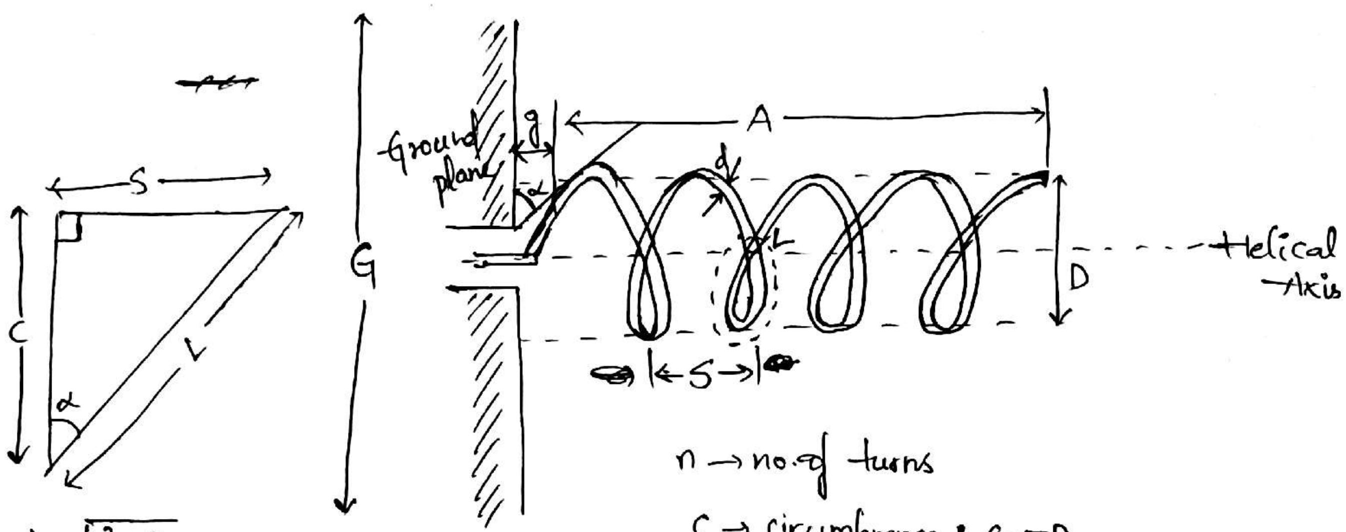
B. Sahithi
ECE-C
15B-4D8

AWP ASSIGNMENT.

1. Explain Helical Antenna.

The Helical Antenna consists of Helical loops that are made with conductor. It is associated with ground plane which is also a Conductor. The structure of Helical Antenna is as shown.



$L = \sqrt{S^2 + C^2}$

$\alpha = \tan^{-1}(S/C)$

$\alpha = \tan^{-1}(S/\pi D)$

n → no. of turns

C → circumference ; $C = \pi D$

where, D = diameter of Helix

S = spacing b/w turns

L = length of one turn

A = Axial length

$\boxed{A = n \cdot S}$

n = no. of turns

G = diameter of ground plane

g = distance of Helix propagation from ground

α → pitch angle → formed by a line tangent to helical axis and plane perpendicular to the Helical Axis.

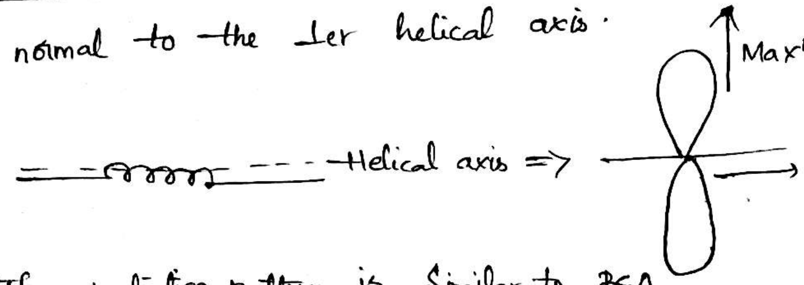
Range of α is → 0° to 90°.

The Helical Antenna propagates EM waves under two

1. Normal mode.

2. Axial mode.

<u>Normal mode:</u> Helical Antenna has max^m radiation to in the of normal to the $\perp$er helical axis.



The radiation pattern is Similar to BSA.

It can be represented in terms of Axial Ratio.

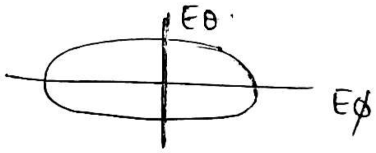
where, $A \cdot R = \dfrac{E\theta}{E\phi}$

$E\theta \rightarrow$ far field Component of short dipole.

$E\phi \rightarrow$ far field Component of loop antenna.

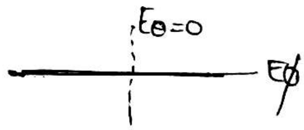
$$E\theta = \frac{j60 I_0 \pi \sin\theta}{r} \cdot \frac{S}{\lambda} \;;\; E\phi = \frac{120\pi^2 I_0 \sin\theta}{r} \cdot \frac{A}{\lambda^2}$$

if $E\theta \neq E\phi$; elliptical polarization.

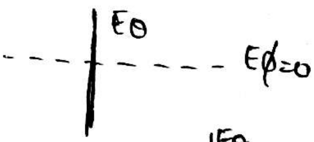


(i) if $E\theta = 0$; $AR = 0$

$\Rightarrow$ Horizontal linear polarization

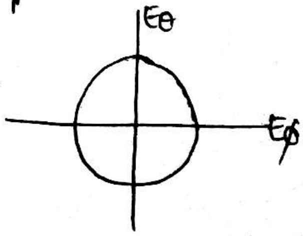


(ii) $E\phi = 0$; $AR = \infty \Rightarrow$ Vertical linear polarization



$\Rightarrow 0 < AR < \infty$.

(iii) $E\theta = E\phi \Rightarrow AR = 1$; it is Circular polarization.



$AR = \left| \dfrac{E\theta}{E\phi} \right| = 1$

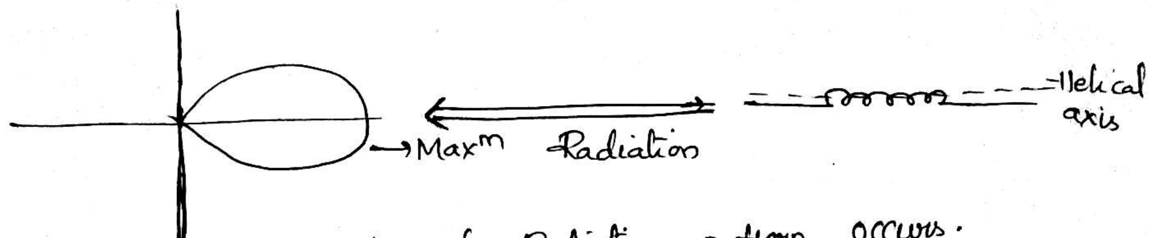
$\Rightarrow S = \dfrac{C^2}{2\lambda}$.

and $\tan\alpha = \dfrac{C}{2\lambda}$.

mode:

The radiation is max^m in direction along Helical axis.

It is Similar to Endfired Array Radiation.



Based on S & D, direction of Radiation pattern occurs.

→ Circumference, ⇒ $\frac{3\lambda}{4} < C < \frac{4\lambda}{3}$

→ Spacing b/w turns, $S = \lambda/4$

→ Ground plane diameter; $G = \lambda/2$

→ pitch angle; $\alpha \rightarrow 12°$ to $18°$ & terminal impedance of helix is b/w 100 to 200.

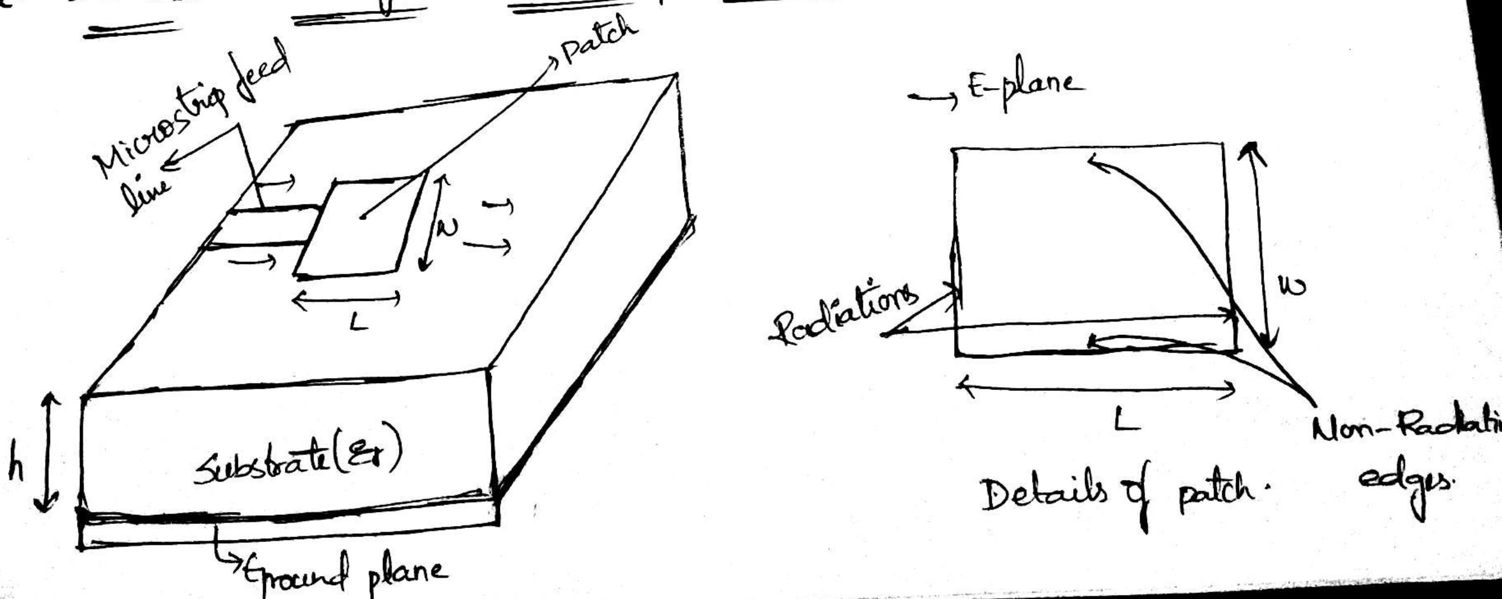
→ The i/p impedance is $R = 140 \frac{C}{\lambda} \Omega$.

$$HPBW = \frac{52\,\lambda^{3/2}}{(C\sqrt{L})} \; ; \quad FNBW = \frac{115\,\lambda^{3/2}}{(C\sqrt{L})} \; ; \quad D = \frac{15nC^2S}{\lambda^3} \; ; \quad AR = \frac{2n+1}{2n} \; ;$$

$$Gain\,(dB) = 10 \log_{10}\left[15\left(\frac{C}{\lambda}\right)^2 \cdot \frac{L}{\lambda}\right]$$

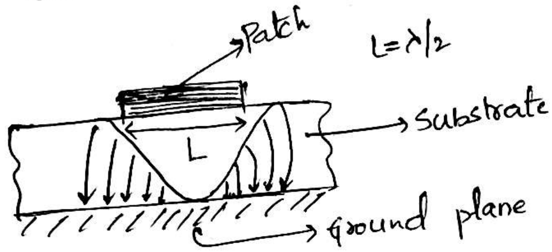
→ To achieve axial mode, all the above parameters are required.

2. Describe Rectangular Microstrip Antenna.



Details of patch.

The most Commonly used Antennas is Rectangular Microstrip
The Rectangular Microstrip Antenna is with a ground plane
Substrate which is as shown. Here, $L >> w$,
There is no radiation at the end of 'w' dimensions. At 'L'
edges, Resonance is Caused at its half wave frequency. where, L
$\bar{E}.F$ produced below the length dimension side of patch. which
are normal to the substrate.



The radiation intensity decreases as fields move away from the patch & phase also changes. For effective radiation of microstrip antenna, the length of patch = $\lambda/2$. Substrate with low dielectric constant. The height of substrate should be limited to a fraction of wavelength. For above microstrip antenna,
effective dielectric Constant,

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+12\frac{h}{w}\right)^{-1/2}$$

$\varepsilon_r \rightarrow$ dielectric Constant
$h \rightarrow$ height of substrate
$w \rightarrow$ width of patch.

The center freq. of operation of antenna is approximately.

$$f_r = \frac{c}{2L\sqrt{\varepsilon_r}} \quad ; \quad L = \frac{c}{2f_r\sqrt{\varepsilon_r}}$$

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$L \rightarrow$ length of patch
$c \rightarrow$ speed.

To obtain freq. of operation of patch accurately, we should Consider width of the patch 'w'.

& width of the patch controls impedance matching & radiation pattern, if width increases, i/p impedance decreases.
To obtain effective radiation of patch, the patch length is extended by 'Δl' on each side.

The practical approximation relation of the above fig:

$$\frac{\Delta l}{h} = 0.412 \frac{(\varepsilon_{eff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.81\right)}$$

For effective radiation, the length becomes l_{eff}.

$$l_{eff} = l + 2\Delta l$$

$$f_r = \frac{c}{2(L+\Delta l)\sqrt{\varepsilon_{eff}}}.$$

The Expression for $\bar{E}.\bar{F}$ component is given by,

$$E_\theta = \frac{\sin[(\beta w \sin\theta \sin\phi)/2]}{\beta w \sin\theta \sin\phi/2} \cos\left[\frac{\beta l}{2}(\sin\theta\cos\theta)\right] \cos\phi$$

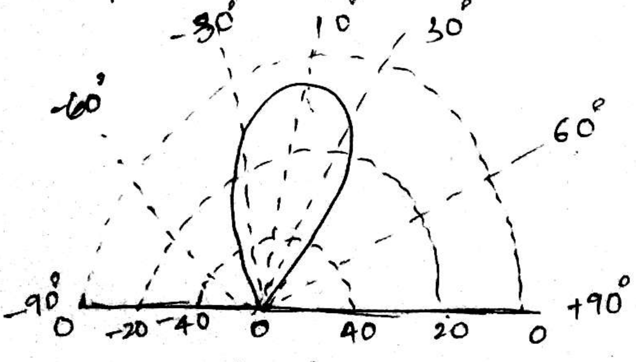
$$E_\phi = \frac{-\sin[\beta w \sin\theta \sin\phi/2]}{\beta w \sin\theta \sin\phi/2} \cos\left[\frac{\beta l}{2}(\sin\theta\cos\theta)\right] \sin\phi.$$

$\theta \rightarrow$ Elevation angle, $\phi \rightarrow$ Azimuthal angle of radiation pattern $\beta = \frac{2\pi}{\lambda}$.

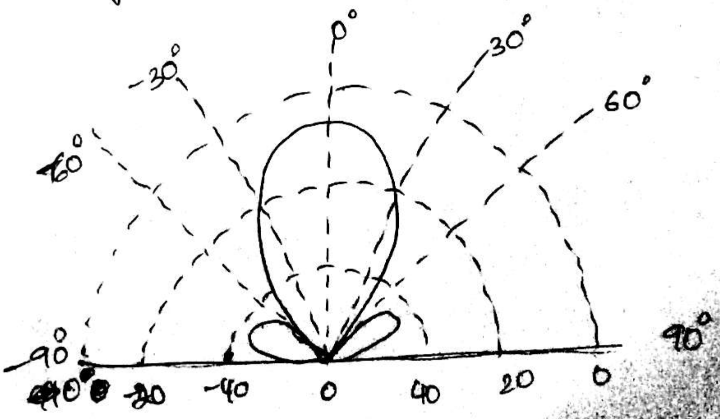
The resultant E.F at any pt.

$$E(\theta,\phi) = \sqrt{E_\theta^2 + E_\phi^2}$$

Normalised Radiation patterns for $L = w = \lambda/2$, $\phi = 0°$ & $\phi = 90°$ planes are;



at $\phi = 0°$



3. Explain Direct Comparison Method.

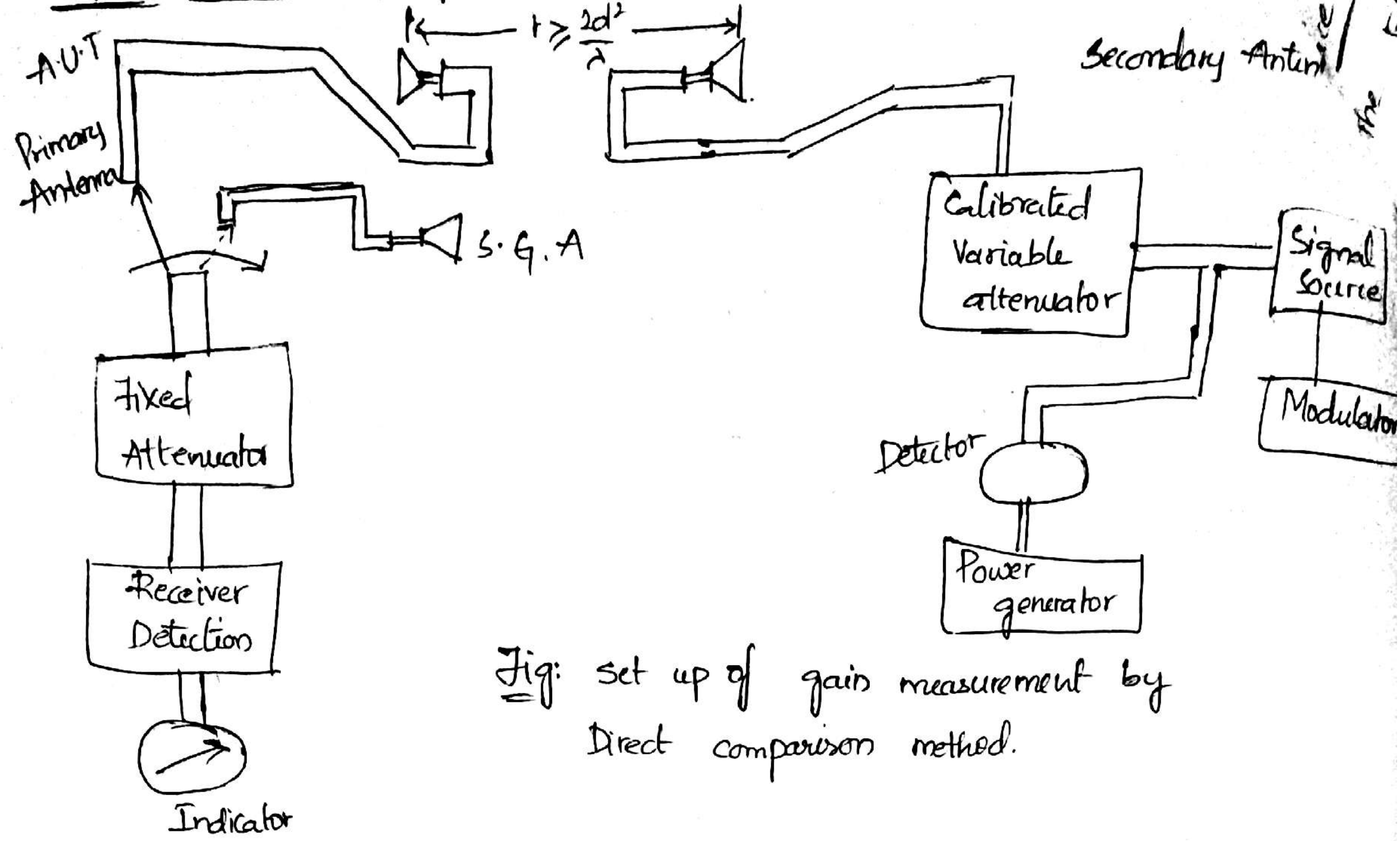


Fig: set up of gain measurement by Direct comparison method.

At high frequencies, gain measurement is done using Direct Comparison method. In this, At Receiver, Primary Antenna is used. There are two primary Antennas. Standard Gain Antenna (S.G.A) and Antenna Under Test (A.U.T). SGA is antenna in which the gain is accurately known and used for gain measurement of other antennas that are under test. At Transmitter, Secondary Antenna, i.e., Source Antenna is used. Distance b/w them is $r \geq \frac{2d^2}{\lambda}$. Through switch, SGA is connected to reciever. The antenna is adjusted in the direction of the secondary antenna to have maximum signal intensity. For this i/p, corresponding primary antenna readings at the receiver are recorded. Corresponding power bridge values & attenuator values are recorded. let it be A_1 & P_1. Then, AUT is connected to switch by changing it's position. To get same reading at receiver, the corresponding attenuator & power values are recorded. let it be A_2 & P_2.

if $P_1 = P_2$, $G_p = \frac{P_1}{P_2} \cdot \frac{A_2}{A_1} \Rightarrow G_p = \frac{A_2}{A_1} \Rightarrow G_p(dB) = A_2(dB) - A_1(dB)$

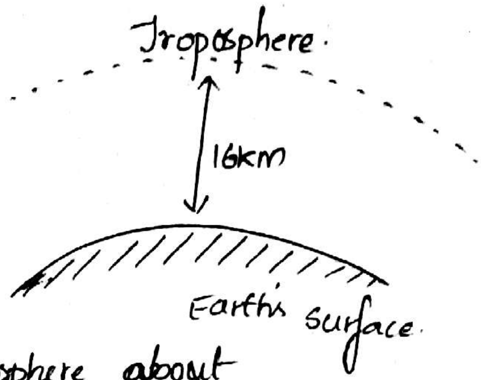
if $P_1 \neq P_2$, let $\frac{P_1}{P_2} = P$, $G = G_p \cdot \frac{P_1}{P_2} \Rightarrow G = G_p \cdot P$.

$\log_{10} G = \log_{10}(G_p \cdot P) \Rightarrow G(dB) = G_p(dB) + P(dB)$.

xplain Space wave Propagation.

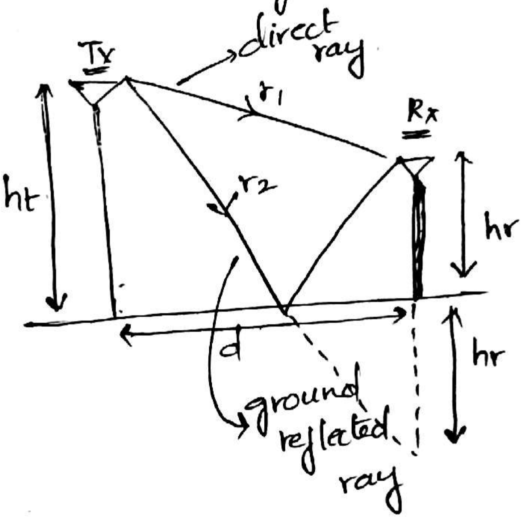
Space wave Propagation:

The EM wave transmitting from T_x to R_x above 16km from surface of earth is Called Space wave propagation.



Troposphere is the region at the atmosphere about 16 km from ground. The frequency used is about 30-300MHz. It is also used for VHF & UHF. The wave reaches receiver through two ways: (i) Via Direct ray (ii) Via ground reflected ray.

→ Field strength of Receiver is mostly contributed by direct and ground reflected waves.



$d \rightarrow$ distance b/w Tx & Rx

$r_1 \rightarrow$ direct ray path

$r_2 \rightarrow$ ground reflected ray path

$$r_1^2 = |h_t - h_r|^2 + d^2$$

$$r_1 = d\left[1 + \frac{1}{2}\left(\frac{h_t - h_r}{d}\right)^2\right]$$

$$r_1 = d + \frac{(h_t - h_r)^2}{d}$$

$$r_2^2 = (h_t + h_r)^2 + d^2$$

$$\text{//ly}, \quad r_2 = d + \frac{(h_t + h_r)^2}{2d}$$

path difference

$$r_2 - r_1 = \frac{2 h_t h_r}{d}$$

phase difference

$$\alpha = \frac{2\pi}{\lambda} \cdot \text{path difference}$$

$$\boxed{\alpha = \frac{4\pi h_t h_r}{d\lambda}}$$

let $E_d \rightarrow$ field due to direct ray

$E_r \rightarrow$ field due to reflected ray.

Resultant field at receive is,

$$E_R = E_d + E_r e^{-j\varphi}$$

$$E_d = E_r = E_s$$

and $\varphi = 180 + \alpha$

$$E_R = E_s\left[1 + e^{-j(180+\alpha)}\right]$$

$$E_R = E_s\left[1 + \cos(180+\alpha) - j\sin(180+\alpha)\right]$$

$$E_R = E_s\left[1 - \cos\alpha + j\sin\alpha\right] \quad ; \; E_s = \frac{E_0}{d}$$

$$E_R = \frac{2E_0}{d} \cdot \sin\left(\frac{2\pi h_t h_r}{\lambda d}\right)$$

For $d >> h_t h_r$

$$E_R = \frac{2E_0}{d} \cdot \frac{2\pi h_t h_r}{\lambda d}$$

$$\boxed{E_R = \frac{4E_0 \pi h_t h_r}{\lambda d^2}}$$

But, due to variations in surface of earth, there will be some shadow region which radiates in very small quantity.

then,

$$\boxed{E = \frac{2E_0}{d} \cdot \sin\left(\frac{2\pi h_t' h_r'}{\lambda d}\right)}$$

this is the $(E\text{ field})_{total}$ in space wave propagation.