Module :- 01

Communication Engineering

Dt/23/07/2018

* Electromagnetic wave :- (Em)

-> Electromagnetic wave or Em wave are waves that are created as a result of vibration between an electric field and a magnetic field.

-> In the other words Em waves are composed of oscillating magnetic and electric fields.

-> Em waves are formed when an electric field comes in contact with a magnetic field.

They are hence known as "electro magnetic waves".

-> The electric field and magnetic field of an Em waves are perpendicular (at right angle) to each other.

-> They are also perpendicular to the direction of the Em waves.

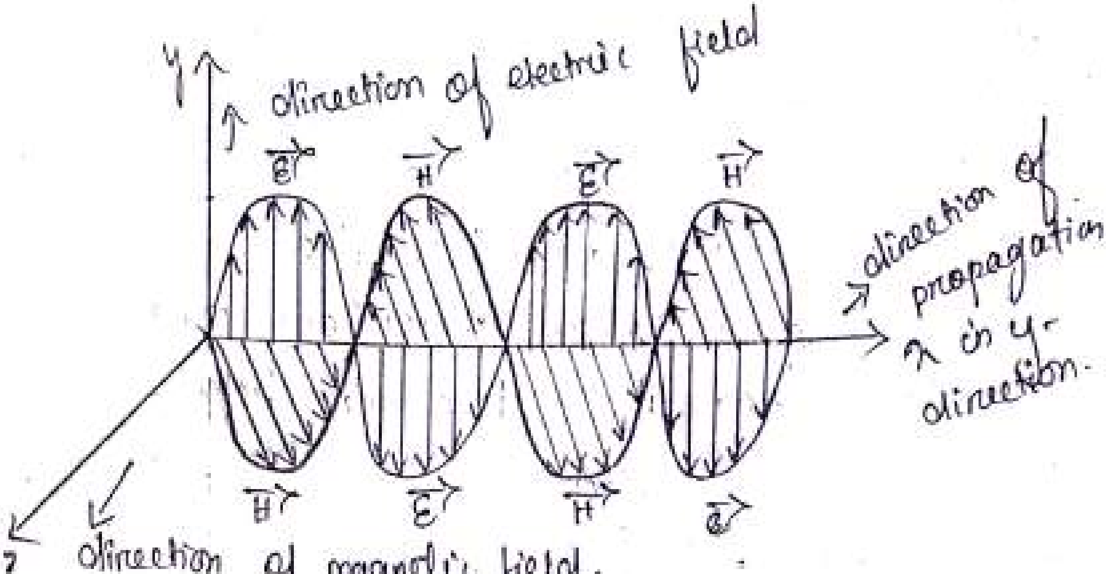
-> Em waves are deflected neither by the electric field nor by the magnetic field.

-> They are capable of showing interference or defraction.

-> It can travel through anything be it air, a solid material or vaccum.

-> The speed of propagation of electromagnetic wave is free space is same as that of light.

* light speed is approximately equal to 3×10^8 m/sec.



→ The wave length is related to frequency and propagation velocity.

$$\boxed{V = f.\lambda}$$

$$V = f.\lambda$$
$$= f \cdot c/f$$
$$= c.$$

$$\Rightarrow \boxed{V = c}$$

V = propagation of velocity.

f = frequency in Hertz.

λ = wave length in meters.

→ Example of electromagnetic wave are radio waves and x-rays, gamma ray (frequency is very high).

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* Effect of Environment:-

→ When the propagation near the earth is taking place. It is effected by several factor and under goes several phenomena like reflection, refraction and defraction.

→ The waves will be reflected by ground, mountains, building.

→ They will be refracted as a pass through layer of earths at atmosphere because of varying density of layer.

→ Also electromagnetic waves may be defracted around tal and massive.

→ They also interface with each other. when two waves form same source meet after having travel by different path.

* Reflection:-

→ If a wave form is incident on a simple surface with an angle the wave reflex back with the same angle. This analogous to light property.

→ Reflection will occure due to presents of building mountain ground when the Em wave are travelling in free space.

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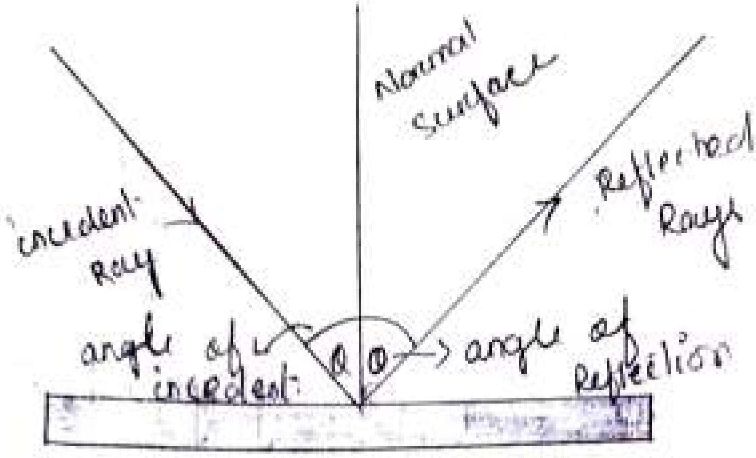

→ In case of reflection the brightness of EM wave is progressively reduce losses of some energy on reflected surface.

→ The angle of incident is equal to the angle of reflection when measured normal to the reflecting surface.

→ For complete reflection of EM wave the reflecting surface must be deal conduct practically that is not the case.

→ Therefore, Some energy will obsereve and some part reflected.

→ In practical case the reflection surface may be of any shape.

→ Reflection may be carner reflection, parabolic or earth irregular surface.

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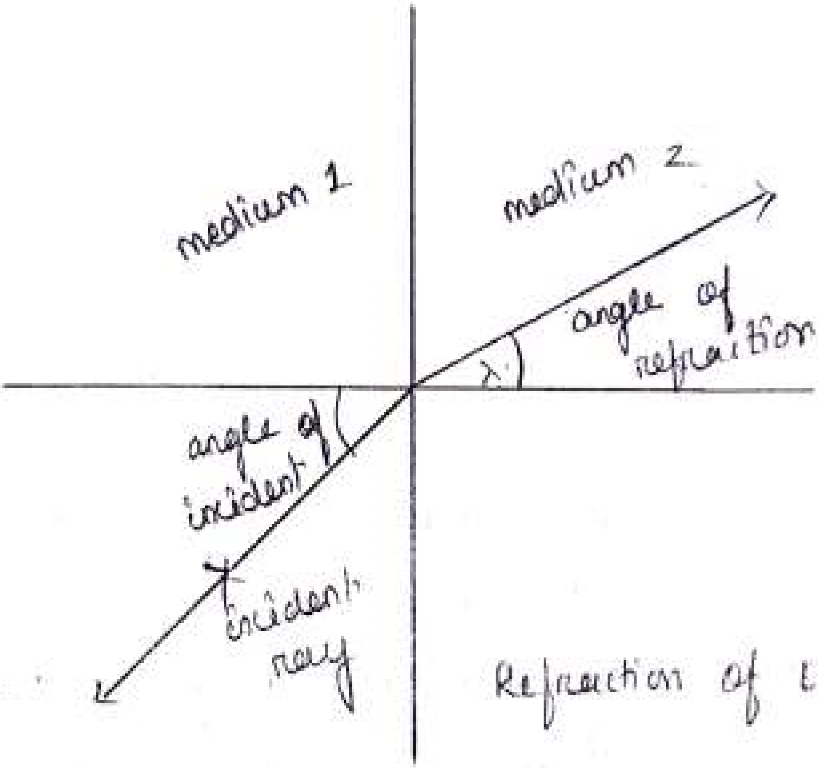
* Refraction :-



Refraction of EM wave.

→ The bending of propagation path when the wave moves one medium to other medium differing in refractive indices is normally reffered as refraction.

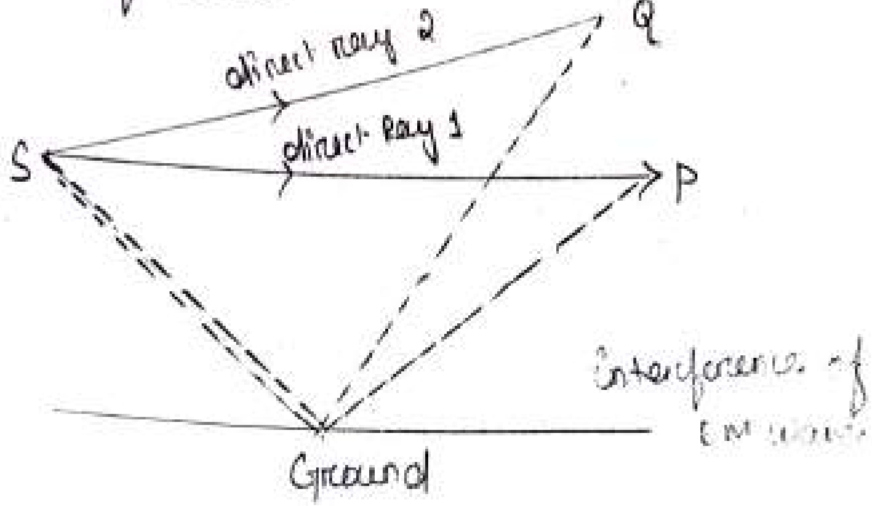
→ This is similar to light property.

→ Refraction takes place when EM wave passed from one propagating medium to a medium having different density.

→ So, the wave acquire new direction in second medium and is brought about by a change in wave velocity.

→ In case of refraction the first signal is being propagated in free space.

* Interference of waves :-



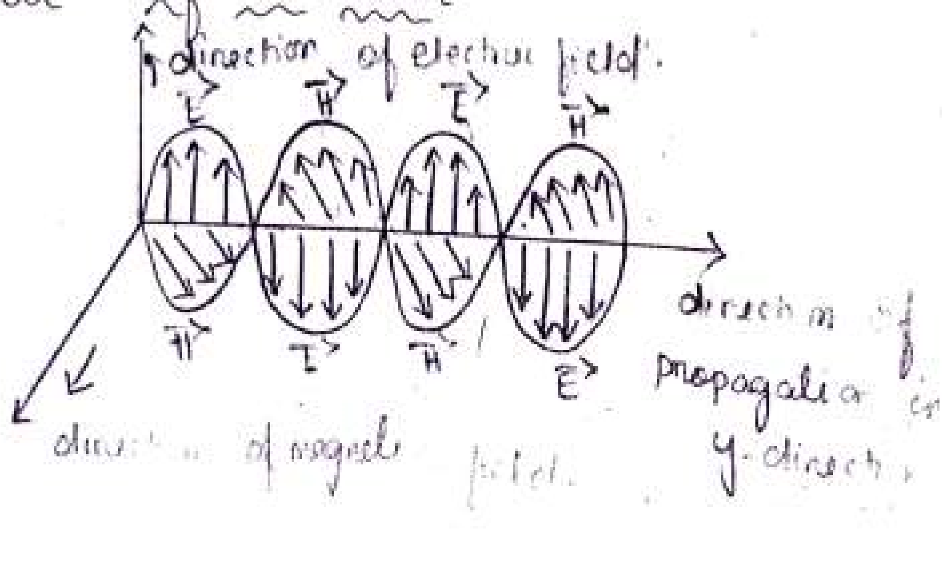
→ When two EM waves travels and left from one source but when they met each other interference occurs.

→ This happens very often in high frequency.

→ Sky wave propagation and in microwave space wave propagation.

→ It also occurs when a microwave antenna is located near the ground and wave reach the receiving point not only directly but also after being reflected from the ground.

* Polarization of EM waves :-



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→ The polarization of a radio wave is expressed in terms of electric field vector orientation.

→ The polarization of plane wave is defined as the direction of orientation in which the electric vector is aligne during the passage of atleast one cycle.

→ If this orientation of direction is unvarrying the polarization is describe as linear.

→ A Em wave is said to be linearly polarized if they all have the same orientation in space.

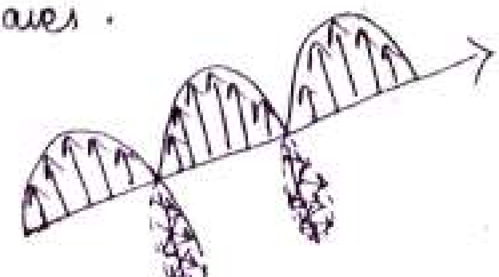
→ As shown in the above figure the electrical field vector are vertical such polarization is called as vertical polarization.

→ Similarly if electrical vector in the horizontal plane the wave is said to be horizontally polarized.

→ It is important to indicate that the direction of antenna and polarization are inter related.

→ If antenna is vertical it will radiate vertical polarized wave.

→ If it is horizontal antenna it will radiate horizontal polarized waves.



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→ Some times the polarization axis rotates as the wave moves through space rotating 360' for each waves.

2 marks
Modes of propagation :-

→ If Earth environment electromagnetic wave propagate in a way that depends not only their own properties but also of the environment itself.

→ That is the property of earth and the various layer of atmosphere.

→ The mode of propagation depends on height in atmosphere at which they propagate.

→ Basically the modes of propagation is classified in to following groups :-

(i) Ground wave or surface wave

(ii) Sky wave propagation.

(iii) Space wave prepagation.

(1) Ground wave or surface wave propagation :-

→ Ground wave propagate along the surface of earth.

→ The propagation take place in medium frequency range from 0.3 to 3 MHz.

→ This is the frequency range in Am broadcast Occure.

→ The ground wave propagation is ~~[illegible]~~ limited to

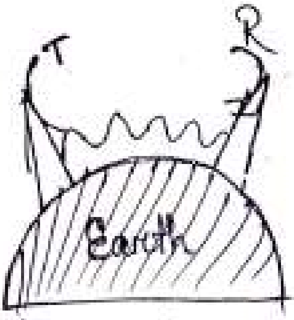
⟵ f λ

100mill.

→ Here atmospheric noise, manmade thermal noise from electric field create disturbance in ground wave propagation.

→ The ground wave may be attenuated due to defraction near the earth.

→ In ground wave propagation there is communication is happen between two station as shown in the below figure.



(Ground wave propagation)

→ If the distance between the two antenna is kept long then there is reduction of field strength due to ground and absorption which reduces the amplitude of signal receiver.

(iii) Sky wave propagation:-

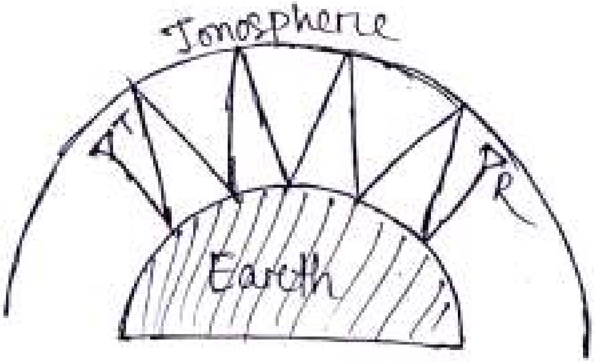
→ The range above the surface of earth 30 to 250 mile are call ionosphere, where sky wave propagation happens.

→ The signal being reflected from the ionosphere which contain several layers of charge particle.

→ The range of frequency for sky wave propagation is above 300 MHz.

→ Here in sky wave propagation long distance high frequency (HF) communication are permitting over the horizon very high frequency (VHF) communication.

→ In sky wave propagation the high frequency range of frequency can transmit. There is a term called "SKIP DISTANCE". which is the shortest distance from a transmitter, measured along the surface of the earth at which a sky wave of fixed frequency will return to earth.



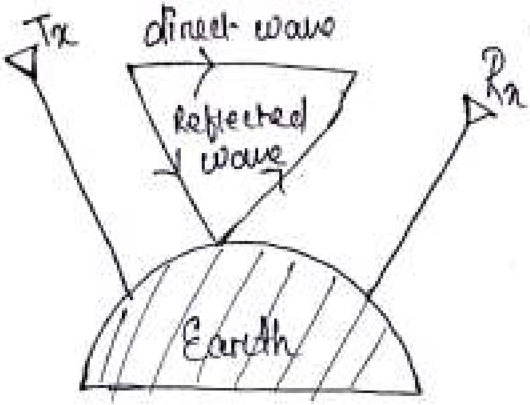
* Space wave propagation:-

→ Space wave propagation is limited to curvature to earth.

→ They can propagation very much like electromagnetic wave in free space.

→ The radio waves having high frequency are basically called as space wave.

These waves ~~are~~ have ability to propagate from transmitter to receiver antenna.



The limitation of Space wave propagation are:-

(i) These waves are limited to curvature of Earth. due to line of sight propagation occurs in space wave propagation.

(ii) The antenna both transmitter side and receiver side must be increased.

Radio horizon :-

→ The radio horizon for space wave is about 4/3 four third's as per as the optical horizon.

→ These effect is caused by the varrying density of atmosphere and because of defraction around the curvature of earth.

→ The radio horizon can be calculated using the formula $D_t = 4\sqrt{h_t}$.

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→ Where D_t = distance from transmitting antenna.
h_t = height of the transmitting antenna of the ground.

→ The above formula naturally applies to the receiving antenna then the total distance can be calculated by,

$$D = D_t + D_r$$
$$= 4\sqrt{h_t} + 4\sqrt{h_r}$$

→ Where, D = total distance between receiving and transmitting antenna.

(1.6) L.Q antenna

Imp **Critical frequency:- (C.F):-**

→ The highest frequency i.e returned to the earth in vertical direction is called critical frequency.

Imp **Maximum useable frequency:- (MUF):-**

L.Q → The highest frequency that returns to earth on a given path is called maximum useable freq

→ The critical frequency and maximum useable frequency are related and that is expressed mathematically,

$$\boxed{f_m = f_c \sec \theta_i}$$

Where, fm = maximum usable frequency.

fc = critical frequency.

θi = angle of incidence.

The equation can be put in the following form :- more conviniently.

$$f_m = \frac{f_c}{\cos\theta_i}$$

Skip distance:-

The minimum distance from the transmitter along the surface of the earth at which a sky wave of given frequency is return to earth by ionospheric layer called skip distance.

Troposphere Scatter propagation:-

In this method the propagation uses the tropospheric scatter phenomena. where radio waves at particular frequencies are randomly scattered as they pass through upper layer of the troposphere.

A beam of radio signal are transmitted in half way between the transmitter and receiver side. Are they travel to the same medium ray data needs to be carried.

Tropospheric Scatter propagation having two forms of fading. They are :-

(I) In the ~~fast~~ 1st type of fading fast-fading occurring ~~signal~~ time per minute. with maxm signal strength variation in excess of 20dB also called rayleigh and is caused by multi path propagation.

(II) In the 2nd type of fading it is very much slower and is caused by variation in atmospheric condition along the path.

5 marks

Actual height and virtual height :-

Ground Surface.

- It is the height which would have been reached by the wave in ionosphere to get reflected rather than actually refracted at lower height in the ionosphere.

OR

Virtual height :-

- When a wave is refracted it is bent down gradually but not sharply.
- However, the path of incident ray and reflected ray are wave. If it is reflected from a surface at a greater height of this layer. Such as greater height is called as virtual height.

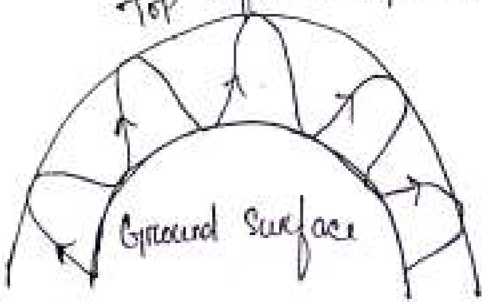
Fading :-

- The decrease in the quantity of signal is termed as fading.
- This happens because of atmospheric effects or reflections due to multipath.
- Fading refers to the variation of signal strength with respect to the time / distance.
- The most common causes of fading in the wireless environment are multipath propagation.

Duct propagation :-

- At a height of around 50 meters from the tropopshere a phenomenon exist.

- Temperature increases with the height.
- In this region of troposphere the high frequency or ~~ ~~ microwave frequency tends to refract back into at atmosphere instead of shooting in to ionosphere to reflect.
- This wave propagate around the curvature of earth. Even ~~up~~ upto to a distance of 1000km.



This refraction goes on continuing in this region of troposphere. This can be termed as ducta propagation.

Antenna :-

→ In order to couple the output of radio transmitter to space. Or to couple the input of a receiver to space.

→ It is necessary in each case to use same type of structure capable of radiating electromagnetic waves or receiving antenna.

→ An antenna is such a structure and may be described as metalic object. Often a wire or group of wires used to convert high frequency current in to electro magnetic wave and viceversa.

→ Their function is to couple the transmitter and receiver to space.

→ In case of microwave the transmitting and receiving antenna should be highly directive.

→ Antenna is very much similar to resonant circuit which has ability to transfer energy from electro static to electro magnetic.

→ If the impedance match is correct the energy being transferred will radiate energy in to atmosphere. In the same way the transformer transform energy from primary to secondary.

→ The spacing length and shape of the device related to the wave length of λ.
→ If the desired transmitter frequency that means mechanical length is inversely proportional to numerical value of frequency.

$$\boxed{T = 1/f} \quad \text{and} \quad \boxed{\lambda = \frac{c}{f}}$$

Ex:- $1MHz = \frac{1}{10^6}$.

$\Rightarrow t = 1/f = \frac{1}{10^6} = 10^{-6}$ μsec ..

$\lambda = \frac{c}{f} = c \times \frac{1}{f} = c \times t$

$= 3 \times 10^8 \times 10^{-6}$

$= 3 \times 10^2$

$= 300M$

Q/ for an operating at 2 MHz. what is the length of the antenna.

Sol $f = 2MHz = 2 \times 10^6$

~~t = 2×10^6~~ $t = \frac{1}{2} \times 10^6$

$\lambda = c \times t = \frac{3 \times 10^8}{2 \times 10^6}$ (1.5)

$= \frac{1.5 \times 10^8}{10^6}$

$= 1.5 \times 10^8 \times 10^6$

$= 1.5 \times 10^{9}$

$= 150$ m

Q) for an operating of 50MHz. what is the length of the antenna.

Sol) $f = 50$ MHz

$t = \frac{1}{50\times10^6}$

$\lambda = c \times t = \frac{3\times10^8}{50\times10^6}$

$= \frac{3\times10^2}{50}$

$= 3 \times \frac{100}{50}$ (2)

$= 6$.

Q) for an operating of 80MHz what is the length of the antenna.

Sol) $f = 80$ MHz

$t = \frac{1}{80\times10^6}$

$\lambda = c \times t = \frac{3\times10^8}{80\times10^6}$

$= \frac{3\times10^2}{80} = 3 \times \frac{100}{80}$ (10/8)

$= 30/8 = 3.7$ m.

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* The Terms Related to Antenna :-

Directivity :-

→ Directivity is a fundamental antenna parameter. is a measure of how "directional" an antenna's radiation pattern is.

→ An antenna that radiates equally in all direc would have effectively zero directivity and the directivity of this type of antenna would be 1 or zero db.

* Directive gain :-

→ Directive gain is define as the ratio of the p density in a particular direction of one antenn to the power density that would be radi by an omnidirectional antenna (isotropic antenna)

→ The power density of both type of antenna measured at a specified distance.

For Example :- The gain of hertzian dipole antenna with respect to the isotropic antenn equal to 1.5 : 1 power.

$$\rightarrow 1.5\,(10 \log_{10})\,db$$

$$= 1.76\,db$$

→ The longer the antenna the higher the directive gain.

* <u>Directivity and power gain</u>:-

→ Another form of gain is used in connection with antenna is power gain.

→ power gain is a comparision of the output power of an antenna in a certain direction to that of an isotropic antenna.

→ The gain of an antenna is a power ratio of comparision between an omnidirectional and unidirectional radiator.

→ The gain is represented in $A(dB) = 10\log_{10}\left(\frac{P_2}{P_1}\right)$.

where,

$A(dB)$ = Antenna gain in decibels.

P_1 = power of unidirectional antenna.

P_2 = power of Reference antenna.

Q// A half wave dipole antenna is capable of radiating 1kW and has a 2.15dB gain over an isotropic antenna. How much power must be delivered to the omnidirectional antenna to match the field strength directional antenna.

(Sol) Given, $A(dB) = 2.15dB$.

$P_1 = 1kw$.

$P_2 = ?$

$$A = 10\log_{10}\left(\frac{P_2}{P_1}\right)$$

$$\Rightarrow 2.15 = 10\log_{10}\left(\frac{P_2}{1000}\right)$$

$$\Rightarrow \frac{2.15}{10} = \frac{10}{10}\log_{10}\left(\frac{P_2}{1000}\right)$$

$$\Rightarrow 0.215 = \log_{10}\left(\frac{P_2}{1000}\right)$$

$$\Rightarrow 10^{0.215} = \left(\frac{P_2}{1000}\right)$$

$$\Rightarrow 1.64 = \frac{P_2}{1000}$$

$$\Rightarrow 1.64 \times 1000 = P_2$$

$$\Rightarrow 1640w$$

* Radiation Resistance:-

⇒ Radiation Resistance is the ratio of power radia[ted] by the antenna to the square of the current at the feed point.

⇒ The value of radiation resistance is depend upon :

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(a) Configuration of an antenna.

(b) Location of antenna with respect to ground and other objects.

(c) Ratio of length of diameter of conductor used.

* Antenna input impedance :-

→ Input impedance (Resistance + Reactance).

→ Antenna input impedance relates the voltage to the current at the input to the antenna.

* Lets take an example an antenna has an impedance of 50Ω. This means that if a sinusoidal voltage is applied at the antenna terminal with an amplitude of 1V. Then the current will gave wave amplitude of 1/50 = 0.02 Amp.

(sol) $I = V/Z$

$$= \frac{1\times 2}{50\times 2} = \frac{2}{100} = 1/50 = 0.02 \text{ Amp}.$$

* Antenna losses and efficiency :-

→ Antenna efficiency is defined as the ratio of the total power radiated by an antenna to the net power (total) accepted by the antenna from the connected transmitter.

→ It is expressed in terms of percentage.

→ It is frequency dependent.

→ In addition to energy radiated by an antenna power loss must be accounted.

→ Antenna losses can be caused by ground resistance, imperfect dielectric near the antenna, energy losses due to eddy current induced into nearby metallic objects and I^2R losses in the antenna itself.

→ We can combine these losses and represent them in

$$\boxed{P_{in} = P_d + P_{rad}} \quad \text{---(1)}$$

where, P_{in} = power delivered to the feed point.

P_d = power lost.

P_{rad} = power actually radiated.

→ Converting the eqn (1) to I^2R terms.

$$I^2R_{in} = I^2R_d + I^2R_{rad} \quad \text{---(2)}$$

$$\Rightarrow \boxed{R_{in} = R_d + R_{rad}}$$

→ From the above expression we can now develop an equation for calculating antenna efficiency.

$$\boxed{\eta = \frac{R_{rad}}{R_{rad} + R_d}}$$

where, R_d = antenna Resistance.

R_{rad} = antenna radiated resistance.

→ Low medium frequency antenna has least

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efficiency because of difficulty in achieving the proper physical length.

→ Antenna approaches efficiency only 75% - 95%.

→ Antenna at high frequency can easily achieve value approaching 100%.

* Effective aperature / capture area:

→ In simple word apperature / capture area of antenna is the effective receiving area of the antenna. and may be calculated from the power received and its comparision with the power density of the signal being received.

→ If,

S = power density of the wave in watts/square meter.

A = capture area of the antenna.

p = Total power absorbed by the antenna.

Then, $p = S \cdot A$ watts or

$A = P/S$.

→ The aperature size can be define in two ways either in terms of actual physical size in the meters or in terms of wave length.

* Bandwidth :-

→ The term bandwidth refers to the range of freq the antenna will radiate effectively.

→ It refers to the frequency range over which operat is satisfactory. And is generally taken between the half power point in the direction of maximum radiation.

→ The bandwidth can also be describe in terms of percentage of the centre frequency of the band.

$$\text{Bandwidth} = 100 \times \left(\frac{F_H - F_L}{F_C}\right)$$

where, F_H is the highest frequency band.
F_L is the lowest frequency band.
F_C is the centre frequency band.

2 marks

Beamwidth :-

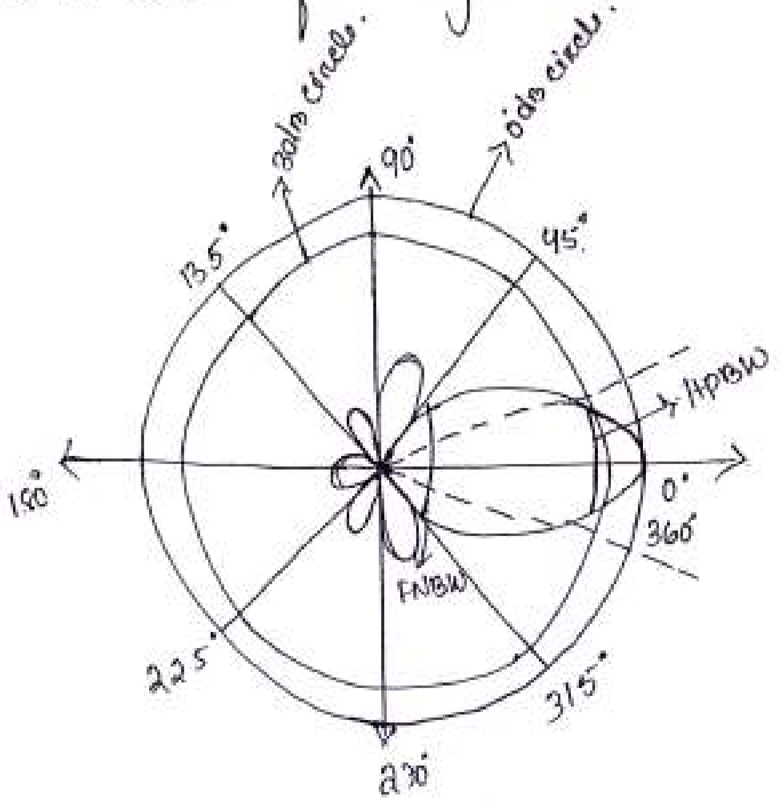
→ The beamwidth of an antenna is described as an angle created by comparing the half power point (3db) and the main radiation lobe to its maximum power point.

* Half power Beamwidth :- (HPBW) :-

→ It is a angular width of a major lobe from maximum to 3dB down.

* First Null Beamwidth :- (FNBW) :-

→ It is a width of a major lobe.



Beamwidth.

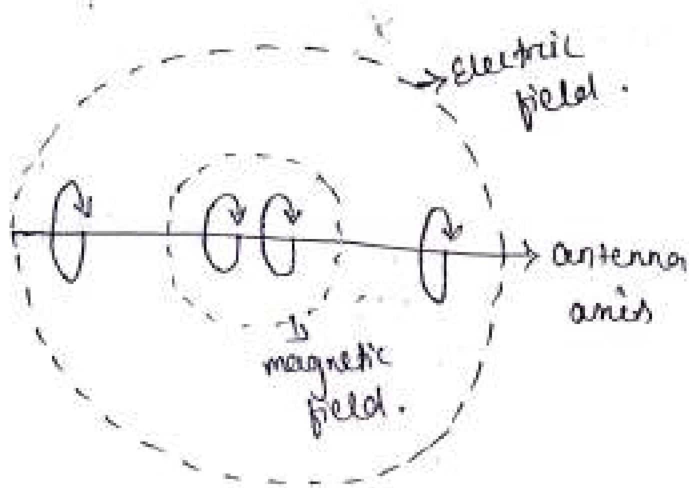
2 marks

Polarization :-

→ polarization of an antenna refers to the direction in space of the E-field (electric vector) portion of electromagnetic wave by the transmitting system.

→ polarization is used almost to describe the shape and orientation of the locus of the electric field vector.

→ It may be a straight line, an ellips or a circ[le]
→ polarization are 3 types linear, vertical and hori[zontal]
→ In case of linear polirization the electric fie[ld] varries in a sinusoidal manner in one plane.
→ when this plane is vertical then it is called vertical polarization.
→ when this plane is horizontal then it is called horizontal polarization.



→ Low frequency antenna's are usually vertically polarized because of ground effect (reflected wav[e] and etc) and physical construction method.
→ High frequency antenna are generally horizont[al] polarized.

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* Directional High Frequency Antenna :-

→ Yagiuda Antenna :-

→ It is a directional antenna.

→ It has operating frequency above 10MHz.

→ It can used for 40-60 km distance.

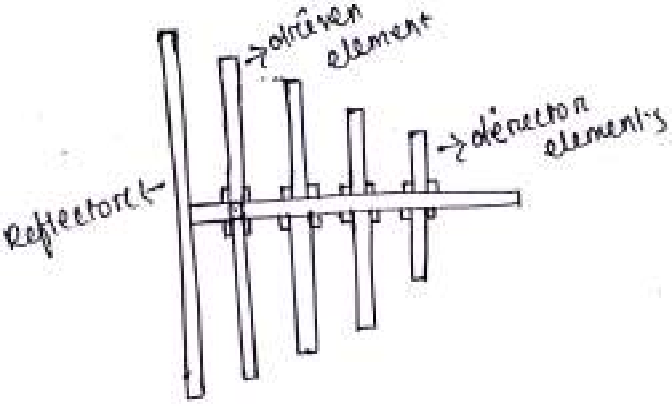
→ A yagiuda antenna is an array consisting of a driven element and parasitic element arranged closed together.

→ It has two types of elements :-

(a) Active element (driven element).

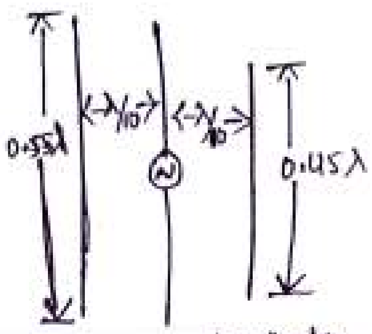
(b) parasitic element (Reflector, director element)

→



→ The yagiuda antenna is used as a high frequency antenna.

→



Yagiuda antenna

Radiation pattern

→ Yagiuda antenna's the front to back ratio is improved by bringing the radiator closer.

→ As a parasitic element is brought closer to the driven element, it will load the driven element more and reduce its input impedance.

→ Sometimes it is called a super gain antenna because of its high gain.

* Advantages of yagiuda Antenna :-

→ High gain.

→ High front to back ratio.

→ Cheap.

→ Light weight

* Disadvantages of yagiuda Antenna :-

→ For high gain level the antenna becomes very l

→ Gain limitation is about 20db.

* Application :-

→ It is used in High frequency (3-30MHz).

→ Very High frequency (30-300 MHz)

→ Ultra High frequency (300-3000 MHz).

→ It is used for home TV receiver.

→ It is used for point to point communication

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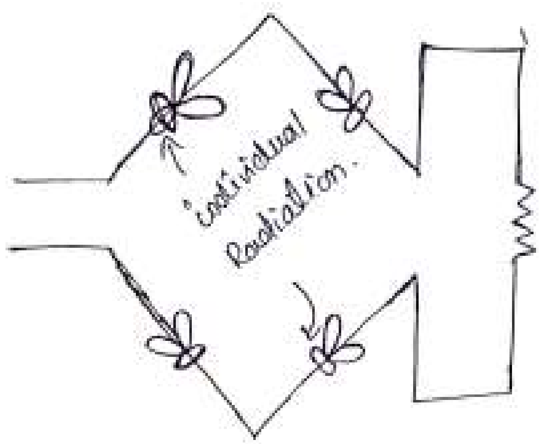
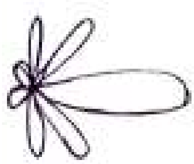
Rhombic Antenna :-

- A rhombic antenna is a broadband directional wire antenna.
- It is an equivalent parallelogram shaped antenna.
- It has two opposite acute angle.
- It is commonly used in high frequency or short wave band.
- Rhombic antenna consist of parallel wires suspended above the ground in a rhombic (diamond) shape.
- Supported by poles or towers at each vertex to which the wires are attached by insulators.
- Each of the four sides are same length.



Rhombic antenna.



Radiation pattern.

→ It is typically fed at 1 of the two acutes vertices through a balance transmission line.

→ The end of the wires meeting at the opposite vertex either left open or a terminal with a non inductive resistor.

→ When resistor is terminated the radiation pattern is unidirectional.

* Advantages :-

→ The input impedance and radiation pattern is relatively constant over 2:1 range of frequencies.

→ Multiple rhombic antenna can be connected in an end to end connection.

→ Good gain and good directivity.

→ Simple and effective transmission.

2 mark

* Disadvantages :-

→ Wastage of power in terminative resistor.

→ Requirement of large space.

→ Reduced transmission effeciency.

* Application :-

→ Used in High frequency communication.

→ Used in long distance sky wave propagation.

→ Used in point to point communication.

Assignment Questions Dt/27/08/2018

2 marks :-

1) What is actual height and virtual height ?
2) Define beamwidth and polarization ?
3) Define (antenna array) ?
4) Define (absorption and attenuation of em waves) ?
5) Describe propagation of wave ?
6) State two disadvantages of rhombic antenna ?

5 marks :-

1) Describe different types of propagation of wave ?
2) Explain critical frequency and maximum usable frequency, skip distance, fading (diffraction, absorption and attenuation) ? (5 marks).
3) Discuss about the parabolic dish antenna with its advantage, disadvantage and application ? (7 marks)
4) Discuss about yagi uda antenna with its advantage, disadvantage and application ? (7 marks).
5) Discuss about the rhombic antenna with its advantages, disadvantages and application ? (5 marks).
6) State and explain the terms (antenna gain) directivity, effective aperture & efficiency ? (5 marks)

parabolic Antenna :- 27/08/2021

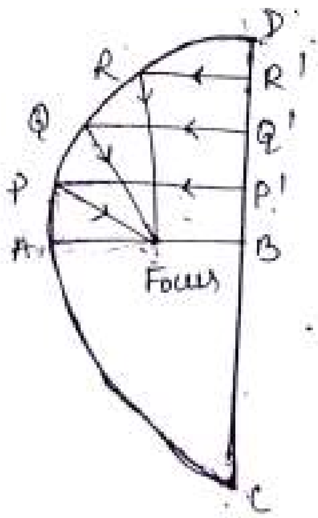
→ parabolic reflectors are microwave antenna. (range is 300MHz – 300GHz).

→ A parabolic antenna is an antenna that uses a parabolic reflector. A curve surface with the crossectional shape of a parabola to direct the radio wave.

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

→ This antenna are widely used for radio and wireless application.

* Principle of Operation :-



→ The standard defination of a parabola is locus of a point which moves in such a way that

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parabolic Antenna :-

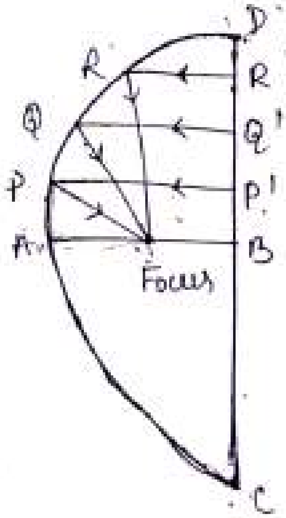
→ parabolic reflectors are microwave antenna. (range is 300MHz - 300GHz).

→ A parabolic antenna is an antenna that uses a parabolic reflector. A curve surface with the crossectional shape of a parabola to direct the radio wave.

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

→ This antenna are widely used for radio and wireless application.

* Principle of operation :-



→ The standard defination of a parabola is locus of a point which moves in such a way that distance from the fix point (called focus) plus its distance from a straight line is constant.

$$\boxed{Fp + Pp' = Fq + Qq' + FR + RR' = K} \quad (1)$$

→ The above figure shows a parabola "CAD", where is at "F". and whose axis is "AB".

→ In equation (1) where, K = a constant which may be change if a different shape of a parabola is required.

→ AF :- Focal length of the parabola.

→ The ratio of the focal length to the mouth diameter $\left(\frac{AF}{CD}\right)$ is called the apparature of the parabola just as camera lens.

→ Methods of feeding of parabolic antenna :-

→ Feed systems are the most different and important parameter part of any dish antenna system.

→ To determine the type of feed for our particular dish we must know 2 factors:-

(a) Focal length

(b) The F/D.

i) Measure the diameter by dish (D).

ii) Measure the depth from rim down to centre (c).

→ Calculate F using $D^2/16c$.

→ Calculate the f/D ratio.
→ If the value come 0.25 – 0.50 is accurate.

* Advantages:
→ High Gain
→ High directivity.
→ Narrow beamwidth.

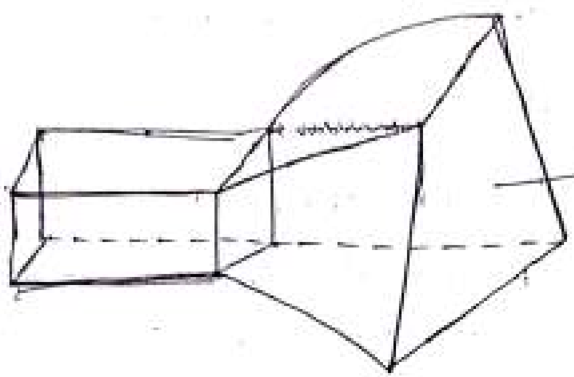
* Disadvantage :-
→ Required reflector and driven elements.
→ Cost is high.
→ Large size.

* Application :-
→ It is used as high gain antenna for point to point communication.
→ Radio telescope.
→ Radar antenna.
→ Sattelite television dish antenna.
→ In application such as microwave link for data communication in sattelite and space craft communication antenna.

DT/28/08/2018

Horn Antenna :-

→ A horn antenna or microwave horn is an antenna that consists of a flaring metal wave guide shaped like a horn to direct radio waves in a beam.



(horn antenna)

* DESCRIPTION :-

→ It is typically consist of a short length of rectangular or cylindrical metal tube [wave guide] closed at one end

→ Flaring into an open ended conical curve pyramidical shape horn on the other end.

→ The radiowaves are usually introduced into the wave guide by a co-axial cable attach to the side.

→ The waves then radiate out the horn end in a narrow beam.

* WORKING

It may be consider as the R_f transformer or impedance which between the waveguide feeder and free space, which has an impedance of $377\,\Omega$.

→ By having flared end to the wave guide, the horn antenna is formed.

→ And this enables impedance to match. It also helps suppress signals travelling vaya unwanted modes in make guide from being radiated.

* TYPES OF HORN ANTENNA

(i) Pyramedical horn antenna:-

A horn with the horn in shape of four side pyramid with a reactngular cross-section Gain of Horn Antenna.

(ii) SECTORAL HORN ANTENNA

It is of two types.

(1) E-plane

(2) H-plane

* GAIN OF HORN ANTENNA :

→ Horn have very little losses, so the directivity of a horn is roughly equal to its Gain.

→ The Gain 'G' of a pyramidical antenna is $(G) = \frac{4\pi A}{\lambda^2} e_A$

where,

'A' is the area of the apreture.

'λ' is the wave length

'e_A' is the dimension parameter between '0' and '1' is called apreture efficiency.

* ADVANTAGES :-

→ It is a directional antenna so it can utilized for long distance communication.

→ Since they don't have any resonant elements, they can operate over a wide range frequencies of a wide bandwidth.

→ The gain of Horn antenna range upto 25dB.

→ Moderate directivity high Gain.

→ Broad bandwidth.

→ Simple construction, adjustments.

* APPLICATIONS :

→ A common element of phase array.

→ used in calibration other high gain antenna.

→ used for making electromagnetic interference management.

→ They are used as feeder for large antenna structure such as parabolic antenna.

* Pyramid antenna :-

→ A horn antenna with the horn in the shape of four sided pyramid with a rectangular crossection.

* Sectoral horn antenna :-

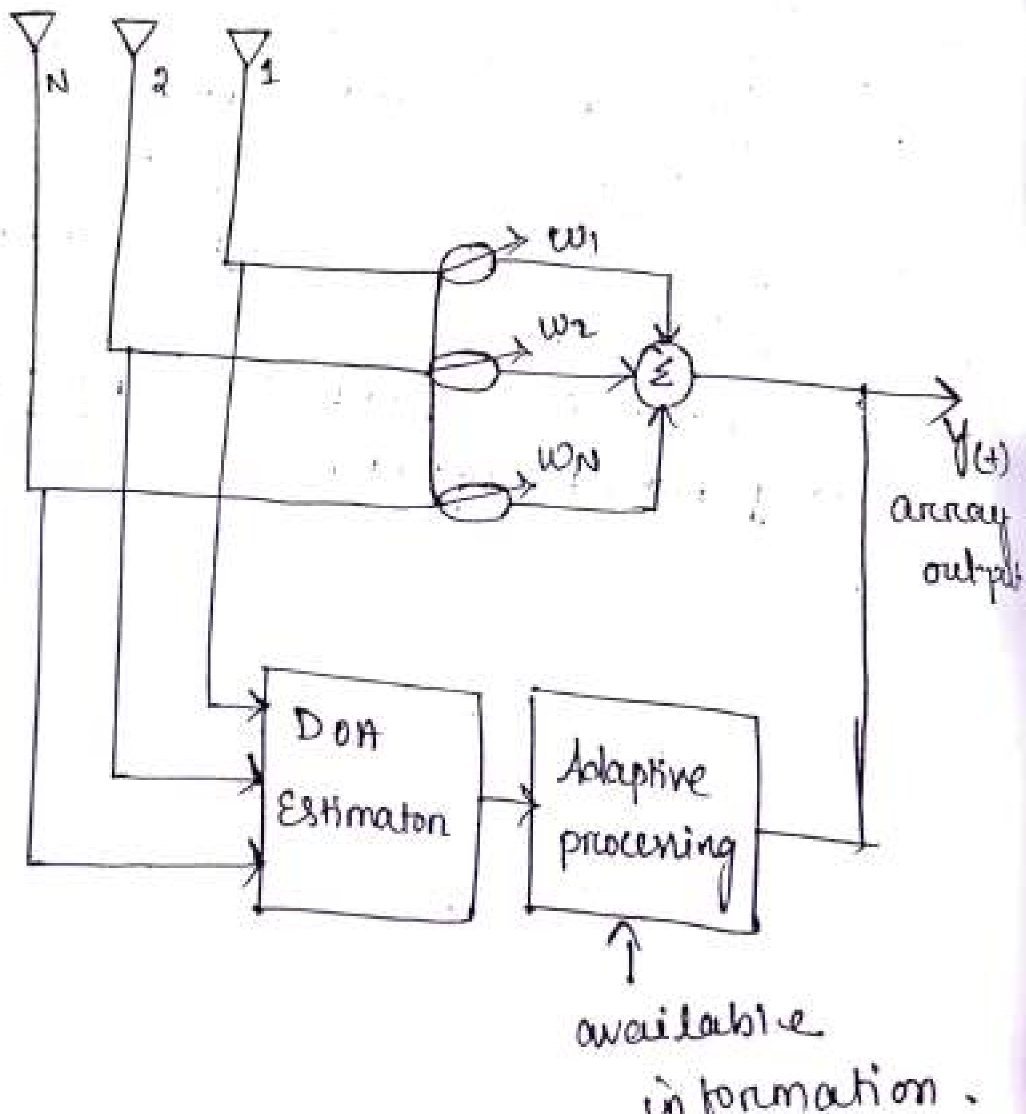
→ This form of horn antenna is one in which only one pair of sight flared and the other remain parallel.

DT-29/08/20

* Smart antenna :-

→ Smart antenna's are antenna array with smart signal processing algorithm which used to identify signal signature such as the direction of arrival (DOA) of the signal and use them to calculate beam forming vectors.

→ which are use to track and locate the antenna beam on the mobile or target.



→ Smart antenna have many function :-

(I) DOA estimation.

(II) Beam forming

(III) Interference nulling.

* Types of Smart Antenna :-

→ There are two major types of smart antenna

(I) Switched beam smart antenna.

(II) Adaptive array smart antenna.

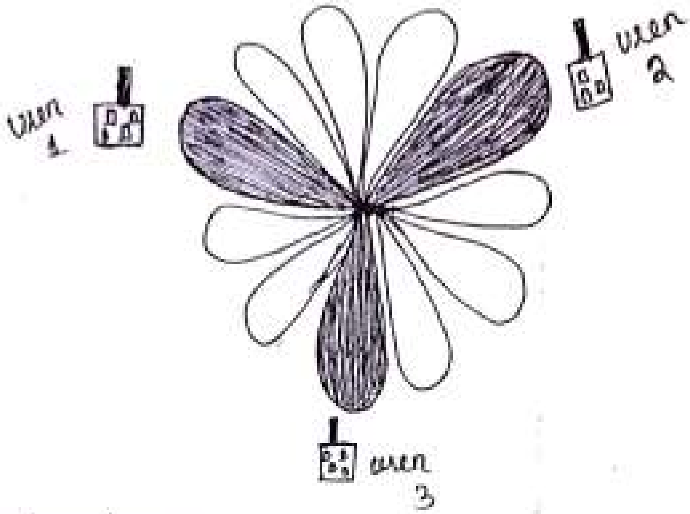
(I) Switched Beam Smart Antenna :-

→ A smart antenna that has many fix beam pattern is known as switch beam antenna.

→ When an incoming signal is detected the base station is determines the beam i.e best aligned in the signal of interest direction and then switches to that beam communicate with the user.

→ The overall goal of the switched beam system is to increase the gain according to the location of the user.

→ However, since the beams are fixed the intended user may not be in the centre of any given main beam.



* Disadvantages:-

→ This technique is simple in operation but is not suitable for high interference area.

→ This system can not produce multipath interference component.

(II) Adaptive Array Smart Antenna:-

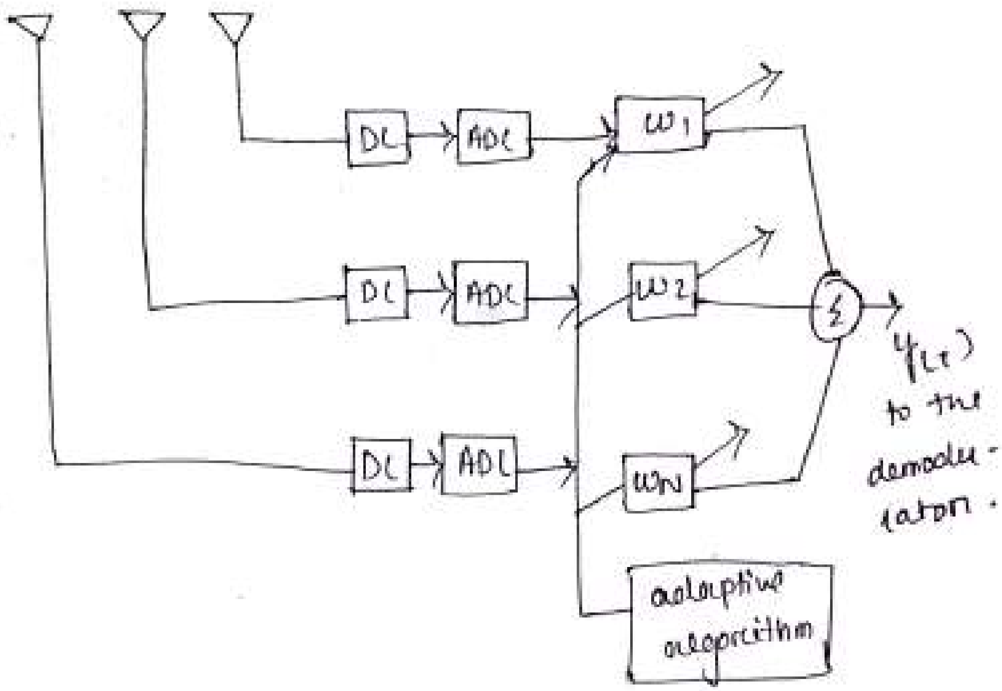
→ Adaptive antenna array is an array of multiple antenna elements that contineously adjust its own pattern with time by collecting feedback from the surrounding environment to keep the array in optimum state.

* Basic working :-

→ Adaptive array utilise signal processing algorithm to continuously distinguish between desired signal, multipath and interfacing signal.

↳ As well as calculate their direction of arrival.

→ The DOA computes the direction of arrival of all signal.



* Advantages :-

→ Increasing number of users.

→ Less interference.

→ Better Bandwidth.

* Disadvantages :-

→ Complexity :- It makes it difficult to diagnose the faults and problem.

→ High cost :- It utilise the latest ic to process expensive technology that makes it extremely costly.

→ Bigger size : Due to number of array used.

* Application :-

→ Cellular and wireless network.

→ In radar.

radar :- radio detector and receiver ...

Satellite system

* E-plane horn antenna :-

→ This form of antenna is one that is flared in the direction of the electric field or E-field in the wave guide.

* H-plane horn antenna :-

→ This form of antenna is one that is flared in the direction of the ~~electric~~ H-field or magnetic field in the wave guide.

* Conical horn antenna :-

→ The conical horn antenna has a circular crossection.

It is normally used with circ.
and is seen less frequently than the
version.

Attenuation :-

→ The inverse square law shows that the power diminishes fairly rapidly with the distance of em wave.

→ Em wave are attenuated as they travel outwards from their source.

→ These attenuation is proportional to the square of the distance travel.

→ Attenuation is normally measured in dB.

→ And happens to be same numarically for both field intensity and power density.

→ Let, P_1 and E_1 be the power density and field intensity respectively.

→ At a distance r_1 from the source of em wave. Let, the P_2 and E_2 and r_2 similar condition apply to the two distances. The attenuation being the greater of the two further point compare to the of power density at the nearer will be in dB. So,

$$\alpha_p = \log\frac{P_1}{P_2} = 10\log\frac{P_t/4\pi r_1^2}{P_t/4\pi r_2^2} = 10\log\left(\frac{r_2}{r_1}\right)^2 = 20\log\frac{R_2}{R_1}.$$

Similarly for field intensity attenuation,

$$\alpha_E = 20\log\frac{\sqrt{30P_t/r_1}}{\sqrt{30P_t/r_2}} = 20\log\frac{r_2}{r_1}$$

, (law of the ...)

Chapter - 2   Dt / 03/09/2[illegible]

...ission Line :-

A conductor design to carry electricity or electrical signal over large distance with minimum losses and distortion.

→ There are two means or media to transmit the information.

(I) The information (energy) can be radiated in the form of electromagnetic wave in to free space as in the radio communication.

→ Free space is the example of unbounded medium.

(II) The information can be transmitted by means of transmission line.

→ The transmission line specifies a set of wires made of good electrical conductor such as aluminium or copper used for transmission of electrical energy.

* Types of transmission line :-

→ The nature & performance of transmission line depends upon :-

(I) The amount of power to be transmitte[d]

(II) The frequencies involved.

From these consideration the transmission line may be chatagorised as :-

(a) power line :- use for transmission of large quantity of power over a fixed frequency.

(b) communication line :- used for transmission of small quantities of power at small band of frequency.

* Types of communication line :-

(i) Co-axial cable

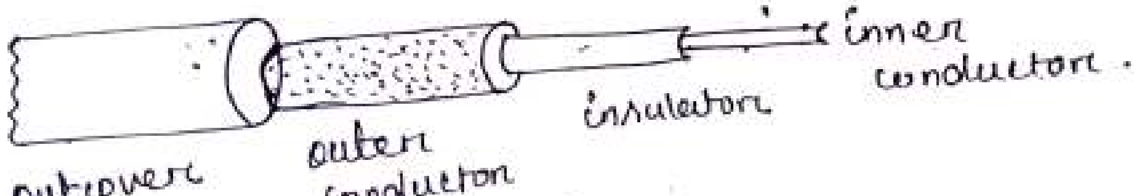
(ii) Open wire

(iii) wave guide

(iv) Twisted pair

(v) Optical fiber.

(1) Co-axial cable :-



→ One wire line is place inside a large hollow concentrict conductor. The arrangement is called co-axial cable. It is called so because of both conductor (outer & inner) have the same axis.

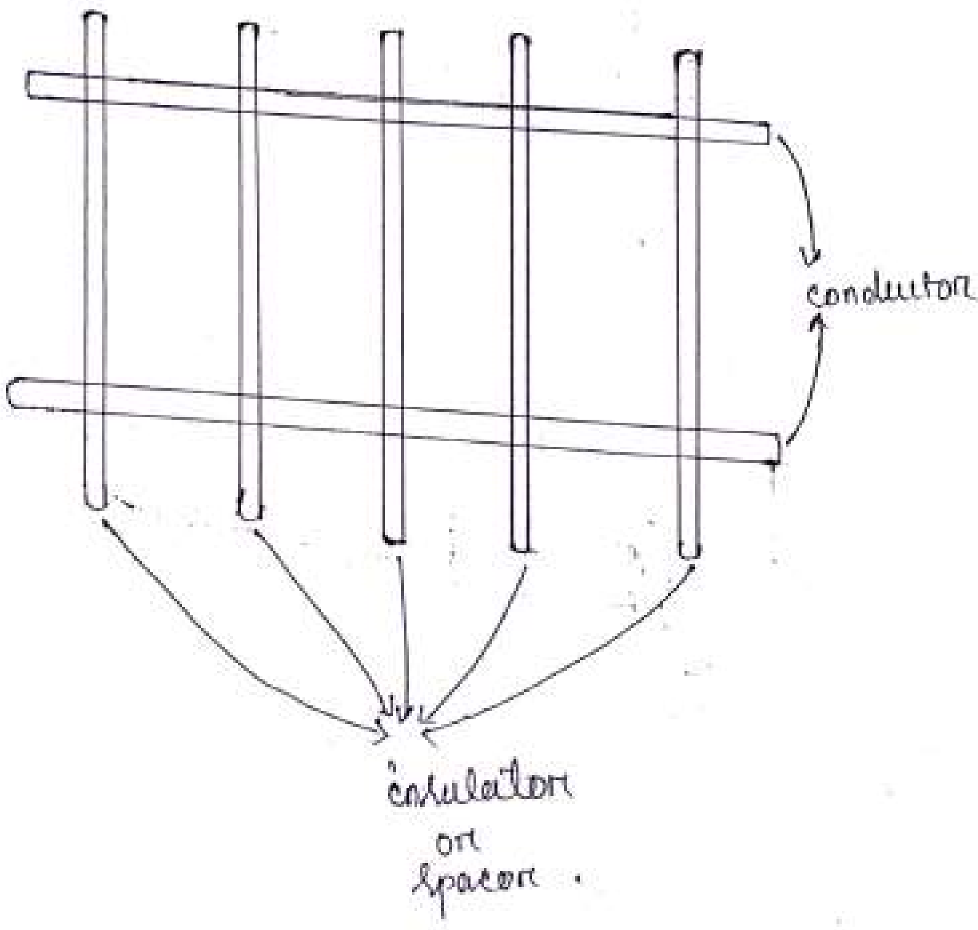
→ In practice the central conductor is supported by solid disc of certain dielectric material.

→ The presence of outer conductor prevents interference from external source and radiation losses at higher frequency.

→ This are used upto a frequency of 3GHz.

It is generally used for connection a transmitter receiver to the antenna.

(ii) Open wire :-



→ It usually consist of two copper or copper alloy conductor spaced a few cm apart and fixed by spacer or insulator.

→ A two wire open line is easy and cheap to construct.

→ However, the use of open wire line become undesirable above 100MHz frequency because of the radiation losses which increases if frequency increases.

(ii) Twisted pair :-

→ This are used to transmit small amount of power.

(iii) wave guide :-

wave guide is a hollow conducting tube of uniform crossection used for UHF transmission by contineous reflection from inner walls of the guide.

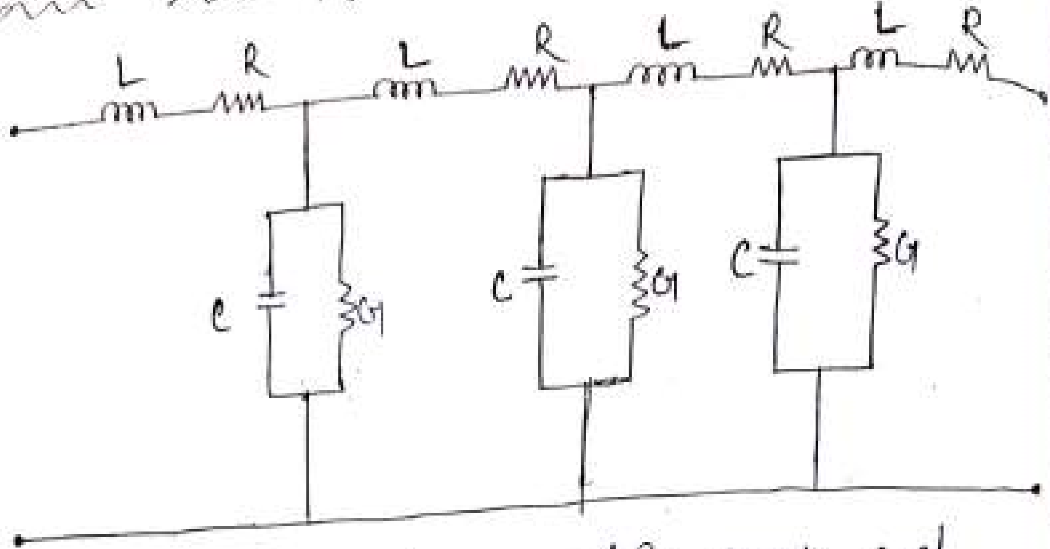
(iv) Optical Fiber :-

An optical fiber is a dielectric wave guide that transfer light signal from one place to another place.

An optical fiber is a flexible, transparent fiber made by thin glass or plastic to a diameter slightly thicker than that of a human hair.

Dt-04/09/2025

* Equivalent circuit of transmission line : (11)



→ Since, each conductor has a certain length and diameter it will have a resistance (R). And an inductance (L).

→ If a current is flowing through the conductor magnetic field created around the conductor.

→ The magnetic field which is proportional to the current.

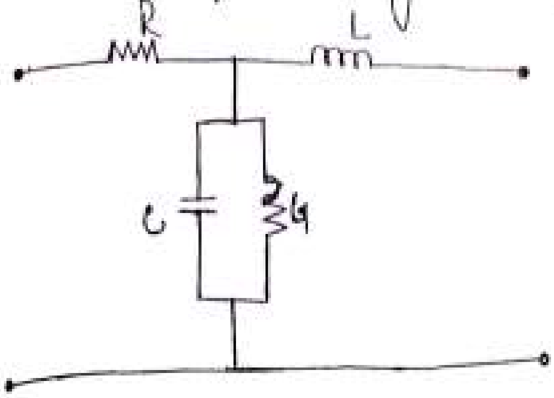
→ It indicates that the line has series inductance (L).

→ Since, there are two wire closed to each other there will be capacitance between them.

→ This wires are separated by a medium called the dielectric. which can not perfect in its insulation.

→ The current leakage through it can be represented as shunt conductance (G).

→ A unit section of line may be represented as



* Different parameters of transmission line :-

(i) Series Resistance (R)

(ii) Series Inductance (L)

(iii) Shunt capacitance (C)

(iv) Shunt conductance (G)

* Secondary constants of transmission line :-

(i) characteristic impedance.

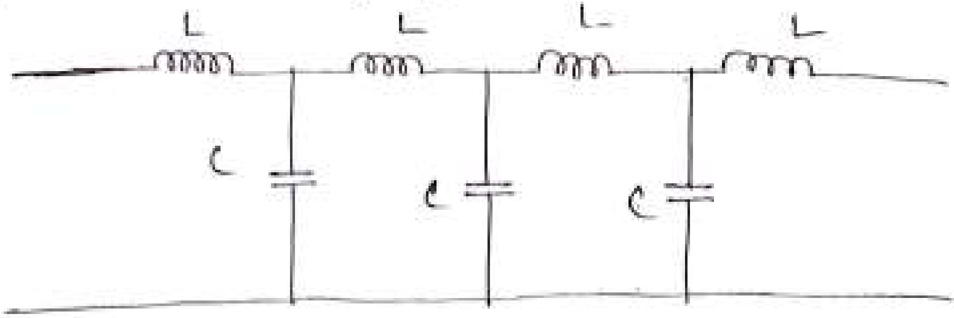
(ii) propagation constante.

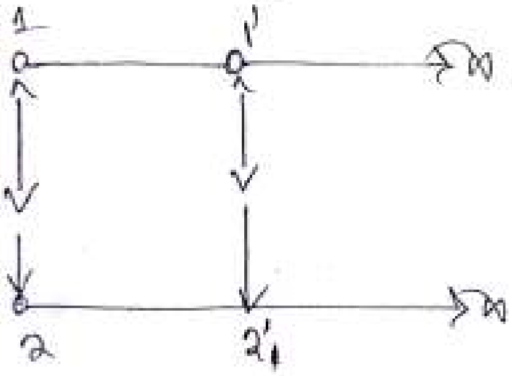
Series impedance = R + jωL (Z)

Shunt impedance (y) = G + jωC .

05/09/20

* Transmission line RF equivalent circuit :-





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

→ This circuit is consist series and shunt impedance must have an input impedance.

→ The characteristic impedance of a transmission line most known is the impedance measured at the input of a line when its length is ∞.

* Method to calculate characteristics impedance :-

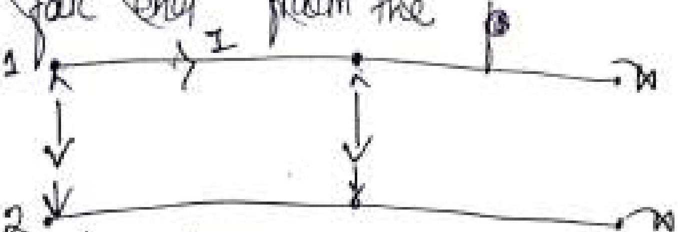
→ The characteristic impedance of a line will be measured at its input when the line is terminated at the far end in an impedance equal to zero. ($Z_{in} = Z_{out}$)

If a line has ∞ length all the power fed into it will be absorbed.

If one moves away from the input voltage and current will decrease along the line.

As a result of the voltage drop across the inductance and current leakage through the capacitance.

So, ~~that through~~ the point 1' - 2' of the figure is just ~~far end~~ from the



$Z_0 = \frac{V}{I}$, $Z = \frac{V'}{I'}$

So, the impedance seen at 1' - 2' of the figure just has far from the far end on this line as the points 1'-2'. So the impedance seen at 1'-2' is also Zo to the voltage and current are lower than at 1-2.

Zo will be measured at the I/p of a transmission line if the output is terminated in Zo under these condition Zo is consider pure resistive.

Dt-11/09/20

* Different losses in transmission line :-

→ The energy losses that happen in case of transmission line are shown below.

(a) Conductor heating.

(b) dielectric heating.

(c) Radiation losses.

→ It is observed that radiation losses in parallel 2 wire line is much more than that of co-axial cable.

(a) Conductor heating :- (I^2R losses) :-

→ The heating rate of conductor is directly proportional to the square of the current.

→ It is inversely proportional to the characteristic impedance (Z_0).

→ Conductor heating will also increase with the increase in frequency.

(c) Radiation losses :-

→ The transmission line act as antenna when the separation distance between the conductor is very small as compare to their wave length.

→ Then the conductor starts radiating energy.

→ As we will increase the frequency radiation losses will also increase.

Dt: 24/09/2018

Dielectric heating :-

→ It is directly depends upon the voltage flowing across the dielectric similar to conductor heating.

→ It is also inversely proportional to the characteristic impedance of the line.

→ In this case the loss also increase with increase in frequency.

→ If we use air as dielectric medium then the loss will be almost equal to zero.

Standing wave Ratio :- (SWR) :-

→ To describe the characteristic of voltage distribution on a transmission line a quantity known as SWR is usually determine.

→ The SWR is used to measure the mismatch between source and load.

→ SWR may be defined as the ratio of maximum voltage to minimum voltage or maximum current to minimum current. i.e

$$SWR = \frac{V_{max}}{V_{min}} = \frac{I_{max}}{I_{min}}$$

where, V_{max} = maximum voltage.

V_{min} = minimum voltage.

I_{max} = maximum current.

I_{min} = minimum current.

→ For any particular line of configuration the value of SWR will be the same whether it is define in terms of voltage ratio or current ratio. When the line is terminated is a purely resistive load the SWR is given by $\frac{Z_0}{R_L}$ or $\frac{R_L}{Z_0}$ which ever is larger.

* Relationship between SWR and reflection co-efficient:-

→ Reflection co-efficient:-

↳ It is defined as the ratio of the reflected voltage to the incident voltage. or it is the ratio of,

$$K = \frac{V_r}{V_i}.$$

where, V_r = reflected voltage.

V_i = incident voltage.

→ Similarly, reflection co-efficient is defined as the ratio of reflected current to incident current, i.e

$$K = \frac{I_r}{I_i}.$$

where, I_r = reflected current

I_i = incident current

→ Standing wave ratio is abriviated as "SWR" and it is denoted by "S".

→ While dealing with the voltage ratio it is abriviated as "VSWR".

→ While dealing with the current ratio it is abriviated as "CSWR".

→ Taking only Rms value and measuring from generation end. The maximum voltage V_{max} appears at a point where incedent and reflected waves are in phase and they add up.

$$V_{max} = |V_i| + |V_r|$$

where, V_i = Rms value of incedent wave.

$|V_r|$ = Rms value of reflected wave.

→ The minimum V_{in} appears at a point where incedent and reflected waves are out of phase and is given by,

$$V_{min} = |V_i| - |V_r|$$

→ From the defination of VSWR we have,

$$VSWR = \frac{V_{max}}{V_{min}}$$

$$V_{SWR} = \frac{|V_i| + |V_r|}{|V_i| - |V_r|}$$

→ dividing numarator and denominator by V_i. we get,

$$V_{SWR} = \frac{1 + \left|\frac{V_r}{V_i}\right|}{1 - \left|\frac{V_r}{V_i}\right|}$$

→ By the defination of reflection co-efficient

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

→ putting $K = \frac{V_r}{V_i}$.

$$\Rightarrow V_{SWR} = \frac{1+K}{1-K}$$

$$\Rightarrow S = \frac{1+K}{1-K}$$

$$\Rightarrow S(1-K) = 1+K$$

$$\Rightarrow S - SK = 1+K$$

$$\Rightarrow S - 1 = SK + K$$

$$\Rightarrow S - 1 = K(S+1)$$

$$\Rightarrow \boxed{K = \frac{S-1}{S+1}}$$

Impedance matching :-

→ A line that is terminated by a load whose impedance is not equal to the characteristic impedance is called mismatched line.

→ The mismatching results in reflection of the power back to source and higher than the normal voltage.

→ The best result will be obtain when the load is matched to the characteristic impedance of the line.

→ matching can be accomplished by the following one or more techniques :-

(i) Use of transformer.

(ii) Use of series capacitance and inductance.

(iii) Use of stub matching.

Stub matching :-

→ Shorted transmission line stubs are often used instead of capacitor or inductor at VHF and above.

→ Usually these are placed in parallel with the main line rather than series. These are installed at some distance from the load.

Defination of stub matching :-

→ The connecting section of open or short circuited line in shunt with the main line at a certain point to effect the matching impedance is called

Stub matching.

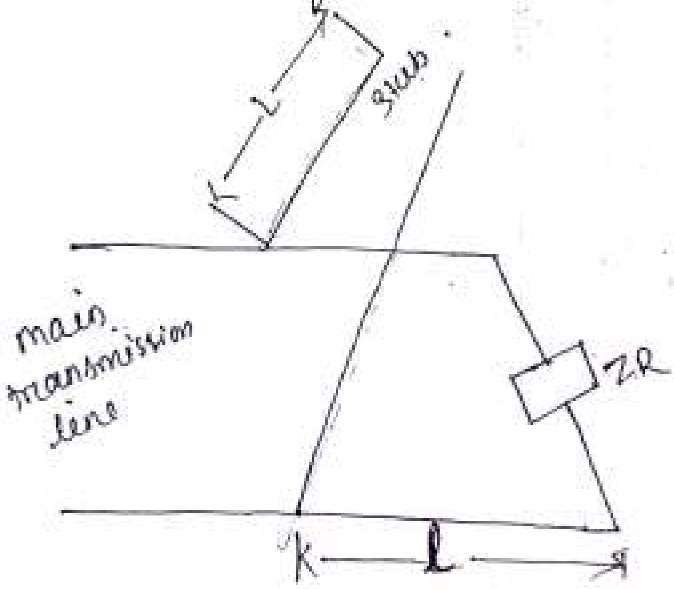
* Advantages:-

→ Length (l) and Z_0 remain unchanged.

Z_0 • characteristic impedance.

→ Mechanically it is adjustable to add adjustable susceptance in shunt with the line.

* Single stub matching:-



→ Here, a known load admittance of the end of a loss less line is used for impedance matching.

→ Varrying the stub L varries only the shunt susceptance so the length l must be so chosen that the input admittance may be brought to the center.

→ It is necessary that the stub should be located as near to the load as possible.

→ And the characteristic admittance of the stub so connected in shunt should be same as that of the main line.

→ The stub has to be connected where there is no reflection.

$$l = \frac{1}{\beta} \tan^{-1} \sqrt{\frac{Z_R}{Z_0}}$$

$$\text{where, } \beta = 2\pi/\lambda$$

→ β give the location of the stub from the load end. The desired length of the stub (L) which will provide susceptance is found to be,

$$L = \lambda/2\pi \tan^{-1} \sqrt{\frac{Z_R + Z_0}{Z_R - Z_0}}$$

* Application:-

→ It is used in short wave range of broadcast band.

* Disadvantages:-

→ The range of terminating impedance which can be transfer is limited.

→ It is used for a fixed frequency only. Hence, the single stub matching system is a narrow band system.

→ It is usefull for open wire system but not suitable for co-axial line.

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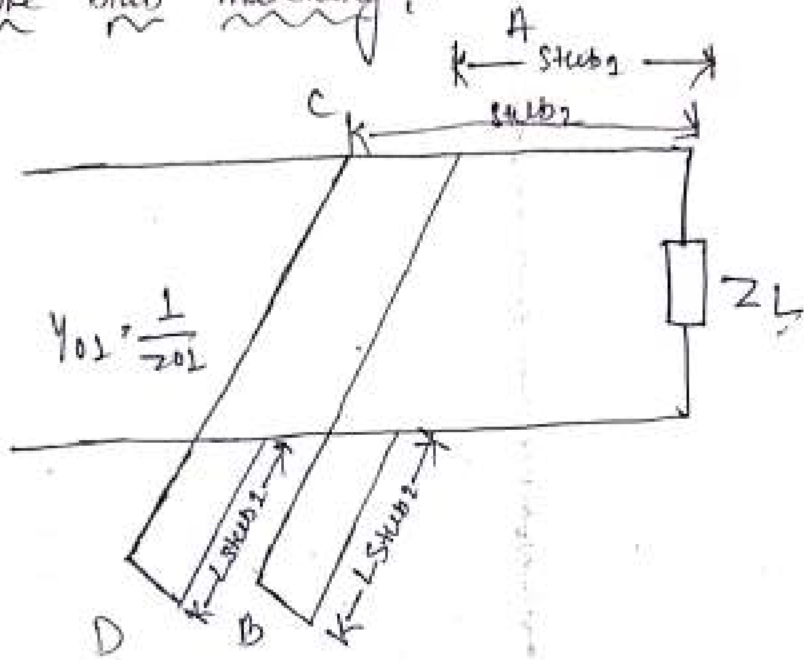
* Double Stub matching :-



→ It is used to overcome the disadvantage of single stub matching.

→ Here, two short circuited stub whose length are adjustable independently but whose are fixed.

→ Impedance matching can be achieved by inserting two stubs at specified location along transmission line as shown above.

→ Along transmission line, there are 2 design transmitter for double stub matching.

(I) (Lstub1) The length of the 1st stub line system.

(II) (Lstub2) The length of the 2nd stub line system.

→ The two stubs usually $\lambda/4$ apart are utilized.

→ Some difficulties are encountered if the two stubs are closed together.

→ The separation of 0.375 λ or $3/8$ λ is minimum/optimum. These type of stub are usually employed for co-axial microwave line.

→ The stub AB nearest to the load is adjustable to make the real part of the admittance at the point CD equal to the characteristic conductance of the line in absence of the second stub AB.

→ The stub is then adjusted to produce zero susceptance at the point CD.. . ..

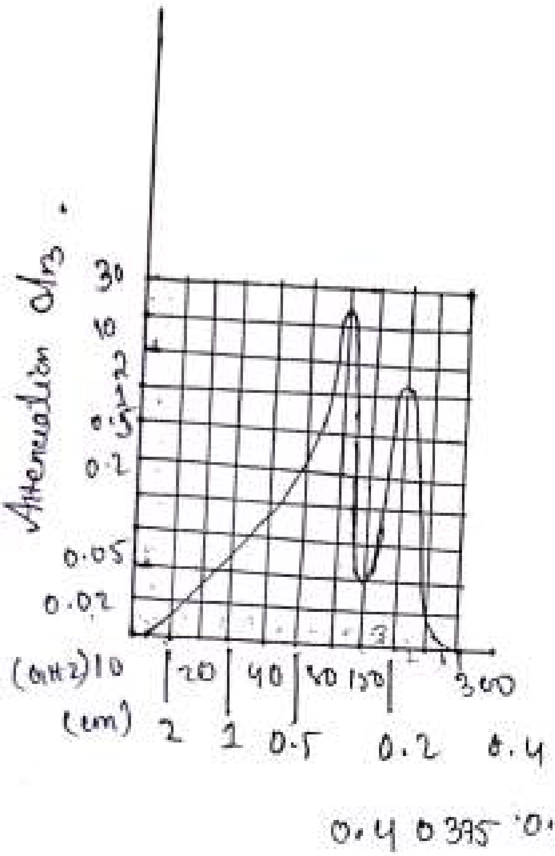
→ By double stub matching it is possible to reduce VSWR below 1.2. (voltage standing wave ratio).

→ The length of the stub may be determined with the help of smith chart.

→ The length of the stub are in the range of

$L_1 \approx 0.348\lambda$ and $L_2 = 0.11\lambda$

* Absorption :-



→ In free space absorption of radio wave does not occure because there is nothing to absorve them.

→ But some energy from the Em wave transfer to the atoms and molecules of the atmosphere.

→ This transfer causes the atoms and molecules to vibrate some what and while the atmosphere is warm only infinite simaly.

→ The energy of the wave may be absorved quite significant.

→ In the above figure absorption by both the

~~oxe~~ oxygen and water vapour. contain of the atmospheric becomes significant at the frequency and then rises gradually. Because of varying molecular resonance. Atmospheric absorption split in to two major components with absorption due to the vapour contain of the atmosphere if there is fog, ~~rainbow~~ rain and Snow then this form of absorption is increased tremendiously.

Ch-4

Television

01/03/10/20

* **Defination :-**

→ The word TV has its origin in two greek words "tele" and "vision".

→ "Tele" means at distance and vision means seeing.

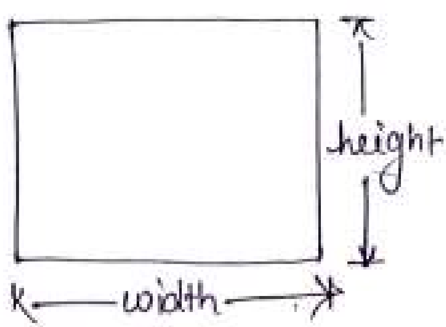
→ Earlier selenium photosensitive cells were used for converting light from picture in to electrical signal.

Imp * Aspect ratio :- (5)

→ According to test and observation the best viewing comfort and ālistic appriciation are obtain when the picture raster has a rectangular format with an aspect ratio i.e <u>width to height ratio</u>.

→ This is because of the binacular vision due to the pair of eyes in the horizontal plane as compare to that in the vertical plane.

→

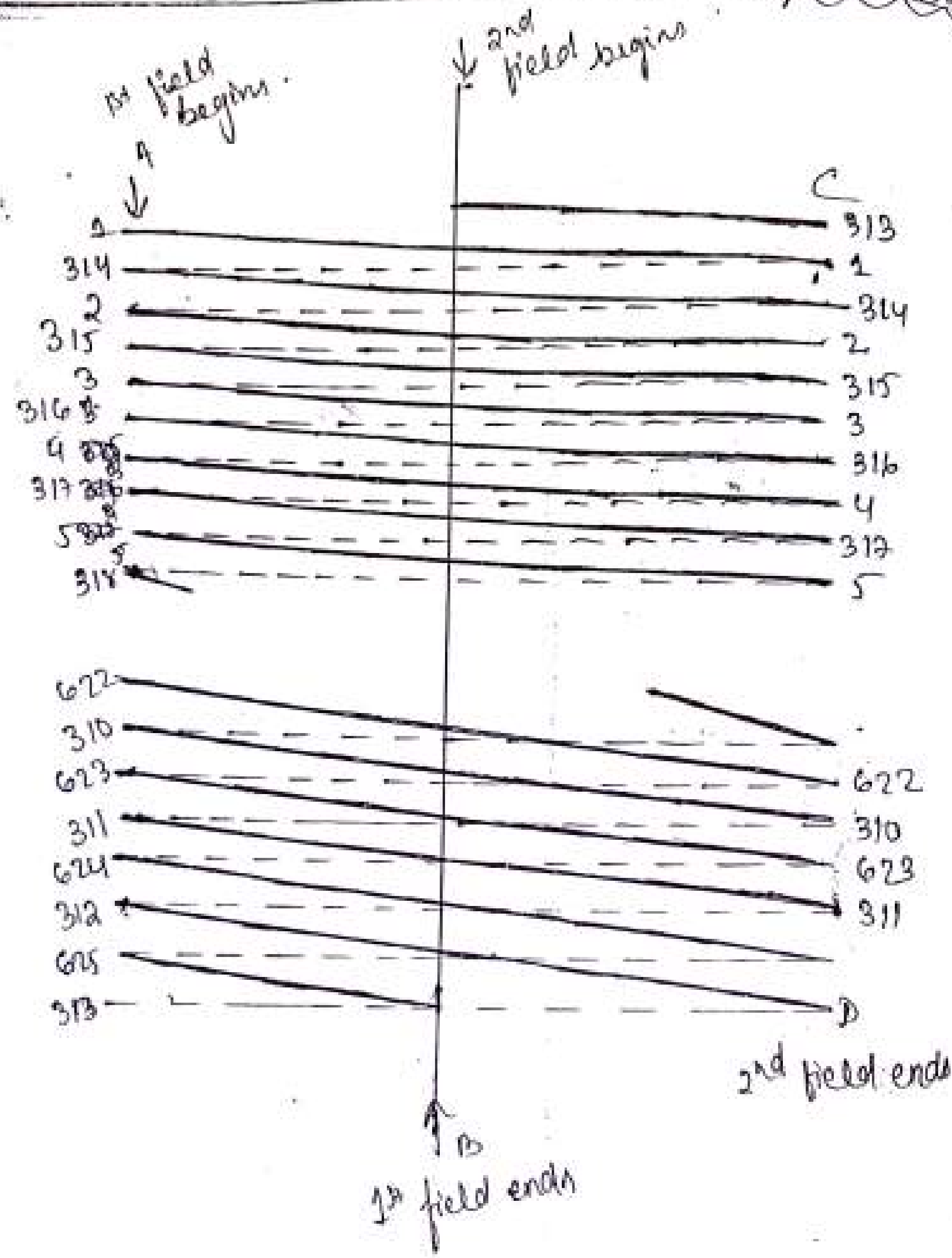


Aspect ratio = width : height

→ 16:9 aspect ratio is used for greater flexibility in TV program,

TV aspect ratio is refers to the ratio of a TV screen width vs height.

Dt/04/10/2017



1st field — thick

2nd field — thin

Horizontal ---- dotted.

Retrace.

Interlace Scanning:-

→ In the scanning process the electron beam sweeps across each horizontal line in regular succession from top to bottom of the picture is called progressive scanning.

→ For continuity of motion each picture frame is scanned 25 times per second in India and 30 times per second in America.

→ The total number of horizontal line into which a picture frame is divided depend upon the standard adopted.

→ In India the no. of lines per picture is 625 compared to 525 lines in America.

→ This means the total no. of line scanned per second in India is 625 x 25 = 15,625.

→ Similarly, total no. of line ~~second~~ scanned per second in America is 525 x 30 = 15,750.

→ The repeatation rate of 25 picture per second in TV again creats the problem of flicker.

→ This problem is solved by especial method of scanning called Interlace scanning.

→ In interlace scanning all 625 lines are not scanned at a stretch but the scanning process is divided into two stages called field.

→ Each field will contained only half the total no. of lines contain in one frame i.e 312 half lines.

→ The scanning beam which moves down at double rate now will scan only alternate lines.

→ The scanning process start at 'A' when the 1st left of 312½ line is scanned. Sequencially in the 1st odd field.

→ The scanning of odd line will end at 'B'.

→ When the beam will suddenly flyback to point 'C'. start scanning the even set of lines. (even field).

→ In the 2nd (even field) which will end at 'D'.

→ From there, the beam will flyback to 'A' and the scanning process will start all over again.

→ Thereby, making the picture repeatation rate double the frame repeatation rate. i.e 50 field per second.

→ Where as the number of lines scanned per second remain same.

Flicker :- (9)

> In motion picture the persistance of vision helps to create an illusion of contenious motion.
> when the picture is projected at repeatation rate of 24 picture frame per second.
> The repeatation rate however produces flicker.
> The flicker rate is reduced by using a rotating shutter to present each picture frame to eyes.
> which virtually makes the picture repeatation rate 48 frame per second and thereby eleminates the flicker.
> In TV persistance of vision not only produce a complete picture from separate elements but also helps create the impression of contenious motion.
> The picture repeatation rate used in TV 25 picture frame per second in India.
> Similarly 30 picture frame per second in America.
> For reducing the flicker in a TV picture a special type of scanning called interlace scanning is used.

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* Resolution :-

→ The ability of the image reproducing system to represent the fine structure of an object is known as resolution.

→ It is necessary to consider this aspect separately in the vertical and horizontal planes of the picture.

→ This depend upon the number of scanning line used for frame.

* Synchronization :-

→ The process by which the horizontal and vertical sweeps at the camera and TV receiver are kept in step with each other is known as synchronization.

→ This is achieve by sending synchronisation signal by the transmitter.

→ This timing signals are in the form of rectangular pulses used to control both the transmitter and receiver scanning.

→ Separate synchronisation signal are required for the horizontal or line sweep and vertical or frame sweeps.

* Since, the frequency of horizontal line scanning is 15,625 Hz.

→ The freq. of the vert. sync. signals will be the same as the field scanning frequency which is 50Hz.

- To eliminate the difference betn odd and even field and to help proper maintain proper interlace betn two field equalizing pulses are also transmitted before and after the frame sync system.

- Rectangular ~~Scanning~~ Scanning :-

- For picture raster of rectangular shape rectangular scanning is most convinient. There are two scanning procedure taking place symentaniously.

  (i) One moving the beam horizontally from left to right at a fast rate.

  (ii) And other beam moving vertically downward at a slow rate.

- movement of the beam are at a constant speed during the forward and downward scan.

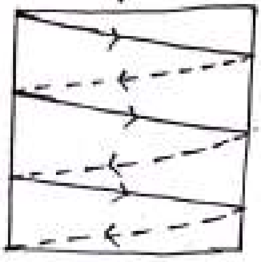
- Thus, the Scanning is in the both direction.

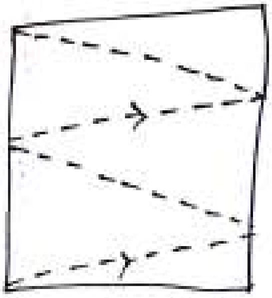
- For each vertical scan the picture is assume stationary and is scanned at a fast rate along a no. of hor. starting line.

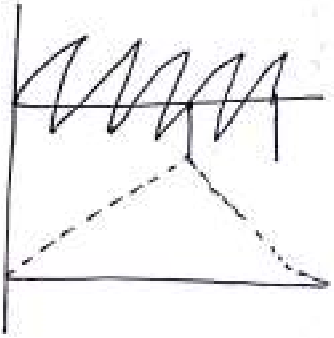
- For good resolution the no. of lines scanned ~~for~~ per picture must be large enough.

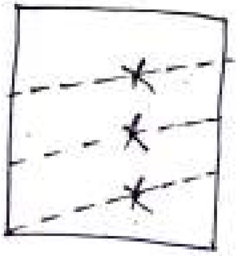
- A relatively low vertical scanning rate is desirable.

To lower limit of vertical scanning rate is said by limit of persistance of vision of human eye.









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Blanking :-

→ Under the action of scanning at the end of each field the scanning beam quickly returned to the start the scanning of another line or field.

→ The path followed by returning electron beam is called retrace.

→ The retrace is made invisible by a process is known as blanking.

COMPOSITE T.V. SIGNAL (7)

→ For the transmition of TV pictures by EM or radio waves, the optical image of the object must first be converted into an electrical image.

→ This is done by camera.

→ The electric charge pattern on the electric image so former is then scanned by the scanning process.

→ The picture information obtained by scanning in the TV camera also known as video signal. is transmitted as a modulation of the picture Rf ~~careen~~. carrier.

(*) The video signal is not transmitted alone but it is accompained by a number of other signal or pulses. which helps in the proper reconstruction of the picture at the recieving end. The pulses are :- (A) Line synchronizing (Horizontal) pulses

(B) field synchronizing ~~(....)~~ (Vertical) pulses.

(C) Equalising pulses.

* A combination of picture signals and all the controlling signal or pulses mentioned above is called a composite video signal.

→ For the formation of a composit video signal, a blanking signal is imposed on the electron beam at the end of horizontal lines. This completely cut off the electron beam from reaching the photosensitive plate of the TV camera.

→ A synchronization pulse which is of a shorter duration than the blanking pulses is then made ride on top of the blanking pulses.

→ Fig(1) indicates the relative amplitude of the picture signal, blanking signal, synchronizing signal in the case of horizontal scanning signal. of the 100% amplitude available.

→ 75-80% is used for picture information.

→ The blanking signal is introduced at a level which completely cut off in the electron beam in the picture tube and no light is produced in the picture screen. This level is called black level.

→ The synchronizing pulses which is on amplitude even greater than 100% than the blanking voltage takes the picture tube even below the cut off region and this is known as blacker than black level.

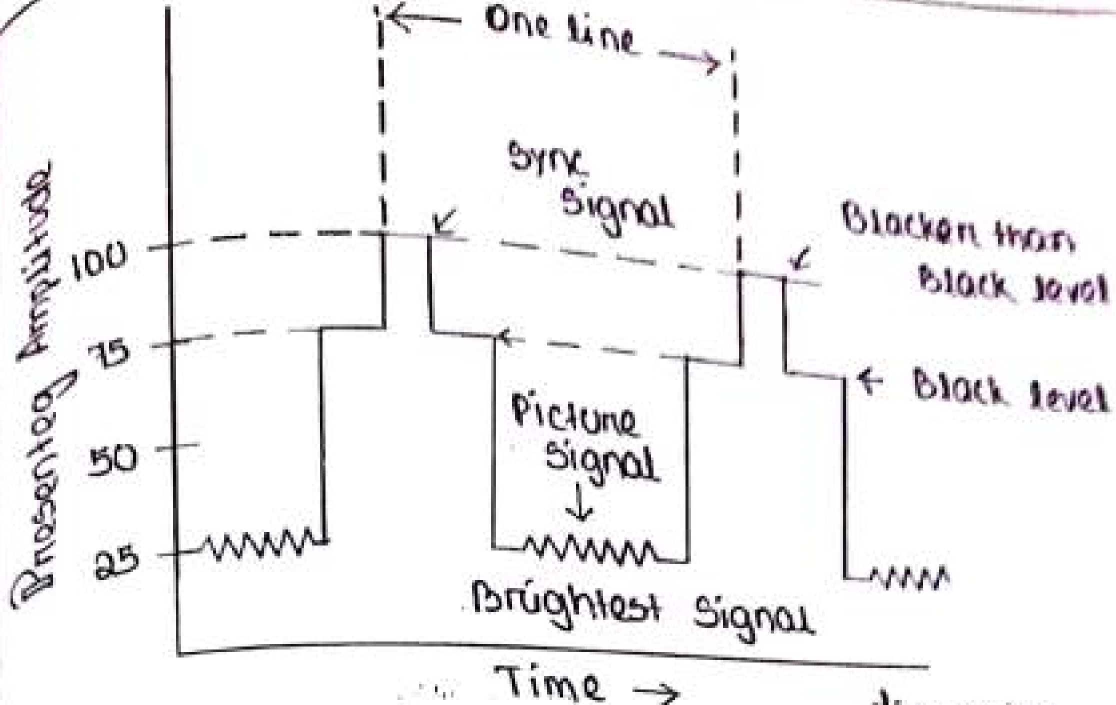


figure (1)

(a) Negative Transmisson

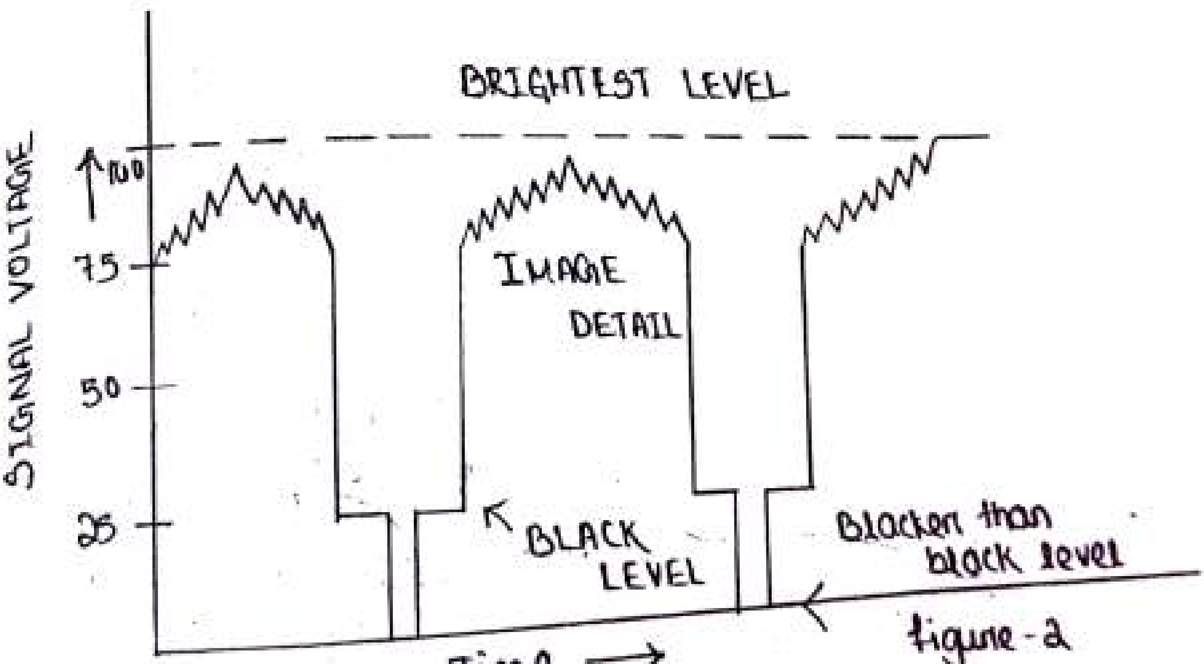
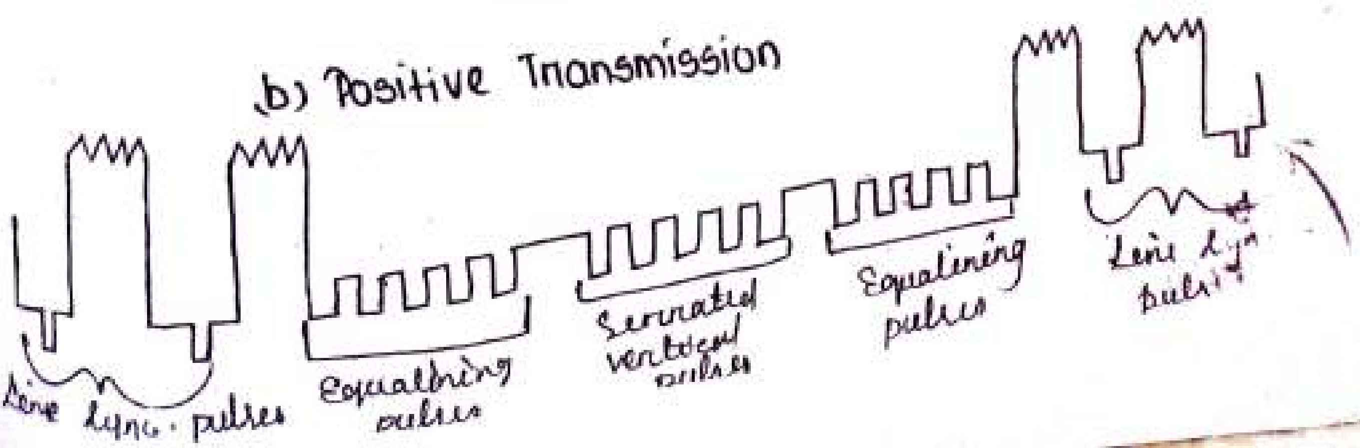


figure-2

(b) Positive Transmission



* **mining of colours:**

→ Red, green, blue are the primary colour.

→ When these colours are mined we get secondary colours.

→ The mining of colours can occures in 2 ways:- additive mining and substractive mining.

* **Additive mining of colours:-**

→ when we see different primary colour comming from independent source we see the combine effect. Additive mining of colours takes place in our eyes and we see a colour different from original one.

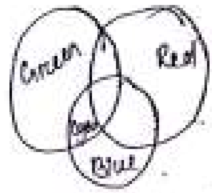
→ mining of Red, green and blue which white colour. Mining of red and green in equal intensities gives yellow colour. Thus,

Red + Blue + Green = white.

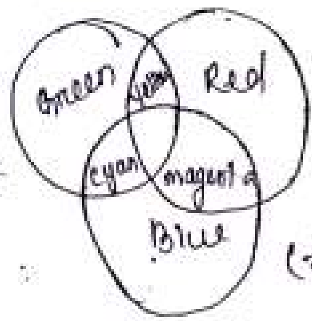
Red + Green = yellow

Red + Blue = magenta.

Blue + Green = cyan.



→ when the intensity of primary colour being mined at different we get some other colour.

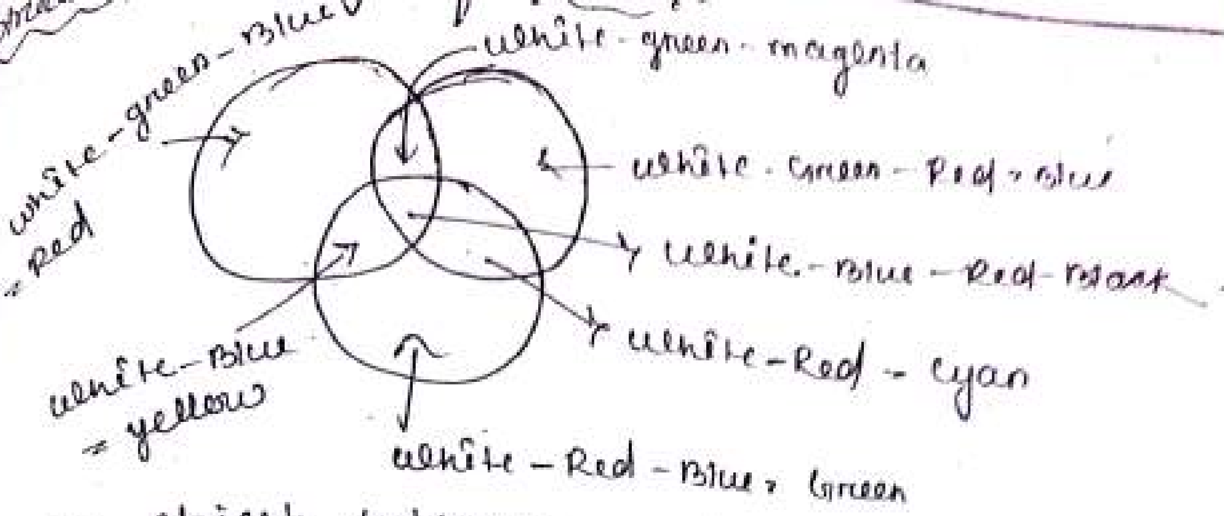


(fig-1).

→ 1 lumen of red mined with 0.5 lumen of green gives reddish yellow.

→ In the above fig(1) each circle represent one primary colour and some colour obtained as the result of additive mining are also shown.

Subtractive mixing of colour :-



→ When an object subtracts a colour from the incident light then subtractive mixing take place :-

→ When white light is incident on a blue object the object observes green and red component of white light and we see the blue colour.

→ When yellow light fall on a red rose green portion is observed and we see only red colour.

→ When all 3 i.e green, blue, red are ~~blocked~~ observed by the object the result is black.

→ According to grass man's law $0.59G + 0.3R + 0.11B = Y$.

where, R = Red, B = blue, G = Green and Y = resultant luminance.

→ Hue :- It is the actual colour seen by eye. Red, yellow, green, blue etc represented as different hues in the spectrum of colours.

→ Hue is the result of the effect produce on the eye by the wavelength of that colour.

→ Luminance or brightness :- It is the total amount of light intensity or light energy receive by eyes. It is express in lumen's.

* Saturation :-

→ It indicate the purity of colour in the other word it represents the amount of other colour present in it.

→ colour signal :- The three primary colour Blue, green and Red produce by 3 camera tube are used to produce the camera signal. 3 colour signals are combined to produce luminant signal and crominance signal.

* Luminance signal :-

→ The signal is obtained by mixing the 3 colours Red, green, blue in propagation of 30%, 59% and 11%.

→ This mix signal is called luminance signal denoted as Y. $Y = 0.3R + 0.59G + 0.11B$.

→ Where; Y is Luminance, R = Red, B = Blue, G = Green.

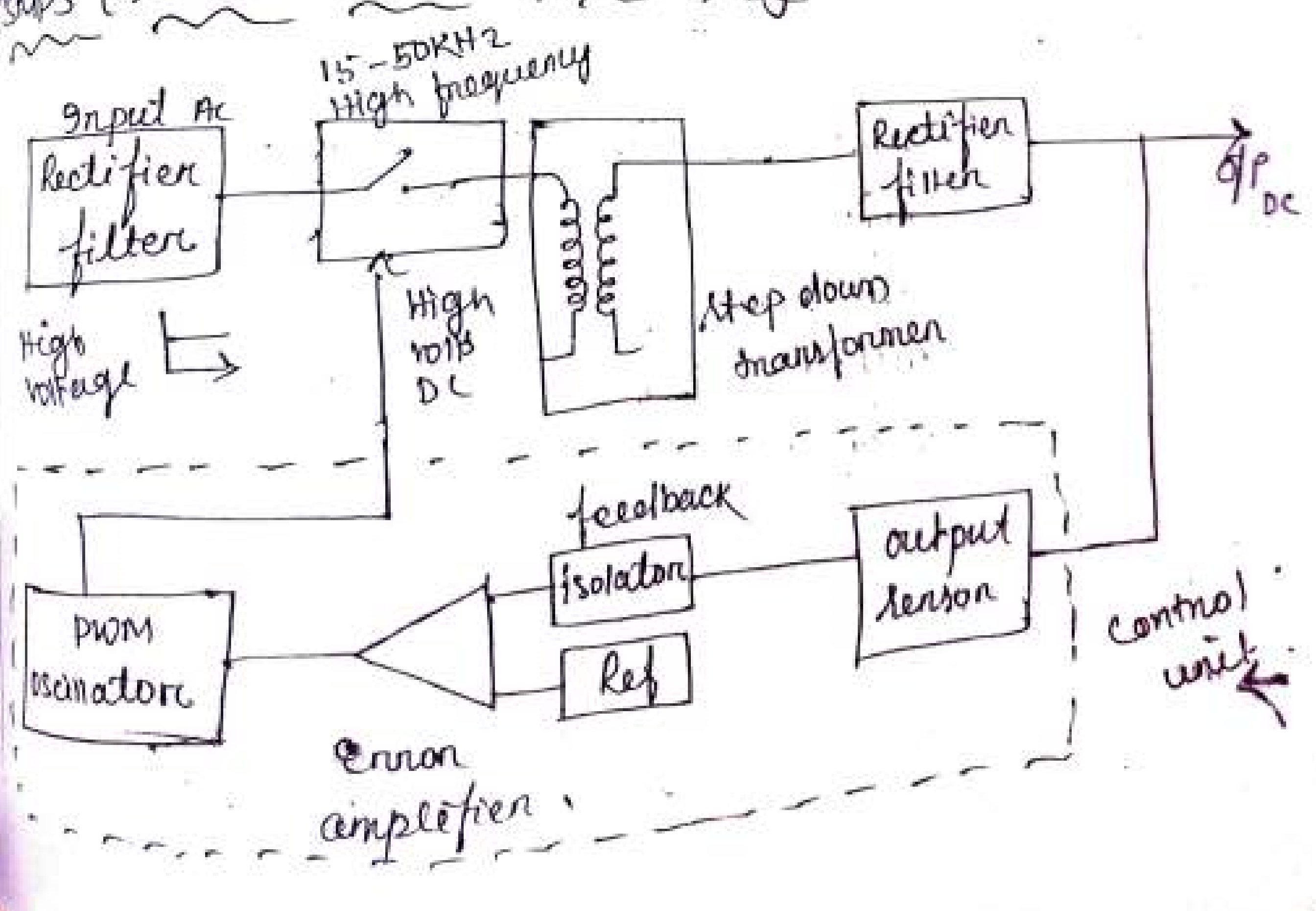
→ The above proportions have been selected keeping in the sensitivity of eye of these colours.

→ Y has the maximum value of 1v / peak white. They white include all the 3 primary colours. Red, green and blue.

For other colours the luminance signal y is sum of luminance contribution of the primary components as follows.

White	Yellow	Cyan	Green	Magenta	Red	Blue	Black
R+G+B	R+G	G+B	G	R+B	R	B	0
1.0	0.89	0.7	0.59	0.41	0.3	0.11	

SMPS (Switched mode power supply):-



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* Smps :- (Switch mode power supply) :-

→ It is a device which provides power to any electrical load and involves some kind of switching action.

* Why go for Smps :-

→ Linear power supply become very bulky with increase in its current ratings. So, we needed something which will allow us to handle large amount of current without taking a lot of space. So, Smps is the solution for that.

→ Smps works on a very high frequency as compared to linear power supplies. As the size of the transformer reduces with increase in frequency the overall size of the smps very small as compare to linear power supply.

→ There are basic 5 blocks in SMPS :-

(I) Input rectifier and filter.
(II) Chopper.
(III) Transformer.
(IV) output rectifier and filter.
(V) feedback circuit.

* Working :-

→ Smps works on high frequencies.

→ we need to increase the frequency of 50Hz Input.

→ Convert the AC input to DC and then chop it at high frequency to get pulsating DC output which is then apply to rectifier and filter.

→ Feedback helps to maintain the level of o/p signal.

* Advantages:-

→ Small size.

→ Low noise.

→ High efficiency (80-95%).

* Disadvantages:-

→ High complexity.

→ produces EMI.

* Microwaves:-

→ micro means very small and waves in this case refers to electromagnetic waves.

→ microwave are therefore very small or very short electromagnetic waves or electromagnetic waves of very short wave length.

→ microwave region varies from 300 MHz to 300 GHz.

→ microwaves are radio waves with wave length ranging from as long as 1 m to as short as 1 mm or equivalently with frequency's between 300 MHz - 300 GHz.

* Propagation characteristic and application various ITU band :

ITU band	Frequency Range	Radio band designation	Wavelength	Propagation uses characteristics	Typical uses.
1	3-30KHz	VLF	100-10Km		
2	30-300KHz	LF	10-1Km		
3	300-3000KHz	MF	1000-100M		
4	3-30MHz	HF	100-10M		
5	30-300MHz	VLF	10-1M		
6	300-3000MHz	UHF	100-10M		
7	3-30GHz	SHF	10-1cm		
8	30-300GHz	EHF	10-1mm.		

* **Advantages of microwave :-**

→ The following are the advantage :-

(i) Low frequency.

(ii) Greater bandwidth capability.

(iii) It improves directive properties - e.g direct broadcast system (DBS).

(iv) Relatively low cost.

(v) There is less fading effect. So microwave communication is more reliable.

(vi) Low power requirement.

(vii) minimum sky noise.

(viii) Line of sight communication.

(ix) It helps us in space communication ground station to space vehicle due its transferring frequency property.

* **Disadvantages :-**

→ Line of sight technology means the signal will not pass through objects like mountains, buildings objects.

→ Subject to electromagnetic and other interference.

→ Needs a no. of repeater stations.

* ~~Disadvantages~~

* Application :-

→ Telecommunication :- International telephone and TV space communication, telemetry communication link for railways.

→ Optical communication.

→ DBS (direct broadcast system).

→ Radar and navigation.

→ Detect air craft ~~[illegible]~~ and ~~craft~~ observe weather pattern, air traffic controler GPS is use to find exact position spot of the glob.

→ Remote sensing :- It is also used in commercial are Industrial application due to heat property of microwave like in microwave oven, drying machine food processing industry, chemical industry. It is also used to identify objects on personal by non contact method.

→ Medical application :- MRI, cancer therapy.

* Microwave wave guide:-

→ A wave guide is a hollow metalic conducting tube used for transmission of energy in TE and TM modes.

→ waveguide may have rectangular and circular shape is commonly used for transmission of microwave energy.

→ The wave guide act as high pass filter in that most of the energy above a certain frequency will pass through the wave guide where as below the cut off frequency will be alternated by the wave guide.

→ wave guides are made from copper, aluminium and brass.

→ The field which are travel by the waveguide must satisfy the boundary condition imposed by the wave of guide.

→ wave guides are simpler to manufacture then co-ax. line since there is no inner conductor is present in it.

→ The power handling capacity of wave guide is ...re because the non-presence of conducting and dielectric material.

→ In wave guide the propagation of the field by the reflection from the waves. power loss in wave guide is less compare to transmission line.

* **Advantages of waveguide on co-ax transmission line:-**

→ Large surface areas:- Reduces copper loss (I^2R low).

→ Low losses.

→ power handling capability.

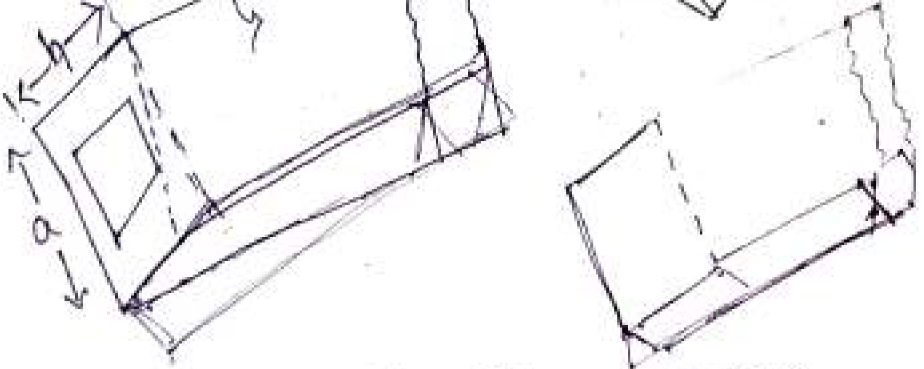
→ **Disadvantages:-**

→ Size.

→ Difficult to install.

→ costly.

* **Rectangular wave guide:-**



→ It is a hollow metallic tube with rectangular crosssection with width 'a' and high 'b' with

* Condition a > b.

→ The wave propagate in z direction.

→ The widest dimension of a wave guide is called the 'a' dimension and determine the range of operating frequencies.

→ The narrowest dimension determines the power handling capability of the wave guide and is called 'b' diamension.

→ The walls are comparised of perfect electric conductor i.e conductivity of the wall is infinity. and that the hollow region is perfect dielectric i.e. means its conductivity is zero.

→ Assume the both conductor and dielectric are loss free is ideal guide.

→ Due to the boundary condition wave guide walls transfers electromagnetic field configuration structure does support transverse electric (TE) and Transverse magnetic modes (TM).

* Advantages of rectangular wave guide :-

→ It is simple to manufacture the co-ax line.

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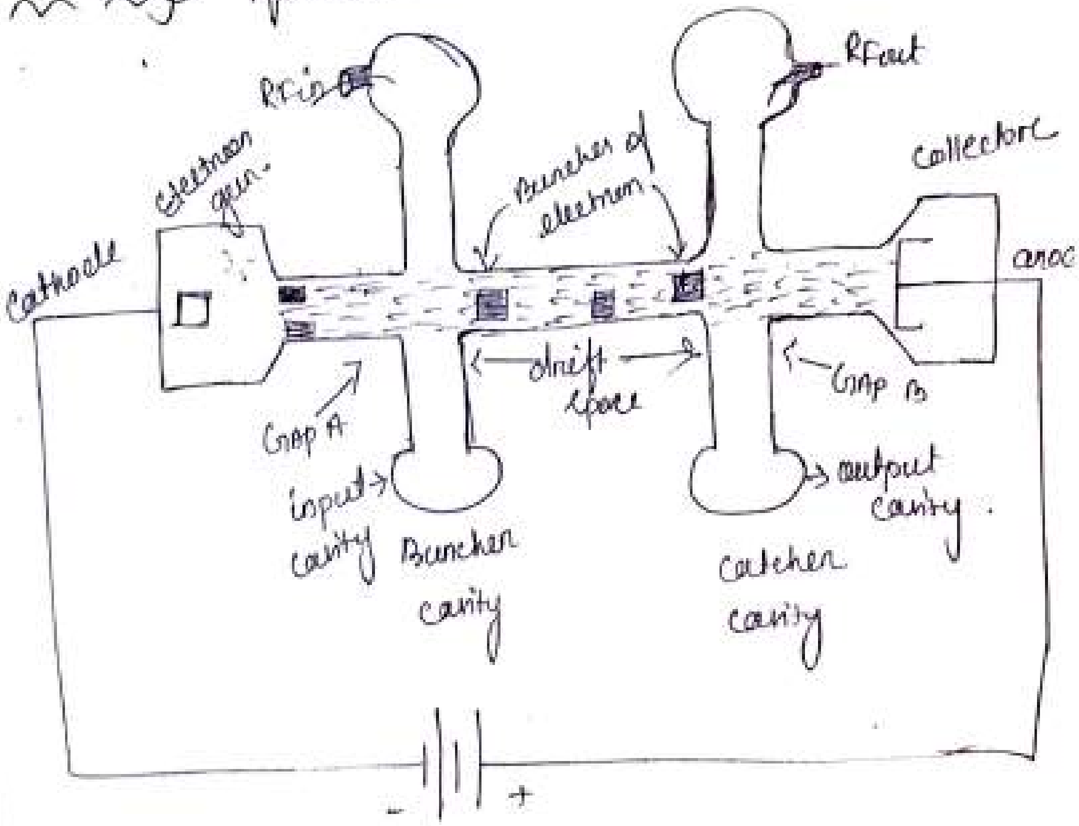
→ Greater power handling capacity.
→ Lower losses per unit length.
→ It's simple form it less expensive for manufacture.

* Application:-

→ Use to transmission line at microwave frequencies.
→ It is widely to coupled transmitter and receiver to the antenna.

Two cavity Klystron :- (5)



→ A klystron is a specialized linear beam vaccume tube which is used as an amplifier for a high Rf.

→ Klystron are velocity modulated tubes that used in radar and communication equipment as oscillator and amplifiers.

→ A high velocity electron beam is formed and sent down along a glass tube through an i/p cavity a field drift space and an o/p cavity to a collector anode.

→ Here, the anode is kept at +ve potential with respect to the cathode.

→ The electron beam passes through a gap consisting of 2 grids of the buncher cavity separated by a very small distance and 2 other grids of the catcher cavity with small gap is.

* Buncher cavity :-

→ The weak microwave signal to be amplified is applied to the buncher cavity through a co-ax cable or a wave guide.

→ The amplified signal is extracted from the catcher cavity.

→ when electron pass through buncher cavity they are velocity modulated of voltage but this is not sufficient for amplification.

* Drift Space :-

Beyond the buncher cavity there is space called the drift space. faster electron exchange their energy to lower electron. finally faster, slower and reference electron move together this phenomenon is known as bunching or drift modulation.

* Catcher cavity :-

(i) The electron then pass through a catcher cavity.

(ii) The function of the catcher cavity absorb the energy from the electron beam.

(iii) The kinetic energy converted to electrical potential energy. So increasing amplitude of the oscillating the electric field in the cavity.

(iv) Then the oscillating field in catcher cavity is an amplified copy of the signal applied to the bunching cavity. and finally the amplified signal is extracted from the catcher cavity through a co-ax cable or wave guide.

* Imp note :-

(i) most amplification at drift space.

(ii) The maxm efficiency of two cavity klystron is 50%

(iii) To improve the efficiency and power gain of two cavity klystron extra cavity are used.

(iv) Correct sequence cathode, bunching cavity, catching cavity, anode collector.

$$\frac{1}{2} m v^2 = e V_0$$

$$v^2 = \frac{2 e V_0}{m}$$

$$v = \sqrt{\frac{2 e V_0}{m}}$$

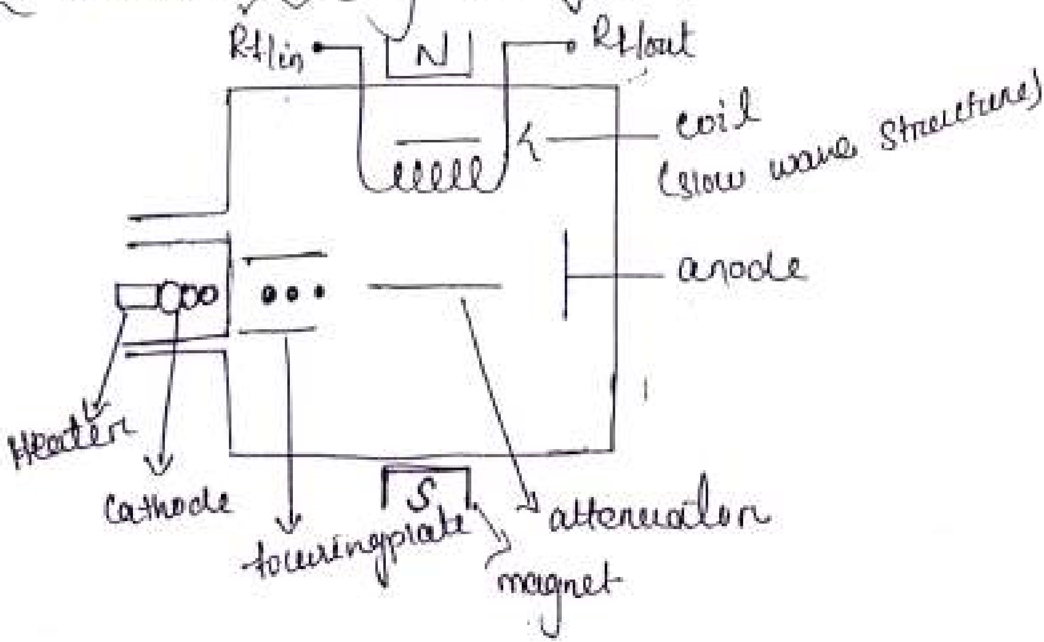
* Application :-

(i) It is used as oscillator or an amplifier in radar communication.

(ii) Sattelight communication.

(iii) Use in UHF TV transmitter.

* TWT (~~Twisted~~ Travelling wave guide tube):-



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→ It is a linear beam used as microwave amplifiers.
→ It is the device in which the interaction betn the beam and radio frequency field is happen.
→ It's main application is used for medium and high power amplifier.
→ It belongs to catagorie of linear beam tubes such as klystron.
→ Two major chatagories of TWT are (i) Helix (ii) coupled cavity TWT.

* Operational parameter:-
→ It's operating frequency range from 300MHz to 50GHz.
→ Power gain 40-70dB. In this mechanism the electrons are generated through the electron gun and travelling towards the anode & a collector and collect the energy.
→ After the electron gun there is a focusing plate which used to focus electron to travel the towards the anode.
→ After the focusing plate there is a slow wave structure coil so the electron pass through this coil & collected at anode.

* Amplification:-
→ To understand the ampn there is an Rf in and Rf out so at Rf in is apply an ac signal that may be +ve signal & may be -ve signal.
→ When we apply +ve half cycle travel the Rf is due to magnetic field electron will acceleanate with velocity so there will be a acceleanating force is present.

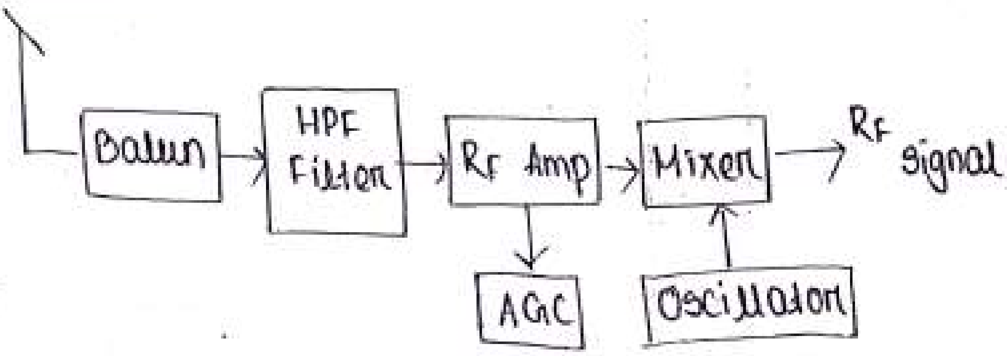
i.e., $F = q(v \times B)$

Point- points are written in ...

→ It consist of Rf tunner, If circuits, video detector, video amplifier, AGC, synchronisation and deflection circuit, audio section, low voltage power supply, high power supply, monochrome, picture tube etc.

RF TUNNER

→ It is known as front end of TV reciever. because the signal from antena is first of all recieve signal from antenna.



↳ The function of Rf tunner are:-

→ It recieves the TV signals and select the required channel.

→ It converts Rf signal into If signal with mixing it with local oscillator.

→ It prevent interfeering signal from entering TV set.

Rf AMPLIFIER

The signal from high pass filter and IF traps entire the RF amplifier whole function is to amplify weak signals and improve the signal to noise ratio.

→ The RF amplifier should have a bandwidth to pass the selected TV channel.

MIXER

→ The mixture changes the Rf signal from differing channels into a common channel by hetrodining the

R_f signal with the frequency of R_f signal.

→ Thus the mixture and the local oscillator can be consider -ed as the frequency changer.

→ The R_f signal has two carrier.

(i) Picture carrier

(ii) Sound carrier

→ The output of mixture consist of two I_f's.

Picture I_f = 38.9MHz

Sound I_f = 33.4MHz

LOCAL OSCILLATOR

→ It provide the local frequency so that it can be hetrodine with the signal obtain from R_f amplifier in the mixture section.

→ whenever a different channel is selected during, the frequency of local provided that the I_f frequencies are same.

I_f CIRCUIT :

→ I_f stands for Intermediate frequency.

→ The I_f in India and in many other countries is 38.9 MHz for video signal and 33.4 MHz for audio signal.

VIDEO Detector

→ The two basic function of video detector are;

(i) To detect the amplitude modulated carrier (I_F) to produce video signal

(ii) To separate carrier sound R_F and field into sound section.

→ It basically a diode.

→ Thus it demodulate the video I_f by the rectification process, the I_f component in the rectified o/p signal is eliminated in vdw signal.

Video Amplifier

→ The video amplifier is needed because the o/p of video detector is only a few volts and it is necessary to strengthen the video signal before feeding it to picture tube.

→ video amplifier increases the strength of video signal to 50 volt

AGC (Automatic Gain ~~Amplifier~~ Control):

→ The output of video amplifier tends to change because the strength of the reciever antenna change from time to time.

→ The AGC has following function in TV signal:-

→ To provide more amplification gain for weak signal

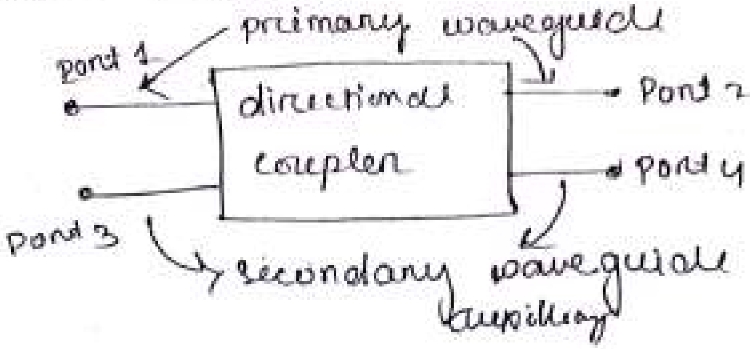
→ To decrease the gain for strong signal so that destoration has reduce and the recection remain nearlly constant.

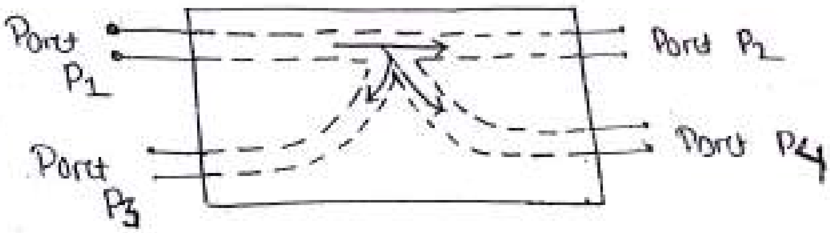
→ To keep the contrast same when we switch from one channel to another.

→ To maintain constant sound level.

Microwave Dt/30/10/2018

Directional coupler:-





→ Basically the directional coupler is a four port waveguide junction.

→ which consist of two waveguides are ; (i) Primary waveguide of Port 1 and Port P_2 and (ii) Secondary waveguide Port 3 and Port 4.

→ Directional coupler is a device used for measurement of unidirectional power, SWR (standing wave ratio).

→ Most coupler sample the energy travelling in one direction only

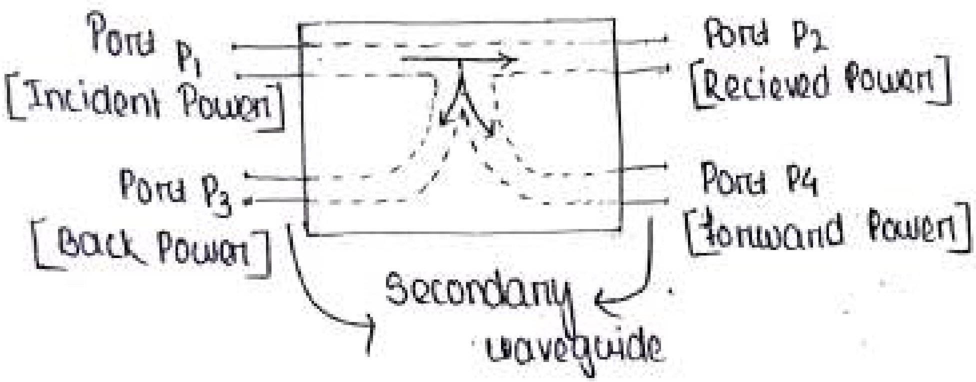
→ But directional coupler can be constructed at sample the energy in both direction so that it is called bidirectional coupler.

→ It is widely used in raddar communication system.

→ The directional coupler consist of two transmission line and consist of mechanism of coupling between them.

→ Its property may be summerized with the aid of the schemetic diagram with match terminator with output ports.

(a) A portion of the wave travelling from Port 1 to Port 2, this coupled to port 4 but not to Port 3.
b) A portion of the wave travelling from Port 2 to Port 1, this coupled to Port 3 but not to Port 4.
c) A portion of the incident on Port 3 is coupled to Port 2 and a portion the wave incident on Port 4 is coupled to port 1 but not to Port 2.



→ The performance of a directional coupler is usually described in terms of coupling and directivity.

VARIOUS I/p and O/p Power :-

- P_i → Incident power at Port 1
- P_r → Recieved power at Port 2
- P_B → Back power at Port 3
- P_f → forward power at Port 4

→ Ideally P_B is '0'

→ The powers are expressed in 'dB'.

COUPLING FACTOR (C)

The coupling factor is a ratio of at incident power and forwarded power.

$$C = 10 \log \frac{P_i}{P_f} \text{ dB} \qquad C = 10 \log \frac{P_1}{P_4} \text{ dB}$$

→ coupling is a measured of how much of the incident power is being sampled.

DIRECTIVITY

→ Directivity is a ratio of forwarded power to back power.

→ for an ideal directional couple $P_b = 0$, therefore directivity is infinity.

$$D = 10\log\frac{P_f}{P_b}\ \text{dB}$$

$$D = 10\log\frac{P_4}{P_3}\ \text{dB}$$

ISOLATION

It is the ratio between Incident power to back power

$$I = 10\log\frac{P_i}{P_b}\ \text{dB}$$

$$I = 10\log\frac{P_1}{P_3}\ \text{dB}$$

$$\text{Isolation (dB)} = \text{coupling (dB)} + \text{directivity (dB)}$$

Application :-

→ These are used to accurately sample the directional power flow in ~~directional~~ transmission line

4. Circulator :-

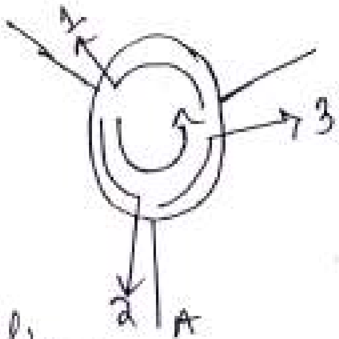
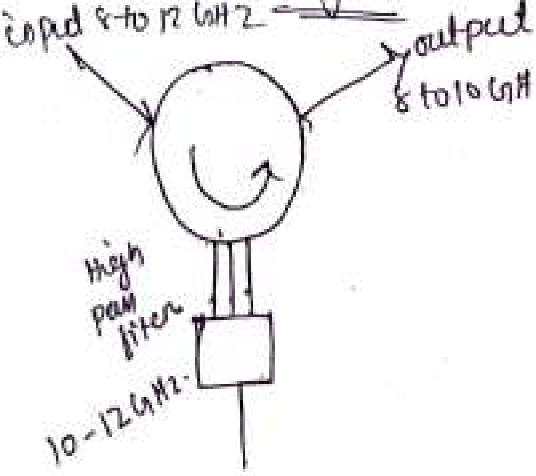


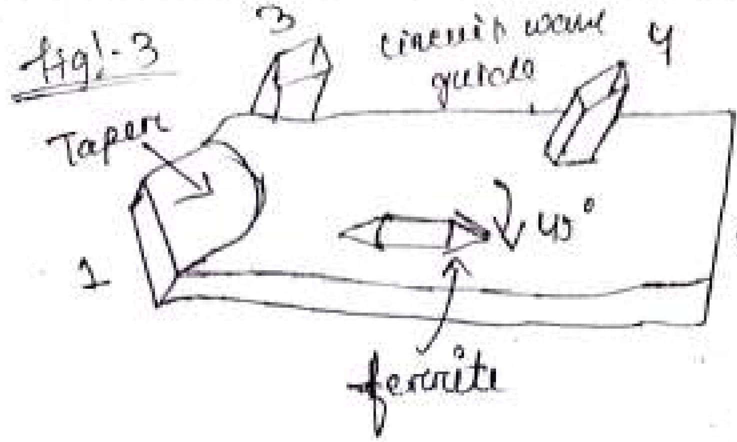
fig-1

fig 1-2



filter could be a piece of waveguide which passes above 10GHz

Fig:-3



Note:- magnet omitted for simplicity.

→ A microwave circulator is a nonreciprocal ferrite device which contains three or more ports.

→ The input from port n will come out at port n+1 but not out at any other direction.

→ A 3 port ferrite junction circulator usually called Y-junction ~~circulator~~ circulator is most commonly used.

→ The signal flow in 3 port circulator is assume as 1-2, 2-3, 3-1.

→ If port 1 is the input then the signal will come out at port-2. In an ideal sit^n no signal should come out at port-3. which is called isolated port.

→ The insertion loss of circulator is loss from 1-2. while the loss from 1-3 is referred as isolation.

→ When the i/p is port-2 the signal is come out at the port 3 and the port 1 is called as isolator.

→ Since circulator contain magnets they should not be mountain near ferrous metal.

→ As shown in the fig-2 the circulator is made in to a diplexer by adding a high pass filter at port-2.

→ Another usefull device is the 4-port faraday rotator circulator.

→ This waveguide handle very high power and provide excellent isolation.

→ ~~This waveguide devices handle~~

→ It consist of circular waveguide and dominant mode of TE11 with transition to standard rectangular guide which can carry TE10 both the end.

→ The end transition port 1 and port 2. Rectangular side port 3 and port 4 placed with their walls along the length of the waveguide twisted to 45°.

→ A ferrite rod is placed inside the circular waveguide and the waveguide is

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surrounded by permanent magnet which produce magnetic field is ferrite rod.

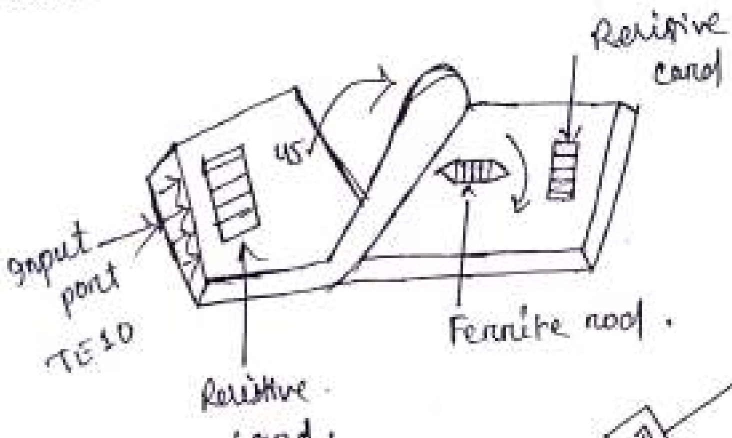
→ The wave travelling from port-1 to port-2 passes & port-3 unaffected, as gate rotated 45° by ferrite rod and continuous pass the port-4 also.

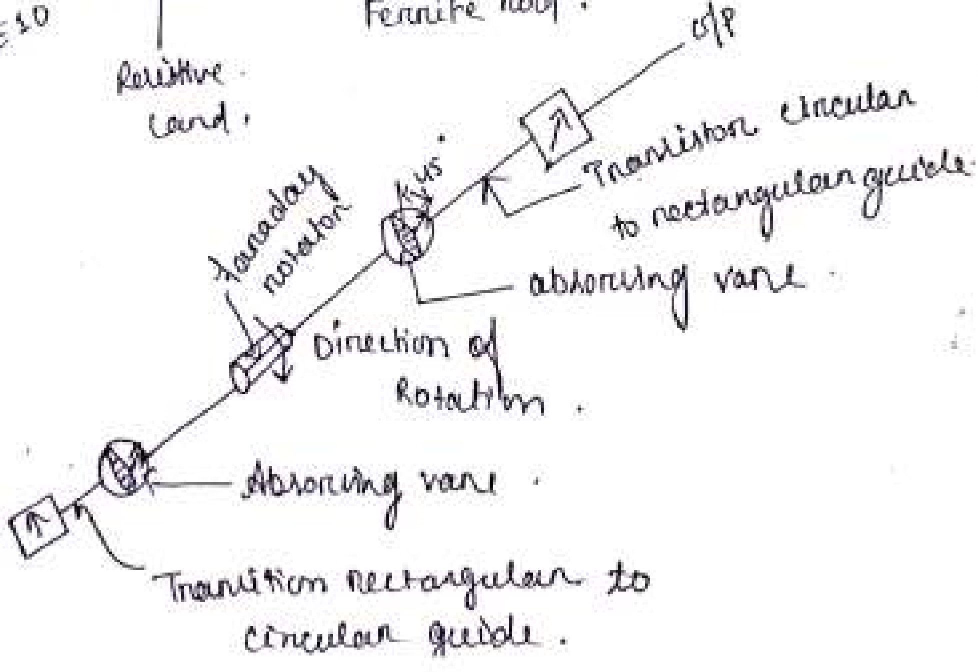
→ <u>Application</u>:-

→ ~~A~~ circulator can be used as ~~radar~~ diplexer for a radar antenna system.

→ 2 and 3 port circulators can be used in a tunnel diode.

③ <u>Isolator</u>:-





→ It is a two port non reciprocal device having unidirectional transmission characteristics.

→ The internal structure of the isolator is showing ~~with~~ above fig. with its i/p and o/p port

→ In an isolator when i/p is given to the i/p port then the output will receive at the o/p port.

→ If we apply the i/p at o/p port side then the o/p will not overcome from i/p port that will zero.

→ Basically in the begining of the isolator there is a resistive card that absorve the horizontal polarized signal.

→ If we provide the input then it absorve ~~only~~ the horizonal polarized signal only. and the vertical polarized signal will be zero. because it does not absorve.

→ After the resistive card there is a twist 45° as shown in the figure and there twist is anticlockwise with direction is twist with anticlockwise which twisted with a resistive card.

⇒ The 2nd rotation of isolator there is a ferrite ~~card~~ rod at 45° in clockwise direction. and also a 2nd resistive card is attached with there resistive rod.

⇒ Now the 2nd resistive ~~load~~ card allow the horizontal polarized signal. So that the o/p will receive through the o/p port.

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→ Ferrite rod is used to minimize the reflection.

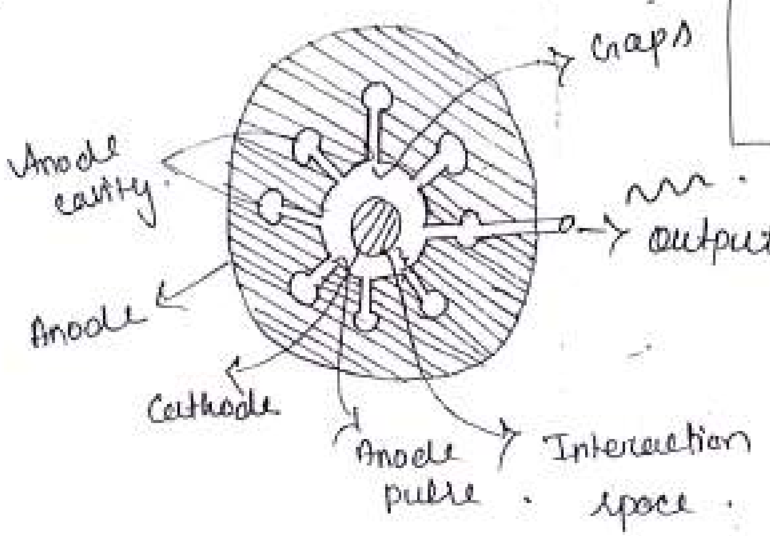
* Application :-

→ It can be used to improve the frequency stability of microwave generator such as Klystron and magnetron.

* Magnetron :-

angle bet^n per cavity $= \frac{360^\circ}{n}$

n = no. of cavity.



→ The magnetron is a high power vacuum tube that works as self excited microwave oscillator generates high energy microwave.

→ This is a multicavity device.

→ It's frequency range is from 0.6 GHz - 30 GHz.

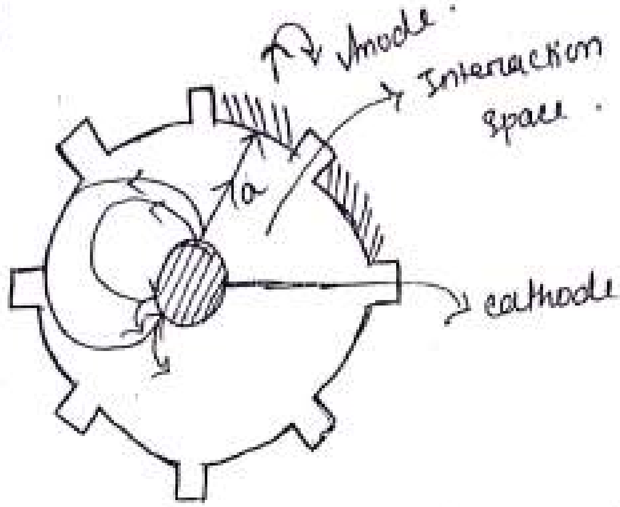
→ It is available with 8-20 cavity.

→ It works with fixed frequency constructively.

→ The anode of magnetron is fabricated in to a cylindrical solid copper block.

→ The cathode and phylament are the centre of the tube.

→ The cavity is controlled the output frequency.



→ Each cavity works like parallel resonant circuit.

→ A cavity magnetron consist of a cathode which is used to release the electrons and no. of anode cavity and a permanent magnet is parallel with the axis of with the cathode, and space betn the anode cavity and the cathode is called interacting space.

→ In this space the electric and magnetic field interact to exherts the force upon the electron.

→ The electron which are emitted from the cathode moves in the diverse path in the interacting space depend upon the strength of electric and magnetic field apply to the magnetron.

TWT :- (operation) (Dt / 26/10/2018)

→ when we apply -ve half cycle through the Rf is due to the source their will resistives forces.

→ Due to accelarate force velocity of electron will decreases and the gap betn the electron also decrease. So their will be a amplified output through a Rf output.

* **Application :-**

(i) ~~ic~~ Low noise Rf amplifier in broadband microwave receiver.

(ii) Radar.

~~[illegible]~~

Sonet is a standardized digital communicatn protocol that synchronously transfers multiple data streams over long distances through fiber optic cables.

It allows simultaneous transmission of voice, data & video at speeds as high as 1 Gbps through a single fiber.

In telephone network it is used for transmission of a large amount of telephone calls & data streams through fiber.

Dt/12/11/2018

SONET (Synchronous optical network):-

→ widely used in telephone network. Synchronous optical network is a standardised digital communication protocol that used to transmit large volume of data with the help of optical medium.

physical configuration and network element:-

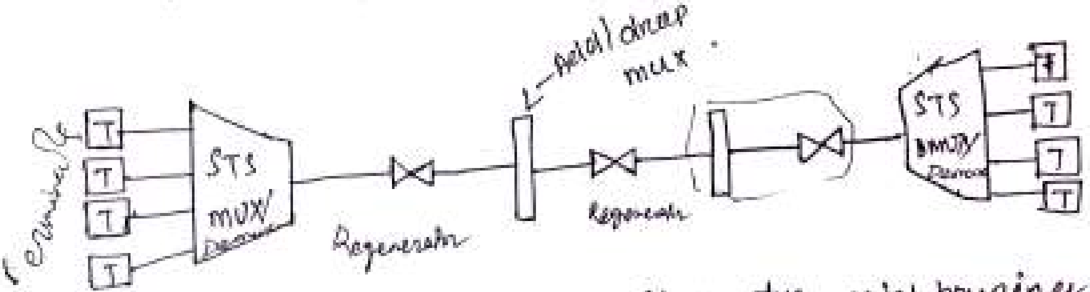
→ The basic devices used in the SONET:-

(1) Synchronous transport signal (STS) multiplexer and demultiplexer.

(2) Regenerator

(3) Add/drop multiplexer.

It can add signal coming from different sources into a given path or remove a signal.

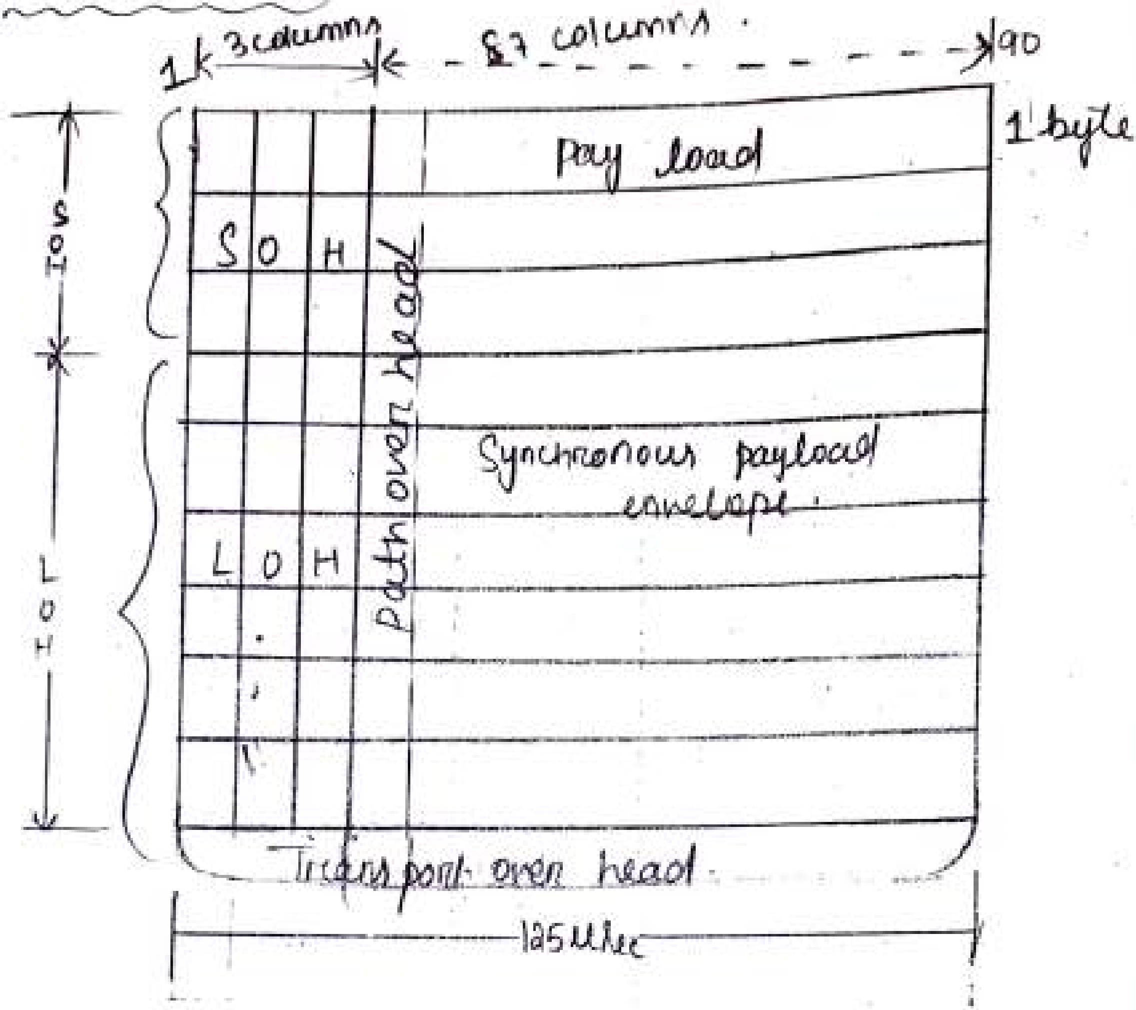


A section is optical link connecting two neighbouring devices.

→ A link is portion of network between two multiplexer.

→ A path is end to end portion of network.

* Frame in SONET :



→ A convention has to be applied distinct digital channel that have been multiplexed together can be distinguishes.

→ SONET uses the concept of framing (pointer on address).

→ SONET Each frame is made up of 9 rows and 90 columns bytes.

→ Thus the frame size is 9×90 = 810 bytes or 810 ______ .

810×8 bits = 6480 bits.

→ A frame is 125 μsec in duration corresponding to the 8KHz voice sample.

→ This gives the STS-1 data have 51.84 mbps.

(i.e 8000 frames/sec = 8000×6480 bit/sec) = 51.84 mbps.

→ The upper three rows of the first three columns are used for section over head (SOH).

→ The lower six rows of first three columns are used for line over head (LOH).

→ The first three column of the frame are used as a transport over head.

→ column 4-90 are used for SPE of 87 column of SPE of 87.

→ The STS-1 frame is transmitted left to right and top to bottom.

* Line over head support (LOH):-

→ Locating the SPE in the frame.

→ multiplexing signal.

→ performance monitoring.

* Section layer over head supports:-

  ⇒ Framing

  ⇒ performance

  ⇒ monitoring.

* Advantages:-

⇒ Reduction in equipment requirements ~~[illegible]~~ and increase in network reliability.

⇒ Availability of set of frames standards that enables produce from different vendors to be connected.

⇒ Definition of a flexible architecture capable of accomodating future application with variety of Tn line.

⇒ High band width and increased flexibility.

* Disadvantages:-

⇒ cost more than other communication system.

⇒ more expensive.

* Application:-

⇒ widely used in telephone network.

ISDN (Integrated service digital network):-

- ISDN stands for integrated services digital network or isolated subscriber digital network (ISDN).
- It is a ckt switched, end-to-end digital transmission standard.
- It supports digital transmission of voice and data over ordinary telephone copper wires, which result in better voice quality than an analog phone.
- It offers ckt switched connections (for either voice or data) at 64Kbps or increments of 64kbps (N × 64Kbps)
- It also provides internet services at a maximum of 128 Kbps.
- It can also support video conference.
- ISDN is reality is a set of protocols for establishing and releasing ckt switched connections with advanced call features for the user.
- It supports simultaneously connection in any combination of data, voice, video, and fax over a single copper line.

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→ multiple devices can be attached to the line.

⇒ There services falls under three categories

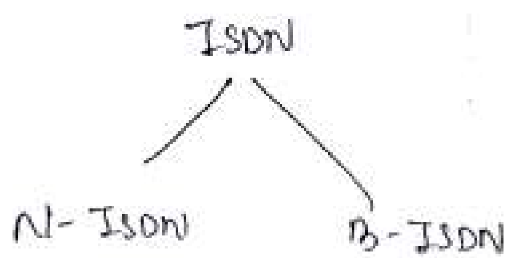
(I) Bearer services and

(II) Supplementary services and

(III) Tele services.

⇒ with ISDN all customers will become digital than analog.

⇒ Two types of ISDN :-



(narrow band ISDN)   (Broad band ISDN).

⇒ N-ISDN :- Carries data upto 64 Kbps. ranging upto T_1 rates.
Sometimes refers to regular telephone and non video capable system.

⇒ B-ISDN :-

The communication standard developed by the ITU. to handle the high bandwidth applications such as video, B-ISDN uses ATM technology, data rate of 155 mbps to 622 mbps.

* ISDN Services :-

ISDN services generally fall in to three categories. They are bearer services, Tele services and supplementary services.

ISDN services

- Bearer service
- Tele service
- supplementary service.

* Bearer services :-

It offers the capability to transport digital voice and non voice services using ISDN standards.

→ It provides means to transfer information (voice, data and voice) between users through packet switching, circuit switching).

1. Reflection :- It is the abrupt change in the direction of propagatn of a wave that strikes the boundary betn two different media. At least some part of the incoming wave remains in the same medium.

Law of Reflection $\angle\theta_i = \angle\theta_r$

Refraction :- It is the change in the direction of propagatn of a wave ~~is~~ when the wave passes from one medium into another & changes its speed.

Diffraction :- The process by which a beam of light or waves is spread out as a result of passing through a narrow aperature or across an edge.

Absorption :- The process by which one thing absorbs or is absorbed by another.

Attenuation :- It is the gradual loss of flux intensity through a medium.

Interference :- wave interference is the phenomenon that occurs when two waves meet while traveling along the same medium.