Assignment No. 1

1. Define and Expliam maximum usable frequency

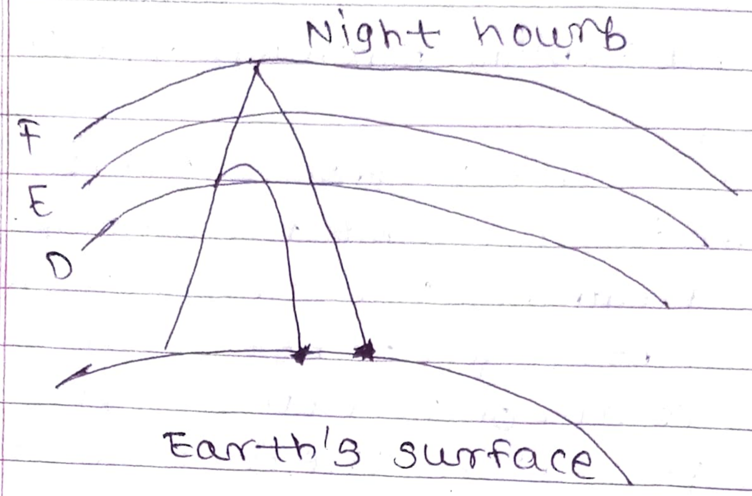
→ Maximum usable frequency (MUF):

The maximum usable frequency is the highest frequency that can be used for sky-wave propagation between two specific points on Earth's surface. It stands to reason, then that there are as many values possible for MUF as there are points on earth and frequencies, in an infinite number. MUF as with the critical frequency is a limiting frequency for sky-wave propagation. However this maximum usable frequency is for a specific angle of incident (angle between the incident wave and the normal) mathematically, MUF is given as:-

$$MUF = \frac{\text{critical frequency } (fc)}{\cos\theta}$$

$$= fc \cdot \sec\theta$$

where θ is the angle of incidence the second eqn is called the second law the second law assumes a flat earth and flat refelecting layer which of course can used only for making preliminary calculations.



(b) Daytime versus Night time propagat

2. What is multipath delay spread?

→ A multipath delay spread, Td is a the difference in propagation time between the longest and shortest path counting only the paths with significant energy

$$T_d = \max_{i,j} |T_i(t) - T_j(t)|$$

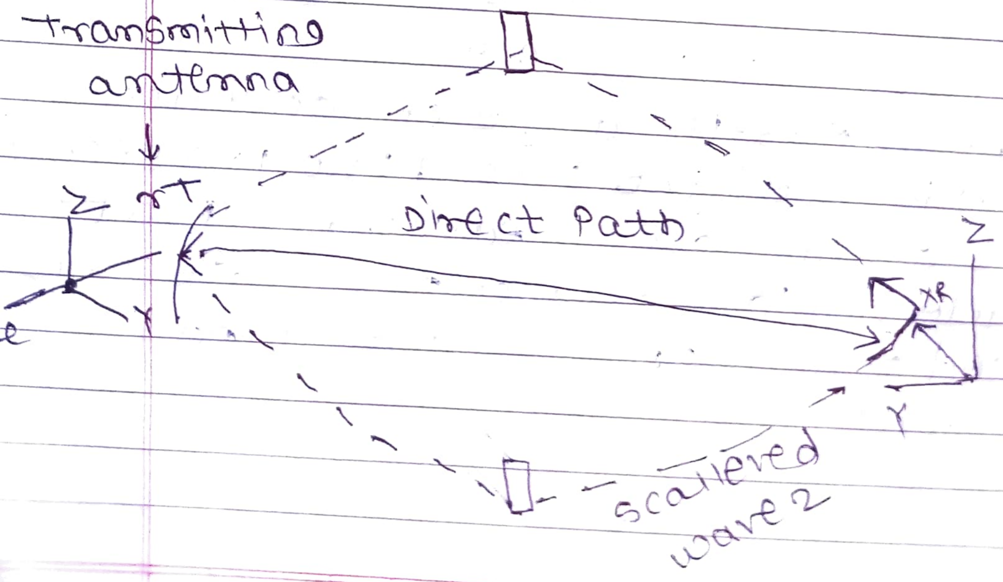


Fig. multipath signal Propagation

1. Sketch the structure of atmosphere and expliain each layer significance of all.

→ Structure of atmosphere:

Essentially three layers comprise the ionosphere (the D, E & F layers) which are shown in fig. It can be seen that all three layers of the ionosphere vary in location and the and in ionization density with the time of day. They also flucture in a cyclic pattern throughout the year and according to the 11 year sunspot cycle. The ionosphere is most dense during times of maximum sunlight.

D layer:

The D layer is the lowest layer of the ionosphere and is located between 50km to 100km abore Earth's surface because it is the layer farthes from the sun, there is very little ionizatio in this layer. Therefore the D layer has little effect on the direction of propagation of radio wave. However the ions in the D layer can absorb amounts of ionization in D layer depends on attitude of the sun abore the horizon Therefore it dissapers at night. The D layer reflect VLF and LF wave and obsorbs MF & HF wave

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E layer:

The E layer is located between 100km to 140Km above Earth's surface. The E most of the waves pass through to the F2 layer where they are refracted back to Earth.

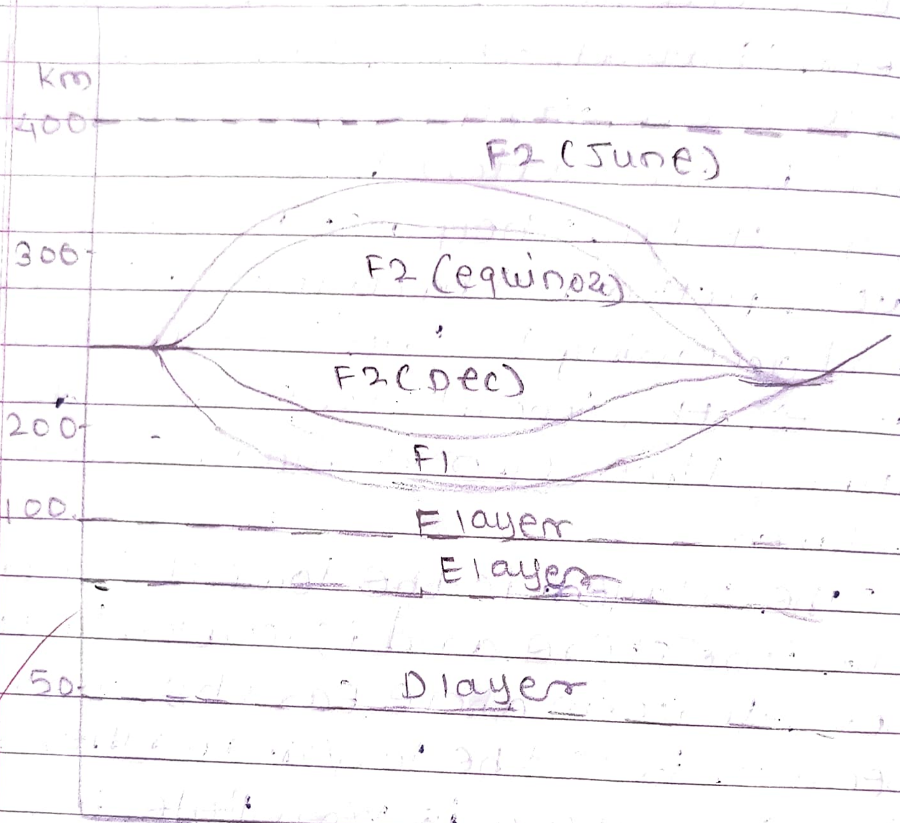

Fig. Ionospheric layers

layer is sometimes called the Kenelly Heaviside layer after the two Scientist who discovered it. The E layer has its maximum density at approximately 110km at noon, when the Sun is at its highest point As with the D layer, the E layer aids MF Surface-wave propagation and reflects HF waves some what during the daytime. The upper portion of the E layer is sometimes considered separately & is called the sporadic E layer because it seems it come and go rather unpredicatable. The sporadic E layer is caused by solar flares and sunspot activity.

F layer -

The F layer is actually made-up of two layers the F1 & F2 layers. During the daytime, the F1 layer is located between 140 Km to 250 Km above Earth's surface and the F2 layer is located 140 Km to 300 Km above Earth's surface during the winter and 250 Km to 350 Km in the summer. During the night the F1 layer combines with the F2 layer to form a single layer. The F1 layer obsobs & attenuates some HF waves.

2. Define the terms virtual height, maximum usable frequency and their relevance in wave propagation.

→ virtual height -

virtual height is the height above Earths surface from which a refracted wave appears to have been reflected. Fig. Shows a wave that has been radiated from Earths surface toward the ionosphere.

The radiated wave is refracted back to Earth and follows path B. The actual maximum height that the wave reached is height However, path A shows the projected path that a reflected wave could have taken and still been returned to Earth at the same location. The maximum height that this hypothel reflected wave would have reached is the virtual height (hv)

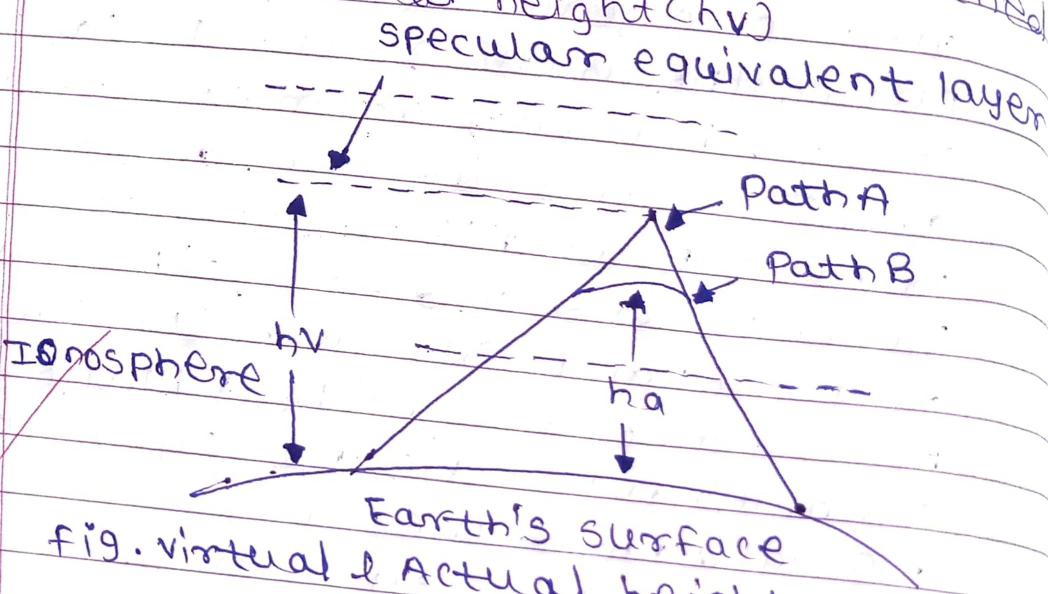

fig. virtual & Actual height

maximum usable frequency (MUF) -
The maximum usable frequency is the heights frequency that can be used for sky-wave propogation bet. two specific points on earth's surface. It stands to reason. then that other are as many values possible for MUF as there are points on earth and frequencies.

$$MUF = \frac{\text{critical Frequency (FC)}}{\cos\theta} \quad (1)$$

$$= FC \cdot \sec\theta$$

where, θ is the angle of incidence above equation is called the secant law. The secant law assumes a flat earth flat reflecting layer, which of course can be never exist. There-fore MUF is used only for making preliminary calculations.

Q.3. Draw and expliam multi-hop propa-gation.

→ i) Skip distances and the curvature of the earth limits the transmission path. when transmitted ray is tangen to earth surface then we get longe single hop transmission practically in a single hop. the sky wave covers a maximum of 2000km for the E-layer and 400km for f2 layer.

ii) Since, earth is semi-circumference is over 20,000 km. multi-hop propagat generally occurs also is north-south propagation there will be day-in-one half propagation and high in other half propagation of the globe and the half portion of the globe and the multi-propagation does occur without any hindrances.

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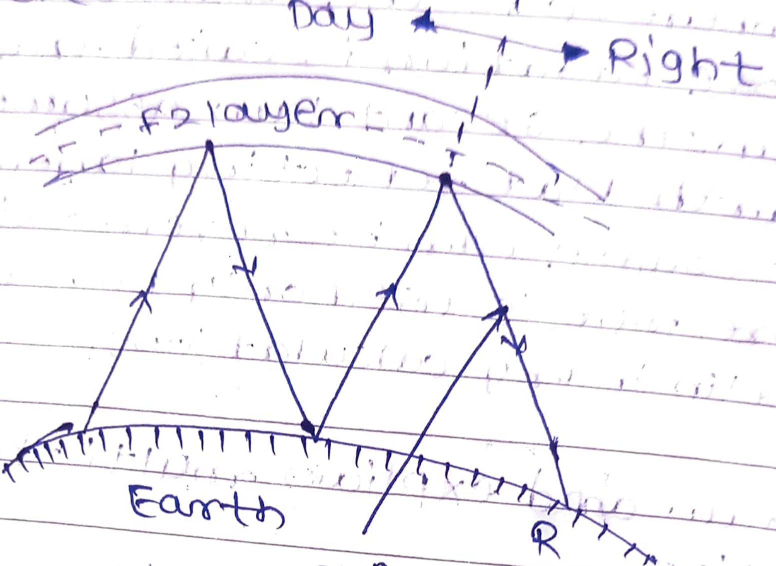
Also, it is found that long distance SW communication generally involve two to four transmission path each contributing appreciable energy to receiere.



skip distance decrease as the height are differ

fig - multi - hop in East - West

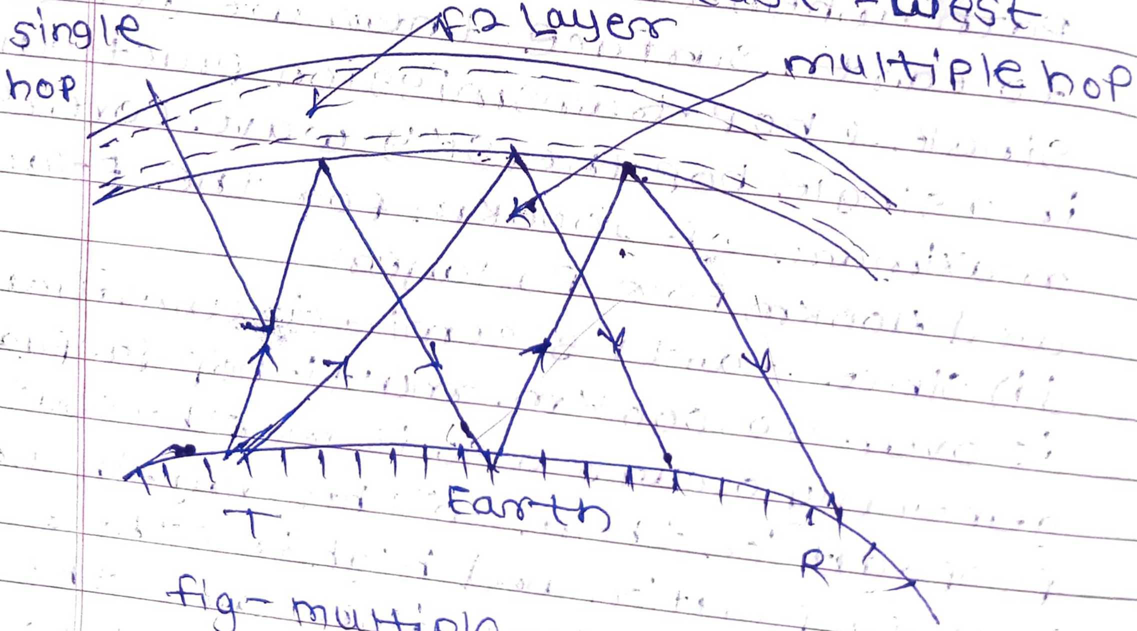


fig - multiple - Hope in south - North

Q.4 Derive the fundamental equation for Free space Propagation (FRITS Eqn) & expliam each parameter of it.

→ i) Radio transmission loss is the ratio of radiated power to the received power Expected loss in free space determine the ratio transmission losses.

ii) For the fundamental equation for free space propagation or transmission first of all assume average power radiated equally in all direction Then assume that the isotropic radiator is kept in a free space is given by.

$$P_r = \frac{W_T}{4\pi d^2} \quad (W/m^2) \quad \text{---} \; (1)$$

where,

$4\pi d^2$ represents surface area of sphere of radius (d) centered at the source.

iii) As all antennas have directional properties i.e. they radiates more power in one direction and less in the other direction the directly gain is defined as the ratio of actual power density along the main axis of the radiation of antenna to that which would be produced by isotropic antenna at source distance field.

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Thus,

$$\therefore G_T = \frac{P_o(\text{test antenna})}{P_{r}(\text{Istropic antenna})}$$

Hence,

$$\boxed{P_D = G_T \cdot P_r = \frac{G_T W_T}{4\pi d^2}} \quad \text{------} \quad (1)$$

But for any antenna maximum directivity gain (G) and effective aperture area (Ae) is related by,

$$G = \frac{4\pi}{\lambda^2} \cdot Ae$$

or

$$\frac{Ae}{G} = \frac{\lambda^2}{4\pi} \quad \text{------} \quad (4)$$

If GR is the maximum directivity gain of receiving antenna then

$$Ae = G_R \frac{\lambda^2}{4\pi} \quad \text{------} \quad (5)$$

$$\boxed{\frac{W_R}{W_T} = \frac{G_T G_R}{4\pi d^2}\left(\frac{\lambda^2}{4\pi}\right)} \quad \text{---- (Watts)}$$

From eqn. 5

Q.5 Explian in brief -
a) Ground wave propagation.
b) Space wave propagation
c) Sky wave propagation.

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a) Ground-Wave Propagation -

i) A ground wave is an electromagnetic wave that travels along the surface of earth. Therefore ground waves are sometimes called surface waves. ground wave must be vertically polarized.

ii) This is because the electric field in a horizontally polarized wave would be parallel to earth's surface, and such waves would be short-circuited by conductivity of the ground.

iii) With ground waves the changing electric field induces voltages in Earth's surface which cause currents to flow that are very similar to those a transmission line. Earth's surface also has resistance and dielectric losses.

iv) Therefore, ground waves are attenuated as they propogate. Ground waves propagates best over surface that is a good conductor, such as salt water and poorly over dry desert areas.

v) Ground wave losses increases rapidaly with frequency. Therefore ground wave propagation is generally limited to frequencies below 2 MHZ.

Here is the diagram of Ground wave propagation.

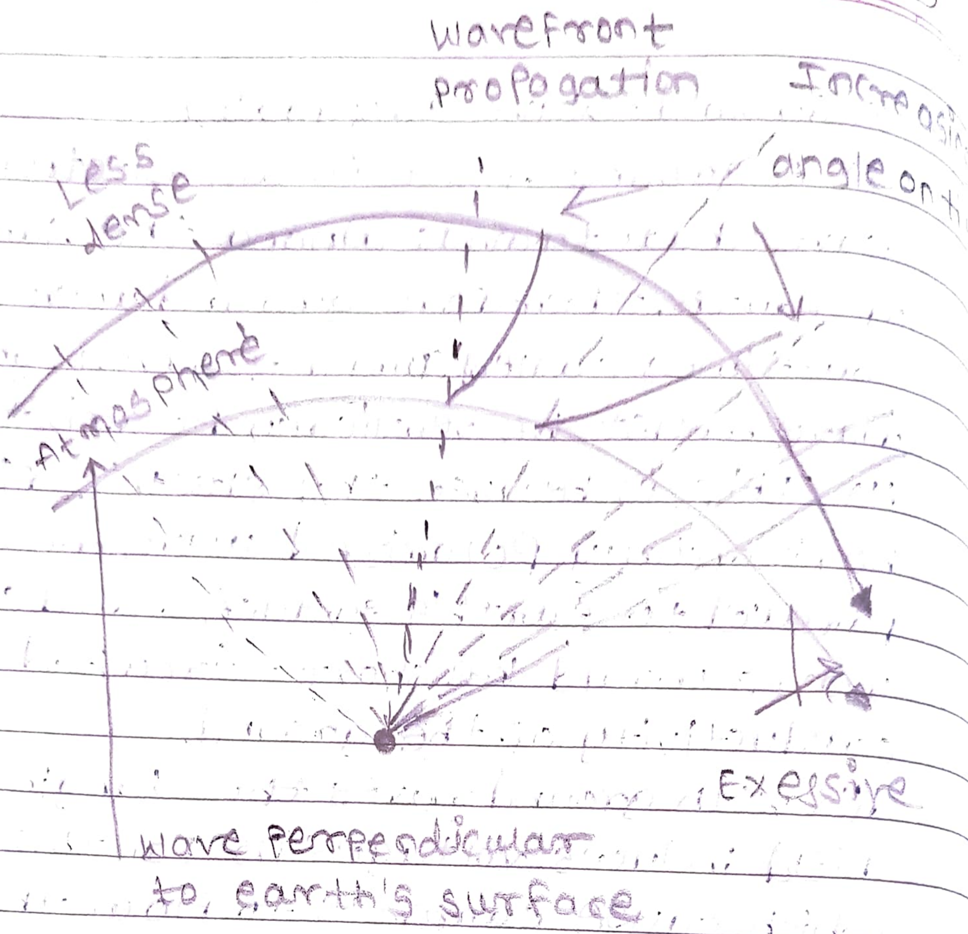

Fig. Ground wave Propagation.

b) Space - wave propogation

i) Space - wave propogation includes radiated energy that travels in the lower few miles of earth's atmosphere space waves include both direct and ground-reflected waves as shown in figure.

ii) Direct waves travel essentially in a straight line between the transmit & receive antennas. Space wave would be parallel to earth's surface, and such waves would be short-circuited by conductivity of the ground.

iii) with ground waves Therefore space wave propagation is limited by the curvature of the earth. ground reflected waves are waves, reflected by Earth's surface as they propogates between the transmit and receive antenna.

iv) it can be that the field intensity at the receive antenna depends on the distance between the antennas and whether the direct and ground-reflected waves are in phase.

v) The curvature of Earth presents is a horizon to space-wave propogation commonly called the ratio horizon. Due to atmospheric refraction, the radio horizon extends beyond the optical horizon for the common standard atmosphere.

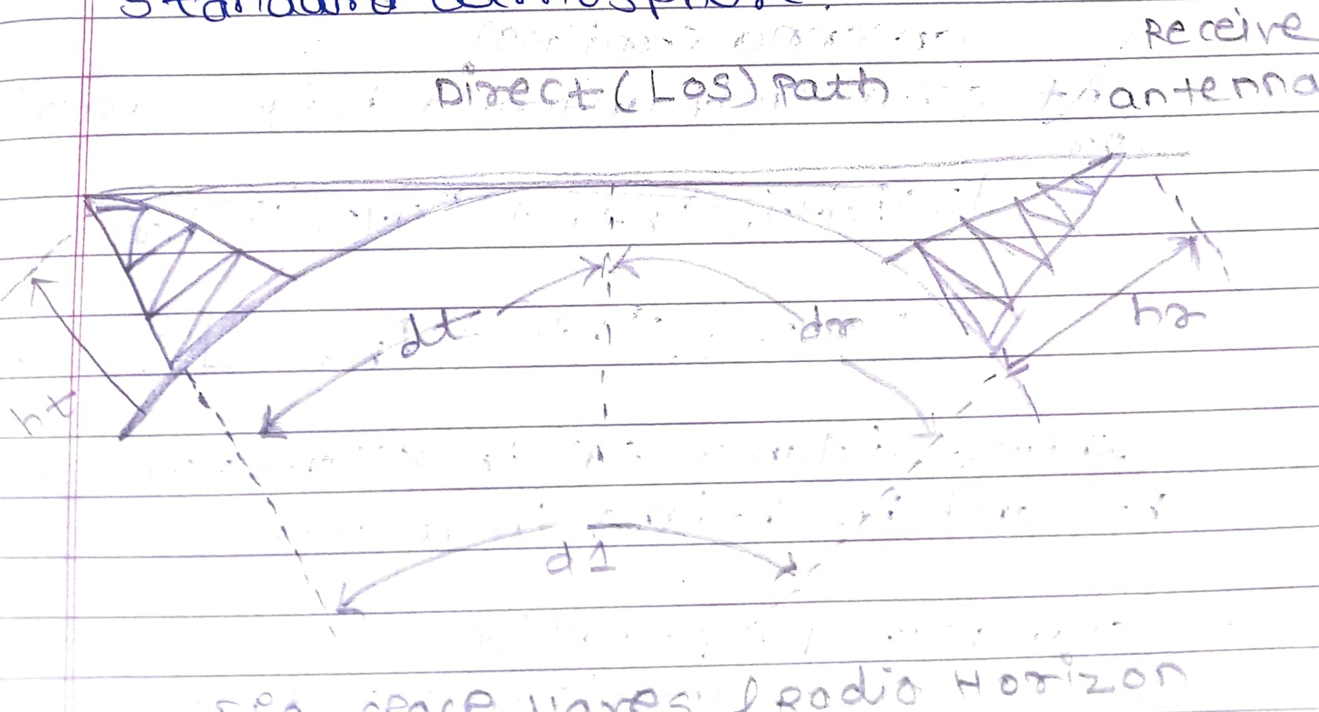

Fig. Space waves & Radio Horizon

The line-of-sight radio horizon for single antenna is given as:-

where, $d = \sqrt{2h}$ ——— (1)

d = distance to radio horizon

h = Antenna height above sea level (feet).

Therefore, for a transmit & receive antenna, the distance between the two antenna is

$d = d_t + d_r$

$d = \sqrt{2h_t} + \sqrt{2h_r}$ ——— (2)

where,

d = total distance (miles)

d_t = radio horizon for transmit antenna (miles)

d_r = Radio horizon for receive antenna (miles)

h_t = Transmit antenna height (feet)

or

$d = \sqrt{4.12}\sqrt{h_t} + \sqrt{4.12}\sqrt{h_r}$

$= 4.12 [\sqrt{h_t} + \sqrt{h_r}]$ ——— (3)

Where, distance (d) in Kilometers and h_t and h_r height in meters.

c) Sky wave Propogation

i) Electromagnetic waves that are directed above the horizon level or

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called sky wave propogation. Typically sky wave are radiated in a direction that produces a relatively large angle with reference to earth sky wave are radiated towards the sky where they are either reflecte or refracted back to earth by the ionosphere.

ii) The ionosphere is the region of space located approximately 50 km & 400km above earth suface. The ionosphere is the upper portion of earths atmosphere therefore its absorbs large quantities of the sun radiant energy, which ionizes the air molecules, creating free electro

iii) When a radio wave passes throug of ionosphere the electric field of th wave exerts a force on the free electrons, causing them to vibrate

Assignment No. 2

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Q.1 Explian radiation mechanism for (a) single wire antenna. b) two wire antenna.

→ Radiation mechanism -

Antenna is a device which converts electro-magnetic wave into RF current or vice-versa. Thus, antenna is called as a transducer.

Antenna is a structure associated with the region of transition between a guided wave and a free space wave, or vice-versa. The basic principle of the antenna that radiation is produced by the accelerated charge. The basic equation of the radiation can be expressed as.

$$\frac{L\,dI}{dt} = \frac{Q\,dv}{dt}$$

A) single Wire Antenna -

conducting wires are characterized by the motion of electric charges and the creation of current flow.

- Assume that an electric volume charge density qv (columbs/m3) is distribute uniformally in a circular wire of cross - sectional area A and volume v..

B) Two wire Antenna -

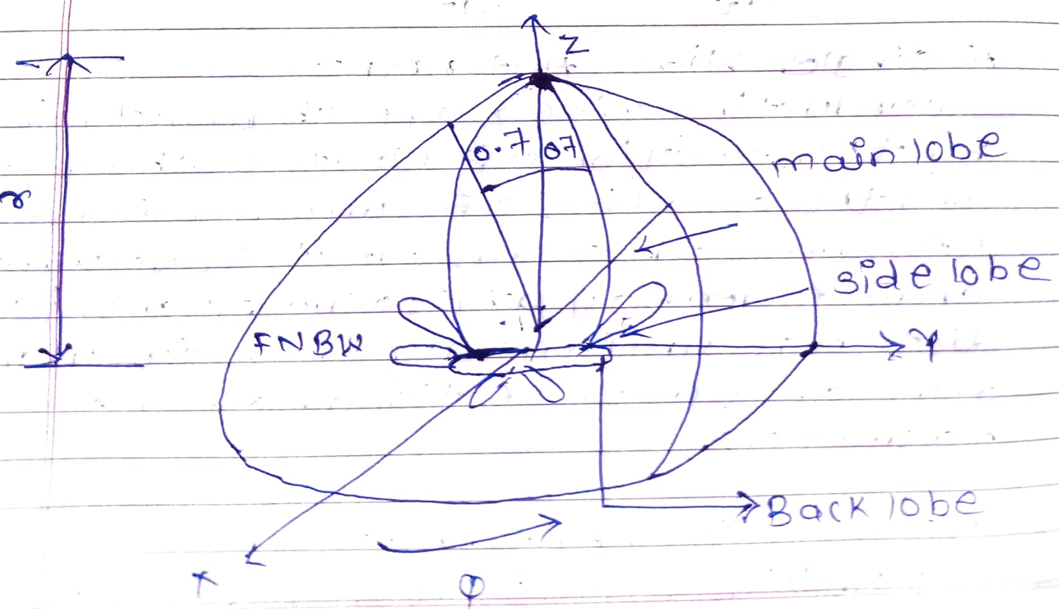
Applying a voltage across the two

conductor transmission line:
- Electric field is generated
- Electric lines of force make free electrons to be displaced
- movment of the charges creates a current.
- magnetic field is generated.

Q.2 Define. a) Radiation pattern b) Radiation power density c) Directivity D) Gain.

→ a) Radiation Pattern

The radiation pattern of the antenna are the three-dimensional quantities involving the variation of field or power as function on the spherical co-ordinate θ and ϕ. A three dimensional field pattern shown in fig.



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b) Radiation Power Density -

The radiation power density of an antenna refers to the power radiated per unit area in particular direction away from the antenna power pattern can be expressed in terms of the power per unit area:

$$P_n = (\theta, \phi) = \frac{P(\theta, \phi)}{P(\theta, \phi)_{max}}$$

c) Directivity -

The directivity of an antenna is defined as the ratio of the maximum radiation intensity or the ratio of the maximum power density to its average power over a sphere which is observed in the far-field of an antenna Thus,

$$\frac{P(\theta, \phi)_{max}}{P(\theta, \phi)_{av}}$$

d) Gain

The power gain of the antenna is the ratio of the radiated power density of a test antenna to the radiated power density of the isotropic antenna. The power gain can be denoted as G_P.

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GP = $\frac{\text{Powerdensity radiated in Particular direction by the test antenna}}{\text{Power density radiated in that direction by an istropic antenna}}$

Q.3 Determine the radiation resistance of an antenna if it has a loss resistance of 20 ohm. power gain 50 and directivity of a) 70 and b) 60

→ Radiation Resistance (R-rad) = (Power Gain * Loss Resistance) / (Directivity)

For directivity of 70:
R-rad = (50 * 20) / 70
= 14.29 ohms

For directivity of 60:
R-rad = (50 * 20) / 60 = 16.67 ohms.

Q.4 Define and Explian a) radiation intensity b) Effective area. c) field of an antenna

a) Radiation intensity - Radiation intensity refers to the Power radiated per unit solid angle in a particular direction from a radiating source, such as an antenna. It measure the Power density of electromagnetic

radiation in a given direction.
mathematically, radiation intensity (I) is defined as the power (P) radiated by an antenna in a particular direction divided by the solid angle (Ω) over which the power is radiated.

$$I = \frac{P}{\Omega}$$

The unit of radiation intensity is watts per steradian (W/sr). A steradian (sr) is a unit of solid angle, representing the area on a sphere's surface subtended by a portion of the sphere's surface equal to the square of its radius.

b) Effective area - Effective area often denoted as (A_ {\text {eff}}) is a key parameter in antenna theory and communication system. it represented the hypothetical area of an antenna that would capture the same amount of power as the actual antenna is given direction.
mathematically effective area is defined as the ratio of the power captured by the antenna in a specific direction to the power flux density of the incident electromagnetic wave.

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$$A_{eff} = \frac{P_{capt}}{S}$$

Effective area is especially used in satellite communications, radar systems, and radio astronomy, where it helps determine and antenna's sensitivity and performance characteristics.

Field of antenna

The field of an antenna typically refers to the electromagnetic field it generates or receives. This field consists of electric and magnetic components that propagate through space, carrying energy and information.

There are two main type of field with antenna.

Near-field - This is the region close to the antenna where the electromagnetic field varies significantly with distance. The near-field is further divided into the reactive near-field and the radiating near-field.

2. Far- field - Also known as the radiation field, this is the region far from the antenna where the electromagnetic field behaves like a propagating wave.

Q.5 Derive the equation for radiation power density.

→ $P = \frac{P_{total}}{4\pi r^2}$

Where,

(P) is the radiation power density

(P - {\text {total}}) is the total power.

(r) is the distance from the source

The equation comes from the fact that the power radiated from a source spreads out over the surface of sphere with radius (r), and the surface area sphere is (4\pi r^2).

Assignment No. 3

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Q.1 What are dipole arrays? Expliain (a) Broadside array and b) Endfire array.

→ Dipole arrays are configurations of many types.
Dipole arrays are arrangements of diople antennas used to transmit or receive electromagnetic waves efficiently in a particular direction.

A broadside array is a type of dipole array where the dioples are oriented parallel to each other and perpendicular to the direction of radiation. This configuration produces a radiation pattern with maximum radiation perpendicular to the plane of the array.

An end fire array, on the other hand consists of dipoles arranged in a line parallel to the direction of radiation. The radiation pattern of an end fire array has maximum radiation along the axis of the array providing directional transmission or reception in that direction.

Q.2 Write a short note on yagi-uda antenna.

→ The yagi-uda antenna, often referred to as a yagi antenna, is a type of directional antenna commonly used in

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communication system. it consists of a driven element, usually a dipole or folded dipole, and several passive elements arranged in a specific configuration. these passive elements include reflectors and directors.

The yagi-Uda antenna works on the principle of interference and resoance. when radio waves are received by the driven element they induced currents that oscillate back and forth. These currents ~~the~~ then coupled to the passive elements, creating constructive & destructive interference patterns that amplify signals in a specific direction while reducing them in others.

Yagi-Uda antennas are commonly used for TV reception, wi-fi communication, and amateur radio operations due to their high gain directionality and relatively simple construction.

They are especially popular for outdoor installations where directional reception or transmission is required.

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Q.3 Explian an expression for radiation pattern of endfire array.

→ The radiation pattern can be calculated by considering the interference between the waves radiated by each element. The radiation pattern is given by the array factor, which represents the combined effect of all the elements.

- The array factor (AF(\theta) for an end fire array can be expressed as:

$$AF(\theta) = \sum_{n=1}^{N} e^{j(n-1)Kd\sin(\theta)}$$

(K) is the wavenumber

(\theta) is the angle of radiation relative to the array axis.

$$AF(\theta) = e^{jKd\sin(\theta)} \frac{e^{jNKd(\sin(\theta)-1)}}{e^{jKd(\sin(\theta)-1}}$$

$$AF(\theta) = e^{j\beta} \frac{e^{jN\beta}}{e^{j\beta}}$$

$$AF(\theta) = e^{j\beta(N-1)}$$

This array factor represents the contribution of all the elements to the radiation pattern. The raddition pattern (P(\theta)) is given by absolute square of the array factor

$$P(\theta) = |AF(\theta)|^2$$

$$P(\theta) = |e^{j\beta(N-1)}|^2$$

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Q.4 Explian the Dolph-chebyshev method of array synthesis.

→ The Dolph-chebyshev method, also known as the Dolph-Tchebyshev method, is a technique used in antenna array synthesis to design arrays with specified radiation patterns. It aims to minimize the maximum side-lobe level while maintaining a prescribed main lobe width. it achieves this by optimizing the array's element weights typically through mathematical optimization algorithms like the fast Fourier transform (FFT) or iterative methods.

The result is an antenna array with improved performance in terms of directivity and side-lobe suppression compared to other synthesis methods.

Q.5 What is array factor? Derive the expression for the array factor of N-element uniform linear array

→ The array factor is a mathematical expression that describes the radiation pattern of an antenna array as a function of the spatial arrangement of its individual elements. it represents the combined effect of the phase & amplitude of each element's radiat[illegible] pattern as well as their spatial separa[illegible]

For a uniform linear array (ULA) with (N) elements, the array factor (AF(\theta)) can be derived as follows:

$$AF(\theta) = e^{j0} + e^{jkd\sin(\theta)} + e^{j2kd\sin(\theta)} + \ldots + e^{j(N-1)kd\sin(\theta)}$$

using the geometric series formula we get:

$$AF(\theta) = e^{j0} \cdot \frac{e^{jNkd\sin(\theta)} - 1}{e^{jkd\sin(\theta)} - 1}$$

$$AF(\theta) = \frac{e^{jNkd\sin(\theta)/2}}{e^{jkd\sin(\theta)/2}} \cdot \frac{e^{jNkd\sin(\theta)/2} - e^{-jNkd\sin(\theta)/2}}{e^{jkd\sin(\theta)/2} - e^{-jkd\sin(\theta)/2}}$$

$$AF(\theta) = e^{j(N-1)kd\sin(\theta)/2} \frac{\sin(Nkd\sin(\theta)/2)}{\sin(kd\sin(\theta)/2)}$$

this expression represents the array factor for a uniform linear array. i- describes how the elements contributions combine to form the overall radidation pattern of the array a a function of angle (\theta)

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Assignment No. 4

Q.1 Expliam in detail cellular radio system envolution:

→ 1. first Generation (1G) - Analog cellular system (1980s):

- The first generation of cellular systems introduced analog technology, such as Advanced mobile phone system (AMPS) in North America & Total Access communication system.
- This system provided basic voice service with limited capacity and security.

2. second Generation (2G) - Digital cellular system (1990s):

- The advent of digital technology marked the second. 2G system brought digital technolgy, offering better voice quality, increased capacity and improved security.
- GSM became the dominant standard globally, facilating international roaming and interoperability
- short message service (SMS) was introduced in 2G networks.

3. Third Generation (3G): Brodband Data (2000s):

- 3G introduced high-speed data transmission, enabling services like video calling and mobile internet.
- Data rates varied with UMTS typically offering higher speeds than CDMA2000

The transmission to 3G paved the way for mobile broadband services.

4. Fourth Generation (4G): LTE and WiMAX (2010s):

4G networks provided significantly faster data rates and lower latency compared to 3G.

Worldwide interoperability for microwave Access (WiMAX) was an alternative 4G technology but was less widely adopted.

4G networks facilitated the widespread adoption of streaming services, mobile gaming and other bandwidth intensive applications.

5. Fifth Generation (5G):

Ultra-Reliable Low Latency Comm^n (URLLC) and massive machine type communication (mMTC):

5G enables applications like autonomous vehicles, remote surgery and augmented reality.

Q.2 Describe the analogy of smart antenna system.

→ Smart antenna technology increases the directivity of the antenna beams so as to enhance the signal at the intended receiver without causing interference to other radio users.

using multiple receive / transmit antenna channels simultaneously in order to increase reliability and hence data capacity.

Smart antenna system like a sophisticated radar array that can pin-point a target with precision. instead of broadcasting in all directions, it focuses its signal like a spotlight, maximizing reception quality and minimizing interference.

Q.3 Describe antenna beam forming in detail.

→ Antenna beamforming is a technique used in smart antenna system to focus radio signals in specific directions.

1. mutiple Antenna Elements:

A smart antenna system consists of multiple antenna elements arranged in an array. Each antenna element captures or emits electromagnetic waves.

2. phase and Amplitude control :- By adjusting phase and amplitude of the signals sent to each antenna element, the system can create constructive interference in the desired direction and destructive interference in other directions.

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3. Beam steering: By controlling the phase and amplitude of each antenna element the system can steer the beam of radiation towards a specific angle or direction in space.

4. Adaptive Beamforming - in some cases the system dynamically adjusts the phase and amplitude settings based on feedback received from the environment or signal being received.

Q.4 Expliam adaptive beamforming in detail.

→ Adaptive beamforming is a technique used in smart antenna system to dynamically adjust the directionality of the antenna array based on changing conditions in the environment or the received signal.

1. initial calibration - initially, the smart antenna system may perform a calibration phase where it analyze the characteristics of the environment.

2. Signal processing algorithms that conti- The received signals from each antenna element are combined and processed using digital signal process, adjust the array's characterc teristics to optimize reception or trans-mission.

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3. Objective Function - Adaptive beam-forming algorithms typically operate based on an objective function, which defines the desired performance criteria. For instance, the objective function may aim to maximize the signal-to-interference-plus-noise ratio (SINR) for a specific target signal while minimizing interference from other directions.

4. Weight Adjustment - The key aspect of adaptive beamforming is the dynamic adjustment of the array's weight.
Each antenna element's contribution to the combined signal is controlled by these weights.

5. Adaptation Algorithm - There are various adaptation algorithms used in adaptive beamforming, such as Least mean squares Recursive Least squares or variant Last or like the sample matrix inversion method.

6. Applications - Adaptive beamforming finds applications in various field, including radar system, wireless communication networks, sonar system and satellite communication or underwater communication

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5. What is cell splitting? Explain

→ 1. Cellular Networks :- In cellular networks, the coverage area is divided into smaller regions called cells, each served by a base station. These cells ensure that the available radio spectrum is efficiently utilized and network.

When a cell becomes congested, cell splitting allows for more efficient use of available radio frequency spectrum and resources by dividing the coverage area into smaller cells. Each smaller cell, often referred to as a microcell or picocell, has its own base station and serves a smaller geographic area and fewer users.

Cell splitting is a key strategy employed by network operators to manage the increasing demand for mobile data and voice services in densely populated areas and to optimize the efficiency of cellular networks.

This results in better network performance, higher data rates and improved call quality for users within the coverage area.

Assignment No. 5

1. Explian travelling wave antennas in detail.

1. Basic Principle :

Traveling wave antennas operate by propagating electromagnetic waves along a transmission line structure, such as a coaxial cable or waveguide. Unlike traditional antennas where the electromagnetic wave is generated at a specific point and radiates outward, traveling wave antennas use the entire length of the transmission line as the radiating element.

2. Structure

The basic structure of a travelling wave antenna consists of a trans-mission line, which is typically a coaxial cable or a waveguide, and a periodic structure along the length of the transmission line. The periodic structure, often in the forms of slots, notches, or periodic variations in the impedance of the transmission line, helps in shaping the radiation pattern and controlling the charac-teristics of the antenna.

3. Propagation -

Electromagnetic waves travelling along the transmission line Interac with the periodic structure, determin the radiation pattern, gain and other performance characteristics of the antenna. creating continuos radiation pattern.

5. Benefits

Broadband operation - Traveling wave antennas can operate over a wide frequency range due to their continuos wave propagation.

Directional radiation pattern: Depending on the design traveling wave antennas can be advantageous for point-to-point communication

Some traveling wave antennas like helical antennas can be relatively compact compared to other types of antennas, space

6. Applications :

Communication system - They are commonly used in wireless comm. system, such as wi-fi, cellular and satellite communication.

Radar system -

Traveling ~~swa~~ wave antennas are used in radar systems for detecting and tracking objects.

Q. 2

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Q.2 Expliain in detail microstrip antenna.
→ 1. structure - A microstrip antenna typically consists of the following components:
• Radiating element - This is the thin, flat conductive strip that serves as the radiator of the antenna. it is usually made of copper or other conductive materials and is placed on the surface of a dielectric substrate.
operating principle: microstrip anten operate based on the principle of coupling electromagnetic energy between the radiating element and the ground plane throught the dielectric substrate. when radio frequency enegy is applied to the radiating element and the ground plane through the electromagnetic waves into space.
Ground plane: Beneath the substrate there's usually a conducting ground plane that provides a reference for the radiation of the antennas. it helps to improve the antenna's radiation efficiency and directivity by reflecting the radidation from the readiting element.
Suitability for a wide range of applications in modern communicati system.

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Q.3 Explian cassegrain feed parabolic reflector with suitable diagram.

→ Primary Reflector (Parabolic Dish):

The primary reflector is a large parabolic dish-shaped surface that reflect incoming or outgoing electromagnetic waves (signals). it has a concave shape, with the feed horn located at its focal point. The primary reflector focuses the incoming signal

1. Primary Reflector: The primary reflector is a large parabolic dish-shaped surface that reflects incoming or outgoing electromagnetic waves. The primary reflector focuses the incoming signals onto the secondary reflector.

2. Secondary Reflector -

The secondary reflector is typically a smaller hyperbolic or ellipsoidal shaped mirror positined in front of the primary reflector, facing towards the feed horn. its purpose is to redirect the signals received or transmitted by the primary reflector towards the feed horn.

3. Feed Horn :- The feed horn located at the local point of the primary reflector. it is a small antenna or wareguide structure that sends or receives electromagnetic signals to or from the reflectors.

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Operation -

1. Incoming signals -

when electromagnetic signals from a distant source reach the antenna system, they are reflected by the primary reflector towards the secondary reflector.

2. Secondary Reflector

The secondary reflector redirects the signals towards the feed horn, which collects and processes them. By properly adjusting the size and position of the secondary reflector.

Q.4 Explian Rhombic antenna design in detail.

→ 1. Wire configuration -

The rhombic antenna comprises four or more wire elements forming a diamond shape. These wires are typically supported by masts or towers at each corner of the diamond

2. Orientation -

The orientation of the rhombic antenna is crucial for its performance of the rhombus is aligned with the desired direction of transmission or reception, This orientation enhances its sensitivity to signals from that specific direction.

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Length -

The length of the wires is typically determined by the desired operating frequency. The longer diagonal is usually around one wavelength long at the operating frequency. The longer diagonal is usually around one wavelength long at the operations.

Bandwidth -

The bandwidth of a rhombic antenna can be adjusted by varying the length and angle of the wires. However, they typically have a narrower bandwidth compared to some other antenna types.

Applications -

Rhombic antennas are commonly used in HF communication systems, particularly for long-range point-to-point links, where their high gain and directional sensitivity are advantageous.

Q.5 Explian yagi-uda Antenna design.

→ 1. Basic structure - A yagi-uda antenna consists of several elements arranged in a specific configuration. The main components include a driven element, one or more director elements.

2. Driven Element - The driven ele-
ment is the main component, that
Is directly connected to the feedline
from the transmitter or receiver.
it is usually a simple dipole or folded
dipole antenna.
3. Reflector Element - positioned
behind the driven element, the
reflector element is slightly longer
than the driven element.
4. Director Element - positioned in
front of the driven element, the
director element are shorter than
the driven element.
5. Applications - yagi-uda antenna
are widely used in applications.
such as television reception, amateur
radio, wi-fi communication.
They are particularly popular
for outdoor installations where
directional sensitivity and gain
are essential for long-range
communication.