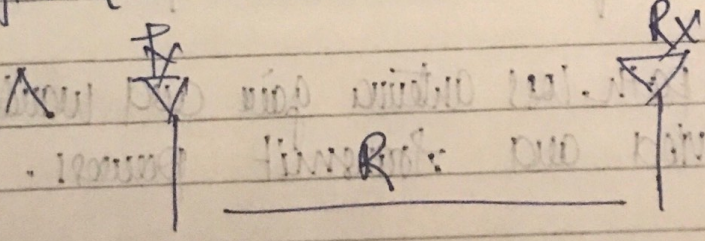
Antenna :

Harald T Friis pioneer in the field of radio receivers.

Friis transmission :-

equating the power at the terminal of receiving antenna as the product of power density of incident wave and the effective aperture of receiving antenna given another antenna some distance away transmitting a known amount of power.

used to calculate the power received from one antenna (gain G_1) transmitted from other antenna (Gain G_2) separated by a distance R at frequency f and wavelength λ.



P_T watts of total power are delivered to the transmit antenna

Transmitting Antenna is Omnidirectional, lossless and receiving P_1 is far field from Tx ant

Hence the power density P is given by

$$P = \frac{P_T}{4\pi R^2}$$

If the Rx antenna has Antenna Gain G_T in the direction of receiving Antenna then

The effective aperture of receiving antenna is A_{ER} and power received by the antenna is P_R than

$$P_R = \frac{P_T G_T A_{ER}}{4\pi R^2}$$

here $A_e = \frac{\lambda^2}{4\pi} G$

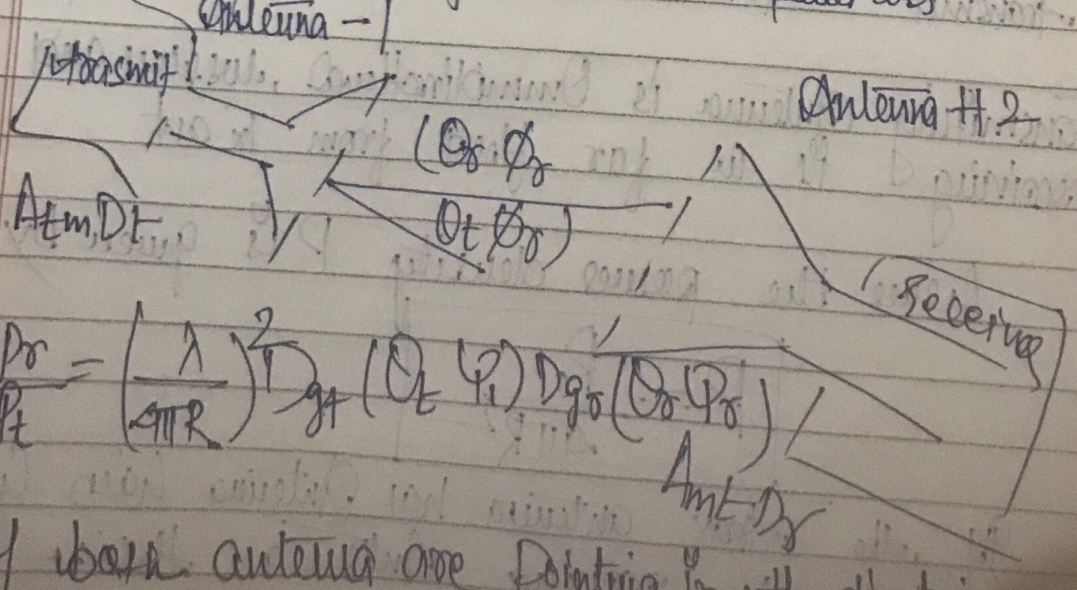
$$\boxed{P_R = \frac{P_T G_T G_R \lambda^2}{(4\pi R)^2}}$$

this is friis transmission formula.

free space path loss antenna gain and wavelength to the received and transmit powers.

Adv

Friis transmission quantifies the power received at the receiving end of antenna and power loss.



$$\frac{P_r}{P_t} = \left(\frac{\lambda}{4\pi R}\right)^2 D_t(\theta_t, \phi_t) D_r(\theta_r, \phi_r)$$

If both antenna are pointing in the direction.

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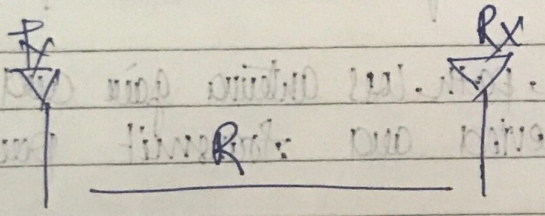

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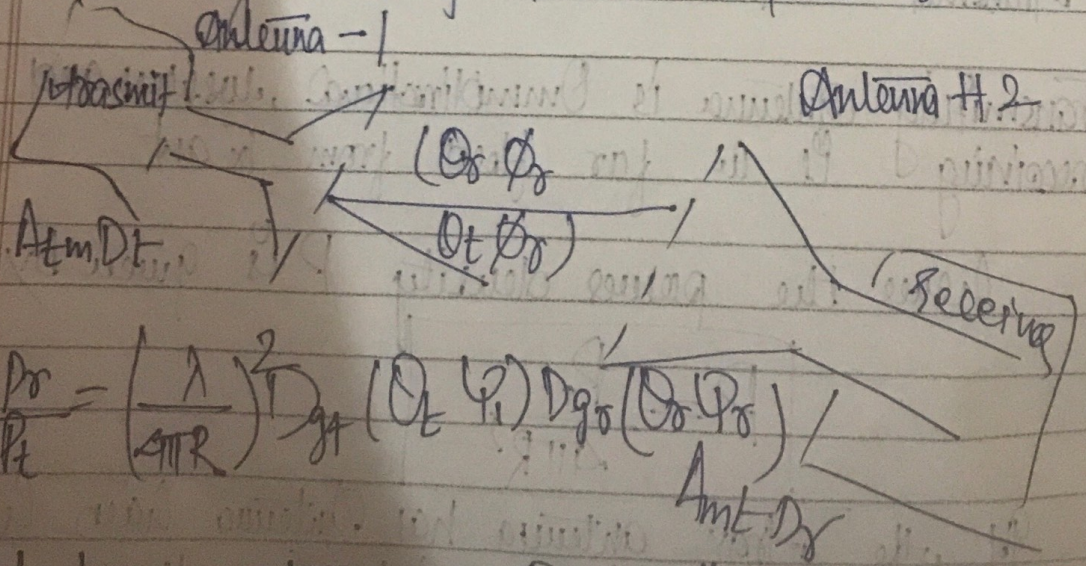


$$\frac{P_r}{P_t} = \left(\frac{\lambda}{4\pi R}\right)^2 D_{gt}(\theta_t, \varphi_t) D_{gr}(\theta_r, \varphi_r)$$

If both antenna are pointing in the direction.

of their max^{m} radiation pattern

$$\frac{P_r}{P_t} = \left(\frac{\lambda}{4\pi R}\right)^2 D_{gt} D_r)$$

and the transmitted power density supplied by antenna 1 at a distance R is given by

$$W_t = \frac{P_t D_{gt}(\theta_1, \phi_1)}{4\pi R}$$

power received at antenna 2 is given by

$$P_r = W_t A_r = \frac{P_t D_{gt}(\theta_1, \phi_t) A_r}{4\pi R^2}$$

Directional Antenna.

Power per unit area

$$S_r = \frac{P_t}{4\pi R^2}$$

Polarization of Antenna :-
polarization of antenna refers to the direction of oscillation in the wave.

- linearly polarized antenna
- Circularly polarized Antenna

Need of Polarization :-

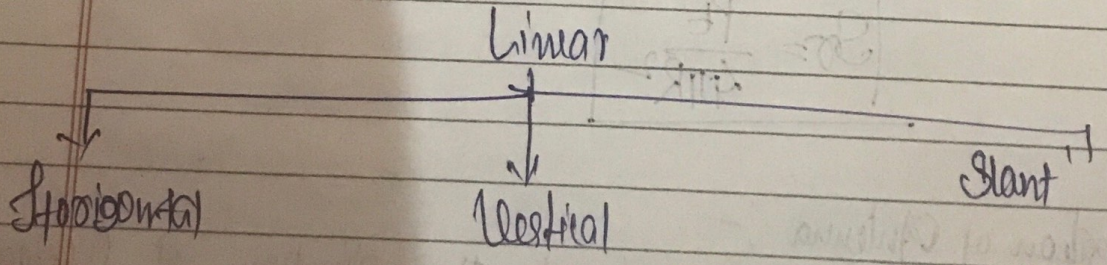
When designing an antenna according on a particular form of Antenna ; it is important which and when they need to be polarized.

Because in mobile or wireless type of antenna there are many reflective there are many obstacles between transmitter and Receiver.

For the em wave the polarization is effectively the plane in which the electric wave vibrated.

When Antenna are sensitive to polarization it is in any particular direction.

Linear polarization : most common form of Antenna polarization . In the radiation is in linear.



Horizontal Polarization :-

⇒ This form of Antenna polarization has horizontal elements.

⇒ Get pick up i.e. receive horizontally polarized signals

electromagnetic waves with the electric field in the horizontal plane.

Vertical Polarization :-

This form of Antenna is defined by vertical elements within the Antenna.

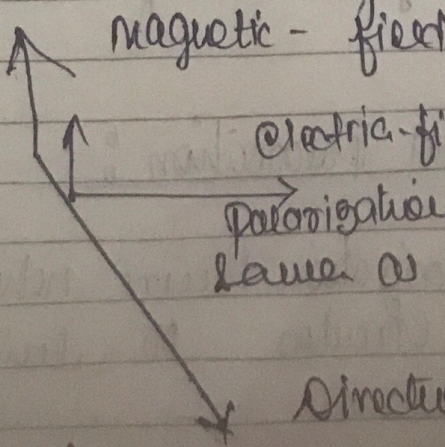
Vertical polarized Antenna have what is termed as low angle of radiation enabling large proportion of their power to be radiated at any angle close to the earth surface.

Vertical polarized are common to see with Automobiles.

Slant polarization :-

Form of radio Antenna polarization that it is an angle to the horizontal or vertical planes.

In this slant polarization ~~that it~~ it an angle both vertical and horizontally polarised Antenna are able to receive the signal.



eg. Em em wave

Circular polarisation :- In Circular polarisation all radiations are in the form of Circular.

Circular polarisation are used generally in satellite communication where it helps to overcome the effects of propagation anomalies ground reflection and effects of spin that occurs in many satellites.

In Circular polarisation tips of the electric field vector will then be seen to trace out a helix or corkscrew as it travels from antenna

Circular polarisation

Right hand
Polarisation vector rotates in right handed fashion

Left hand

In left hand polarisation polarisation vector rotates in left hand fashion.

3) Final Elliptical Polarisation :-

This type polarisation occurs when there is a mix of Circular or linear polarisation

Ques:
This can be visualised as before the tip of the electric vector tracing out an elliptical shape.

Reciprocity :-

Reciprocity is most useful properties of Antenna. It states that receive and transmit properties of Antenna are identical.

Properties Under Reciprocity:

* Equality of Directional patterns.
* Equality of Directives
* Equality of effective length.
* Equality of Antenna Impedance.

Equality of Directional Patterns :-

Input Impedance of Antenna :-

Input Impedance relate the Voltage and Current at the input of Antenna.

The real part of the antenna impedance represents power that is either radiated away or absorbed within the Antenna.

The imaginary part of the Antenna represents power that is stored in the near field of Antenna.

Eg: Let us say an Antenna having impedance of 50 ohms.