication equipment.

NETWORK ARCHITECTURE



- It consists of central office (CO) and the residential and business
- The digital subscriber line access multiplexer (DSLAM) that handles all the traffic generated from the user and the data centre make up part of the central office
- DSLAM takes many customer connections put them on a single high speed connection to the internet.
- Asynchronous Transfer Mode (ATM) switch is a local exchange switch that allows a connection to PSTN for telephone exchange.
- The Internet Service Provider is the company that provides internet services that the customers pay for.
- The central office is connected in two types of customer (i) Residential & (ii) Business.

→ The proxy server is a server that acts as intelligent to provide security, administrative control and caching service for LAN in the business.

→ In the residential network the user needs a

DSL modem for high speed internet access which is obtained by using an internet adapter for connecting the DSL to the computer. Internet cable also known as CAT5 is used to connect the DSL to the computer.

Features of Broadband Communication

- Voice over IP (VOIP)
- wireless communication
- Interactive data (e-mail)

5.1. Broadband Communication System :- Fundamental of components and Network architecture.

Network architecture is the design of computers, media and other devices in a network and how they communicate.

Two most widely used types of network architecture are:-

- (i) client-server network
- (ii) peer to peer network

The entire network is composed of the radio access network (E-UTRAN) and the core network (EPC), both of which have been defined as new components of the end to end network.

The components of network architecture :-

Servers, clients, transmission media, shared data, shared printers and other hardware and software resources, network interface card (NIC), local operating system (LOS) and the network operating system (NOS).

Network architecture is the complete framework of an organization's computer network. It includes hardware components used for communication, cabling and device types, network layout and topologies, physical and wireless connections, implemented areas and future plans.

Essential network components :-

Switches, Routers, wireless access point (WAPs), Repeaters,

Hubs, bridges

Basic network types :-

LAN → local area network covers small geographical areas, laptops will be connected via cables.

wide Area network (WAN) extends between larger geographical area.

5.2 Cable broadband data network :- Architecture, importance & future of broadband telecommunication internet based network. 119/11

* Cable networks deliver internet access through a shared architecture. Cable broadband networks utilize statistical multiplexing to share a fixed amount of network capacity across a group of users.

* The network architecture is a hybrid of fiber and co-axial cable, utilizing frequency division duplexing to divide upstream and downstream transmissions.

* Approximately 750 MHz to 1 GHz of spectrum is typically available on cable networks to be shared across all services, including television, broadband and voice.

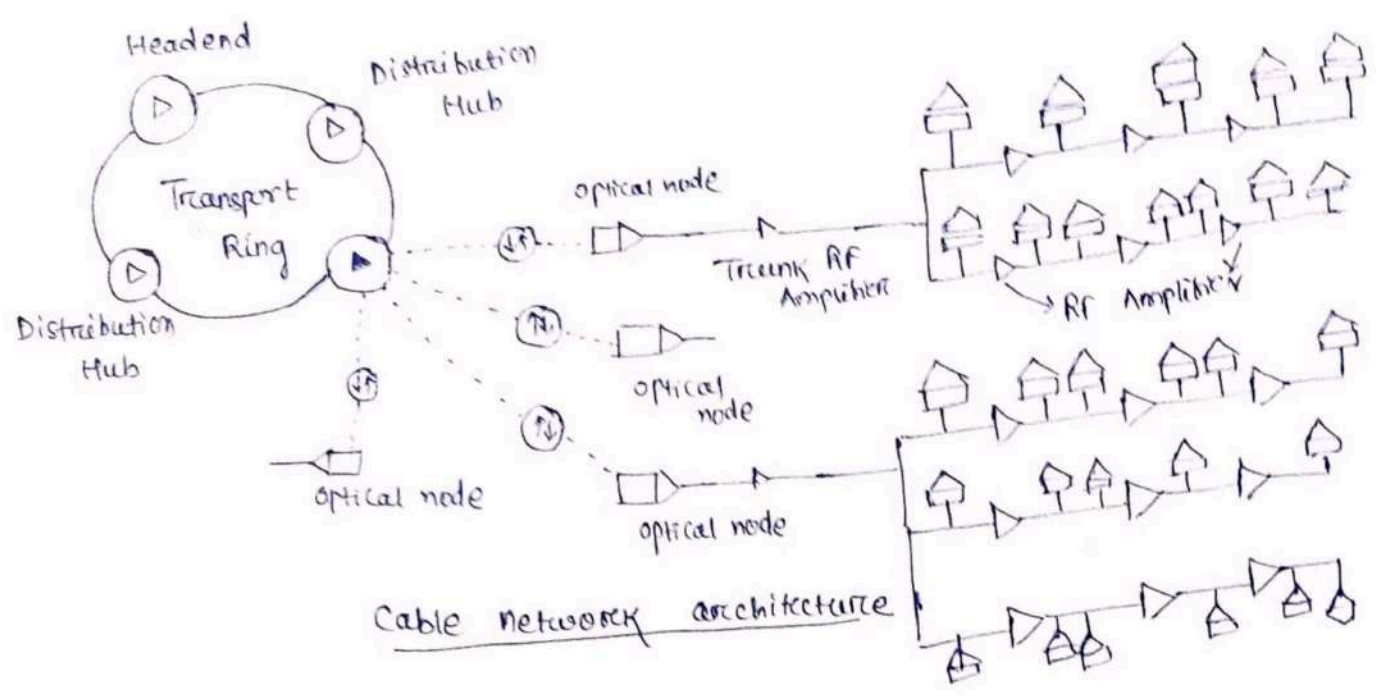
* Upstream traffic uses the lower portion of the frequency duplex cable system, between 5 MHz and 42 MHz usually and downstream traffic uses the remaining upper portion of the available frequencies.

* Cable networks have historically been segmented into 6 MHz wide channels, reflecting the channel bandwidth for over-the-air broadcast television. The bandwidth used for video services on today's network is a function of the amount of content carried, the transmission technology, delivery architectures.

* Cable broadband technology known as Data over cable service interbase specification (DOCSIS). DOCSIS technology addresses both the physical layer and media access control layer of cable broadband services.

* In a typical cable network, fiber optics connect the headend to a neighborhood hub, and then to an optical node. Co-axial cable then extends beyond the node to the end customers,

of which there are generally between 50 and 500 households. Beyond the node, the Co-axial network may utilize amplifiers to extend the range of the signal. These 50 to 500 households on the node share the capacity provided by DOCSIS technology.



Importance of Cable Internet :-
 It delivers better bandwidth, transfer speeds and reliability. It is most effective. The best advantage of cable broadband service is that it does not require any phone service to operate. Broadband provides access to the highest quality internet services such as video conferencing. It provides a higher speed of data transmission.

5.3 SONET (Synchronous optical network) :- signal frame components
 topologies advantages, applications and disadvantages
 It is the American National Standard Institute standard for synchronous data transmission on optical media. The international equivalent of SONET is synchronous digital hierarchy (SDH). Together, they ensure standard so that digital networks can interconnect.

Internationally and that existing conventional transmission system.

Application of SONET Communication :-

(i) SONET's high level of global standardization makes it much easier to set up gateway between different network providers.

(ii) SONET simplifies communication on multiple levels offering reduction in equipment required for processing increasing network reliability and decreasing both equipment and maintenance costs.

Synchronous Optical Networking (SONET) is a standardized protocols which transfers multiple digital bit streams synchronously over optical fiber using laser (or) highly coherent light from light emitting diode.

Advantages of SONET :-

(i) Better network reliability.

(ii) Lower equipment investment.

(iii) Better connectivity between different telecom carriers.

(iv) Highly flexible architecture.

(v) Increased bandwidth.

Disadvantage of SONET :-

(i) High percentage of SONET protocol overhead.

(ii) Strict synchronization schemes required.

(iii) Complex and costly SONET equipment contrast to cheaper optical ethernet.

(iv) fiber laying unutilized in a ring architecture, waiting on a failure.

5.4. ISDN - ISDN Devices interfaced, services, Architecture, applications.

ISDN : Integrated service; digital network (ISDN) are network termination devices that connect four-wire local loop. It is comprised of digital telephony and data transport services offered by regional telephone carriers.

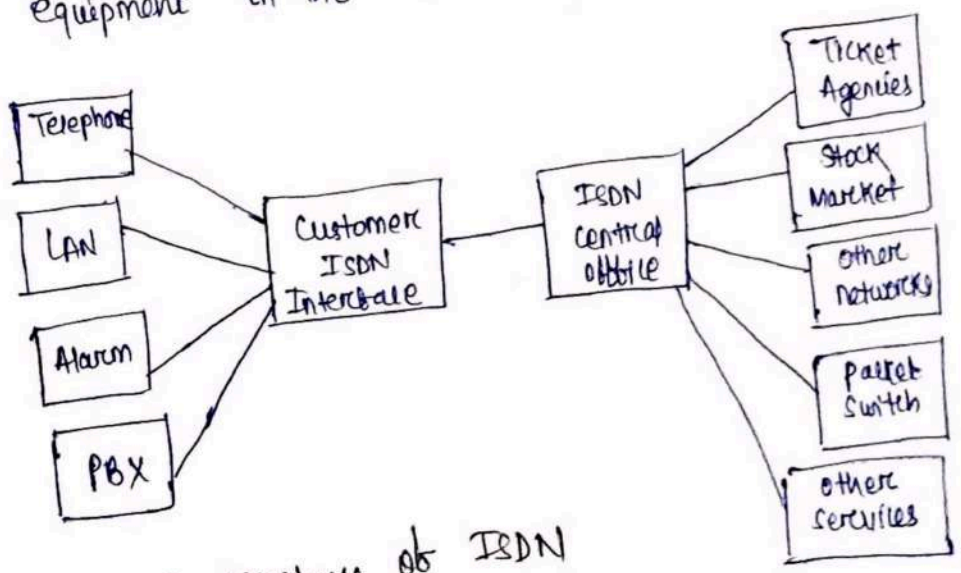
ISDN Devices :-

ISDN devices include terminals, terminal adapters, ^(TAs) network-termination devices, line termination equipment and exchange-termination equipment.

ISDN terminals are of two types. Specialized ISDN terminals are to as terminal equipment type-1. Non-ISDN terminals such as DTE, that predate equipment type-2.

ISDN specifies a number of reference points such as TA and NTIS. ISDN points include the following:-

- R- The reference point between non-ISDN equipment and a TA.
- S- The reference point between user terminals and the NT2.
- T- The reference point between NT1 and NT2 devices.
- U- The reference point between NT1 devices and line termination equipment in the carrier network.



Architecture of ISDN

ISDN applications include

(i) high speed image applications.

(ii) Additional telephone lines in homes to serve the telecommuni-

cating industry.

(iii) High speed file transfers and video conferencing.

5.5 BISDN - Interbases and Terminals, Protocol architecture applications:-

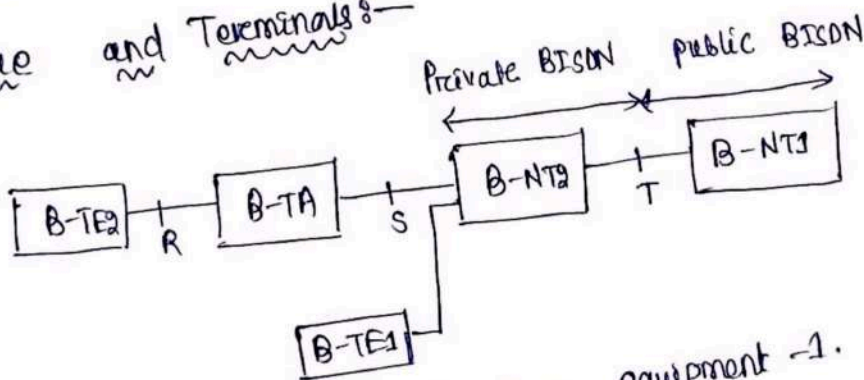
BISDN interbase and terminal is that it provides transmission channels capable of supporting rates greater than the primary ISDN rate.

BISDN is a digital network operating at data rates in excess of the 2.048 Mbps - the maximum rate of standard ISDN.

BISDN's foundation is cell switching and the international standard supporting it is asynchronous transfer mode (ATM).

BISDN is a concept of broadband data transfer, ATM is a technology used to implement BISDN.

Interbase and Terminals:-



B-TE1 : Broadband terminal equipment -1.

B-TE2 : Broadband terminal equipment -2.

B-TA : Broadband terminal adaptor.

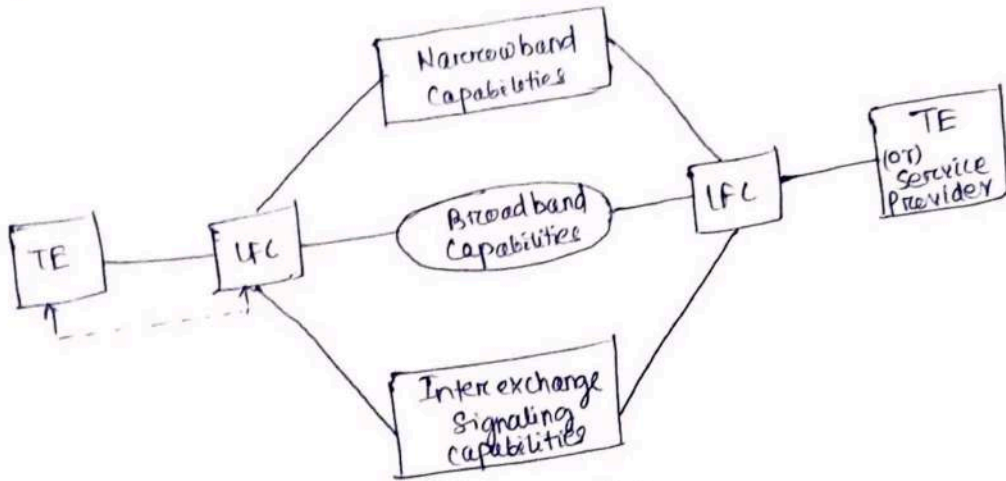
B-NT1 : Broadband network termination -1.

B-NT2 : Broadband network termination-2.

S: An interface between B-ISDN terminal and private network.

T: An interface between B-ISDN private and public network.

R: An interface between B-TE₂ and B-TA.



LFC = local function capabilities

TE = terminal equipment

Architecture of B-ISDN

- Applications :-
- (i) High quality video.
 - (ii) Terminals allow the synergistic combination of video, voice, document transmission services.
 - (iii) High speed transmission capability.