DESIGN AND SIMULATION OF DIFFERENT TYPES OF ANTENNA USING MATLAB

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ABSTRACT

An antenna is "a means for radiating or receiving radio waves." In other words the antenna is the transitional structure between free-space and a guiding device.
Antennas are employed in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN & radar. There are several critical parameters affecting an antenna's performance that can be adjusted during the design
process. These are field patterns, power pattern, resonant frequency, impedance, gain, polarization, directivity, efficiency and beam width out of these we will incorporate mainly seven parameter of the antenna. In this MATLAB 2012 is used for the programming of the antenna. **MATLAB** stands for "MATrix LABoratory" and is a numerical computing environment and fourth-generation programming language. MATLAB allows matrix manipulations, plotting of functions and data,
implementation of algorithms, creation of user interfaces, and interfacing with programs with programs written in other languages.

Keywords *- E & H field patterns in 2D& 3D, power patterns in 2D &3D, HPBW, Directivity, Beam width, etc.*

1. INTRODUCTION

While designing an antenna various parameters need to be taken care of. The important among them are the Gain, Directivity, Field Intensity, and Beam width. An antenna should possess its maximum energy in the direction of main lobe while possessing a minimum of side and back lobes. For this reflector surfaces are used.
Metallic surfaces act as superb reflectors, while dielectric surfaces absorb the Electromagnetic radiation falling upon them. Hence, it is imperative to have a design that extends to handle these factors effectively. Various losses arise in the transmission due to mismatching and the reflections suffered by the waves in the atmosphere due to precipitation, dust, water-vapours etc. Rain drops play the most important role due to spherical symmetry, due to which circular polarization becomes a necessity. To increase the bandwidth various methods such as use of thicker wires and combination of multiple antennas to give a single assembly is preferred.

This project focuses on the development of the radiation pattern which provides us the antenna parameters such as directivity, gain, electric field intensity, beam width along the main lobe and co-existence of circular polarization. The existing designs of dipole, aperture, various types of horn, micro-strip, TWT and loop antenna were simulated using MATLAB in my project.

Firstly, a literary survey of basic and existing antenna types was done. The basic antenna types included the dipole, aperture, various types of horn, helical, micro-strip, TWT and loop antenna. The next step was to perform the mathematical analysis of these types of antennas to calculate the mathematical equations for the electric field and magnetic field intensities. These equations were then simulated in MATLAB to generate the corresponding outputs. The outputs were verified theoretically.

2. DESCRIPTION OF DIFFERENT ANTENNAS

2.1 Dipole Antenna

Dipoles antennas are also known as wire linear or curved antennas. A dipole antenna is a radio antenna that can be made of a simple wire with a center-fed driven element. It consists of two metal conductors of rod or wire, oriented parallel and collinear with each other (in line with each other), with a small space between them. As the name suggests the dipole antenna consists of two terminals or "poles" into which radio frequency current flows. This current and the associated voltage causes electromagnetic or radio signal to be radiated. Being more specific, a dipole is generally taken to be an antenna that consists of a resonant length of conductor cut to enable it to be connected to the feeder. For resonance the conductor is an odd number of half wavelengths long. The current distribution along a dipole is roughly sinusoidal. It falls to zero at the end and is at a maximum in the middle. Conversely the voltage is low at the middle and rises to a maximum at the ends. It is generally fed at the centre, at the point where the current is at a maximum and the voltage a minimum. This provides a low impedance feed point which is convenient to handle. High voltage feed points are far less convenient and more difficult to use. There are different types of dipole antenna depending upon the length dipole such as infinitesimal dipole ($L \ll \lambda$), Small dipole ($\lambda/50 < L \leq \lambda/10$), half wavelength dipole ($L=\lambda/2$), quarter-wavelength dipole ($L=\lambda/4$). One of the most commonly used antennas is the half-wavelength dipole. Because its radiation resistance is 73 ohms, which is very near the 50-ohm or 75-ohm characteristic impedances of some transmission lines.

E- and **H-**fields associated with the dipole antenna is given as:

$$E(\theta) = j\eta \frac{Ie^{-jkr}}{2\pi r}\left[\frac{\cos\left(\frac{kl}{2}\cos\theta\right)-\cos\left(\frac{kl}{2}\right)}{\sin\theta}\right] \quad (1)$$

$$H(\theta) = j \frac{Ie^{-jkr}}{2\pi r}\left[\frac{\cos\left(\frac{kl}{2}\cos\theta\right)-\cos\left(\frac{kl}{2}\right)}{\sin\theta}\right] \quad (2)$$

Where, $\lambda = 3\times10^{10}$/freq., $k = 2\pi/\lambda$, $I_o = 1$, $\eta = 120\pi$

Directivity associated with the dipole antenna is given as:

$$Do = 4\pi \frac{F(\theta,\emptyset)max}{\iint_0^{\pi} F(\theta,\emptyset)\sin\theta\, d\theta\, d\emptyset} \quad (3)$$

Where,

$$F(\theta,\emptyset) = F(\theta) = \left[\frac{\cos\left(\frac{kl}{2}\cos\theta\right)-\cos\left(\frac{kl}{2}\right)}{\sin\theta}\right]^2 \quad (4)$$

HPBW associated with the dipole antenna is given as:

$L \ll \lambda$ 3-dB beam width $=90^0$

$L = \lambda/4$ 3-dB beam width $=87^0$

$L = \lambda/2$ 3-dB beam width $=78^0$

$L = 3\lambda/4$ 3-dB beam width $=64^0$

$L = \lambda$ 3-dB beam width $=47.8^0$

Amplitude patterns of a circular loop for **E**-Plane & **H**-Plane when frequency=3e10hz, L=1.5cm, R=1cm

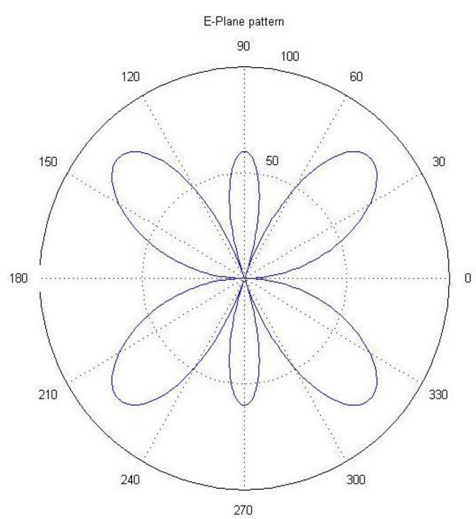

Fig 2.1 2D amplitude patterns of a dipole for **E**-Plane

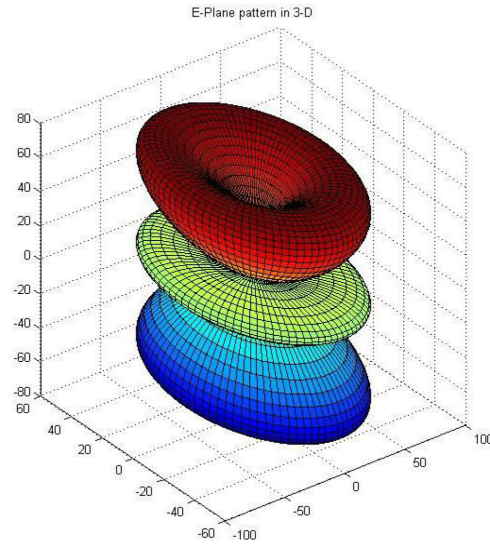

Fig 2.2 3D amplitude patterns of a dipole for **E**-Plane

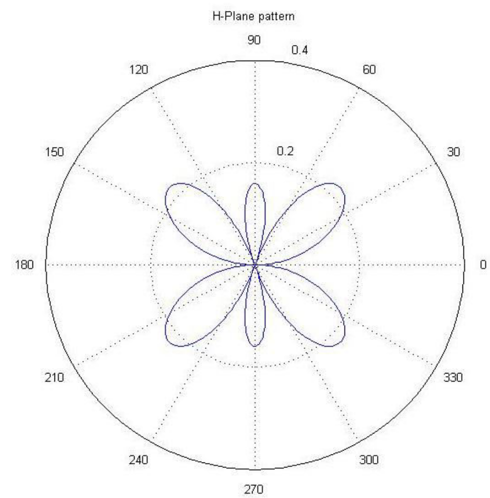

Fig 2.3 2D amplitude patterns of a dipole for **H**-Plane

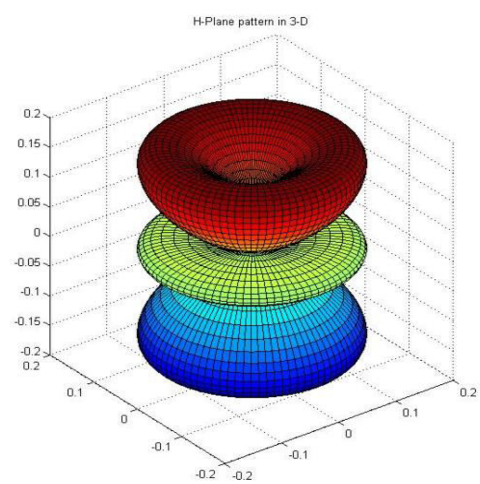

Fig 2.4 2D amplitude patterns of a dipole for **H**-Plane

2.2 Loop Antenna

Loop antennas take many different forms such as a rectangle, square, triangle, ellipse, circle, and many other configurations. Because of the simplicity in analysis and construction, the circular loop is the most popular and has received the widest attention. It will be shown that a small loop (circular or square) is equivalent to an infinitesimal magnetic dipole whose axis is perpendicular to the plane of the loop. That is, the fields radiated by an electrically small circular or square loop are of the same.

Loop antennas are usually classified into two categories, electrically small and electrically large. Electrically small antennas are those whose overall length (circumference) is usually less than about one-tenth of a wavelength *($C < \lambda/10$)*. However, electrically large loops are those whose circumference is about a free-space wavelength*($C \sim \lambda$)*. Most of the applications of loop antennas are in the HF (3–30 MHz), VHF (30–300 MHz), and UHF (300–3,000 MHz) bands. When used as field probes, they find applications even in the microwave frequency range. The radiation resistance of the loop can be increased, and made comparable to the characteristic impedance of practical transmission lines, by increasing (electrically) its perimeter and/or the number of turns. Another way to increase the radiation resistance of the loop is to insert, within its circumference or perimeter, a ferrite core of very high permeability which will raise the magnetic field intensity and hence the radiation resistance. This forms the so-called ferrite loop.

The main advantage of loop antenna is that this is simple, inexpensive, and very versatile antenna. Loop antennas with electrically small circumferences or perimeters have small radiation resistances that are usually smaller than their loss resistances. Thus they are very poor radiators, and they are seldom employed for transmission in radio communication. When they are used in any such application, it is usually in the receiving mode, such as in portable radios and pagers, where antenna efficiency is not as important as the signal to-noise ratio. They are also used as probes for field measurements and as directional antennas for radio-wave navigation.

E- and **H-**fields associated with the loop antenna is given as:

$$E_\varphi = \frac{ak\eta I_0 e^{-jkr}}{2r} J_1(k.a.\sin\theta) \quad (5)$$

$$H_\theta = \frac{-E\varphi}{\eta} = -\frac{akI_0 e^{-jkr}}{2r} J_1(k.a.\sin\theta) \quad (6)$$

Where, $\lambda = 3\times10^{10}/\text{freq.}$, $k = 2\pi/\lambda$, $I_o = 1$, $\eta = 120\pi$

Directivity of loop antenna is given as:

$D0 = 3/2 = 1.761$ dB $[\,(a < \lambda/6\pi, C < \lambda/3)]$ (7)

$D0 = 0.677(C/\lambda)$ $[(a \geq \lambda/2, C \geq 3.14\lambda)]$ (8)

HPBW of loop antenna is given as:

HPBW = 90

Amplitude patterns of a circular loop for **E**-Plane when frequency=3e10hz, a=0.759cm, R=0.01cm

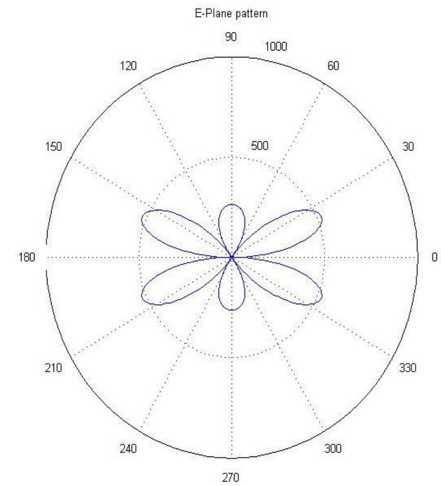

Fig 2.5 2D amplitude patterns of a circular loop for **E**-Plane.

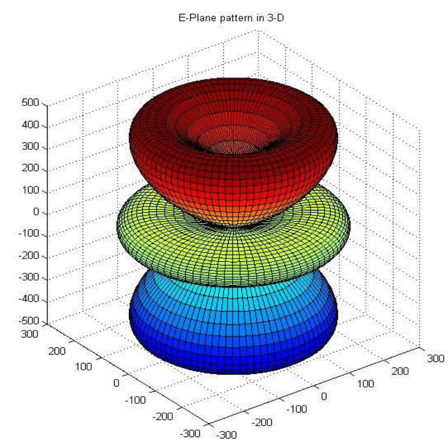

Fig 2.6 3D amplitude patterns of a circular loop for **E**-Plane.

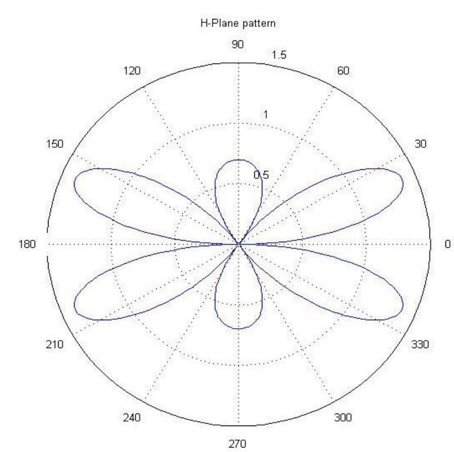

Fig 2.7 2D amplitude patterns of a circular loop for **H**-Plane.

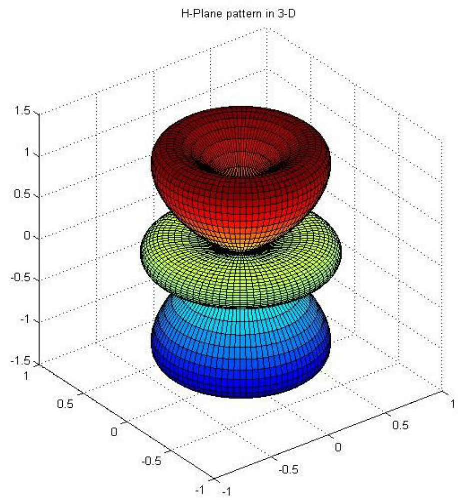

Fig 2.8 3D amplitude patterns of a circular loop for **H-**Plane

2.3 Horn Antenna

One of the simplest and probably the most widely used **microwave antenna** is the horn. The horn is widely used as a feed element for large radio astronomy, satellite tracking, and communication dishes found installed throughout the world. In addition to its utility as a feed for reflectors and lenses, it is a common element of phased arrays and serves as a universal standard for calibration and gain measurements of other high gain antennas. Its widespread applicability stems from its simplicity in construction, ease of excitation, versatility, large gain, and preferred overall performance.

An electromagnetic horn can take many different forms. The horn is nothing more than a hollow pipe of different cross sections, which has been tapered (flared) to a larger opening. The type, direction, and amount of taper (flare) can have a profound effect on the overall performance of the element as a radiator.

2.3.1 E-Plane Sectoral Horn Antenna

E- and **H-**fields associated with the **E-** plane sectoral horn antenna is given as:

E-Plane (φ = π/2)

$E_r = E_\varphi = 0$

$$E_\theta = -j\frac{a\sqrt{\pi k\rho 1}\;E1e^{-jkr}}{8r}\{-e^{j(k\rho 1(\sin\theta/2)^{\wedge}2)}\left(\frac{2}{\pi}\right)^2(1+\cos\theta)F(t_1', t_2')\} \quad (9)$$

$$t_1' = \sqrt{\frac{k}{\pi\rho 1}}(-b1/2 - \rho 1\sin\theta) \quad (10)$$

$$t_2' = \sqrt{\frac{k}{\pi\rho 1}}(+b1/2 - \rho 1\sin\theta) \quad (11)$$

H-Plane ($\emptyset = \mathbf{0}$)

$E_r = E_\theta = 0$

$$E_\varphi = -j\frac{a\sqrt{\pi k\rho 1}\;E1e^{-jkr}}{8r}\{(1+\cos\theta)\left[\cos\left(\frac{ka\sin\theta}{2}\right)/\left(\frac{ka\sin\theta}{2}\right)^2 - \left(\frac{\pi}{2}\right)^2\right]F(t_1'', t_2'')\} \quad (12)$$

$$t_1'' = -b_1/2\sqrt{\frac{k}{\pi\rho 1}} \quad (13)$$

$$t_2'' = +b_2/2\sqrt{\frac{k}{\pi\rho 1}} \quad (14)$$

Directivity of *E*-plane sectoral horn antenna is given as:

$$D_E = \frac{64a\rho 1}{\pi\lambda b_1}\left[C^2\left(\frac{b_1}{\sqrt{2\lambda\rho 1}}\right) + S^2\left(\frac{b_1}{\sqrt{2\lambda\rho 1}}\right)\right] \quad (15)$$

HPBW of *E*-plane sectoral horn antenna is given as:

$$HPBW = b_1{}^2/8\lambda\rho 1 \quad (16)$$

The *E*-plane pattern is much narrower than the *H*-plane because of the flaring and larger dimensions of the horn in that direction.

Amplitude patterns of a **E**- plane sectoral horn for **E**-Plane when frequency=3e10Hz, A1=1cm, B1=2.75cm, A=0.5,B=0.25,R=0.1cm,rho1=6λ

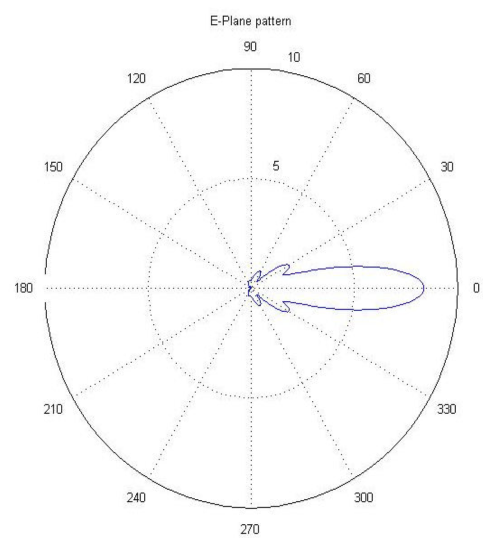

Fig 2.9 2D amplitude patterns of a **E**- plane sectoral horn for **E**-Plane.

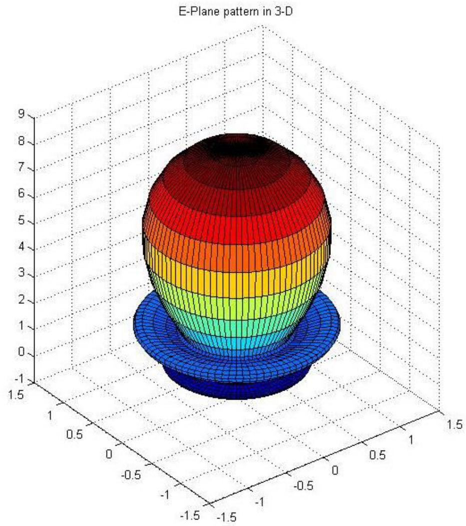

Fig 2.10 3D amplitude patterns of a **E**- plane sectoral horn for **E**-Plane.

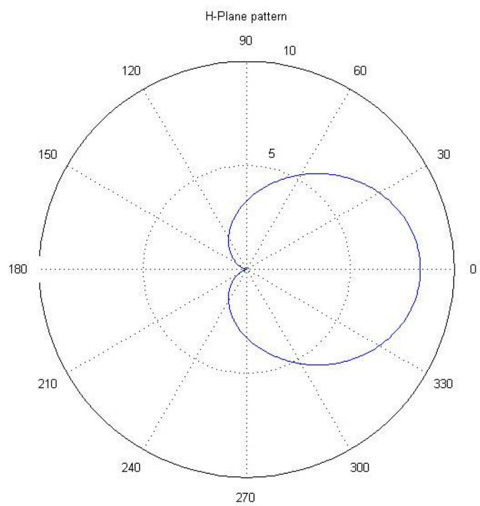

Fig 2.11 2D amplitude patterns of a **E**- plane sectoral horn for **H**-Plane.

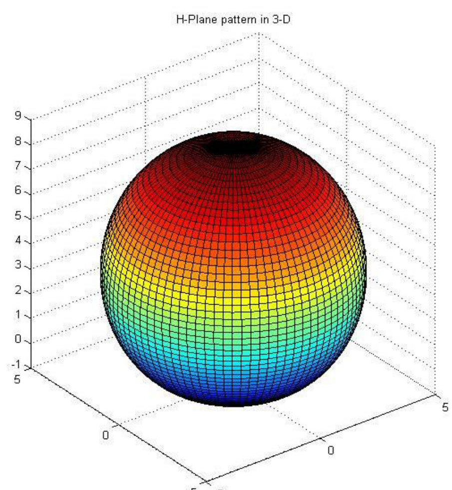

Fig 2.12 3D amplitude patterns of a **E**- plane sectoral horn for **H**-Plane.

2.3.2 H-Plane Sectoral Horn Antenna

E- and **H-**fields associated with the **H**- plane sectoral horn antenna is given as:

E-Plane ($\emptyset = \pi/2$)

$E_r = E_\varphi = 0$

$E_\theta = jE_2 \frac{b}{8}$

$$\sqrt{\frac{k\rho 2}{\pi}} \frac{e^{-jkr}}{r} \{(1+cos\theta) \frac{sinY}{Y} [e^{jf_1} F(t_1', t_2') + e^{jf_2} F(t_1'', t_2'')]\} \quad (17)$$

$$Y = \frac{kb}{2} sin\theta \quad (18)$$

$$k_x' = \frac{\pi}{a_1}$$

$$k_x'' = -\frac{\pi}{a_1}$$

H-Plane ($\emptyset = 0$)

$E_r = E_\theta = 0$

$E_\varphi = jE_2 \frac{b}{8}$

$$\sqrt{\frac{k\rho 2}{\pi}} \frac{e^{-jkr}}{r} \{(1+cos\theta)[e^{jf_1} F(t_1', t_2') + e^{jf_2} F(t_1'', t_2'')]\} \quad (19)$$

Where,

$$k_x' = ksin\theta + \frac{\pi}{a_1}$$

$$k_x'' = ksin\theta - \frac{\pi}{a_1}$$

$$t'_2 = \sqrt{\frac{1}{\pi k\rho 2}} \left(+\frac{ka_1}{2} - k'_x \rho_2\right)$$

$$t'_1 = \sqrt{\frac{1}{\pi k\rho 2}} \left(-\frac{ka_1}{2} - k'_x \rho_2\right)$$

$$t''_1 = \sqrt{\frac{1}{\pi k\rho 2}} \left(-\frac{ka_1}{2} - k''_x \rho_2\right)$$

$$t''_2 = \sqrt{\frac{1}{\pi k\rho 2}} \left(+\frac{ka_1}{2} - k''_x \rho_2\right)$$

Directivity of H-plane sectoral horn antenna is given as:

$$D_E = \frac{4\pi b\rho 2}{\lambda a_1} [[C(u) - C(v)]^2 + [S(u) - S(v)]^2] \quad (20)$$

Where, $u=\frac{1}{\sqrt{2}}\left(\frac{\sqrt{\lambda\rho_2}}{a_1}+\frac{a_1}{\sqrt{\lambda\rho_2}}\right)$, $v=\frac{1}{\sqrt{2}}\left(\frac{\sqrt{\lambda\rho_2}}{a_1}-\frac{a_1}{\sqrt{\lambda\rho_2}}\right)$

HPBW of H-plane sectoral horn antenna is given as:

$$\text{HPBW}=\frac{a_1^2}{8\lambda\rho_2} \qquad (21)$$

Amplitude patterns of a **H**- plane sectoral horn for **E**-Plane when frequency=3e10Hz, A1=1cm, B1=2.75cm, A=0.5,B=0.25,R=0.1cm,rho2=6λ

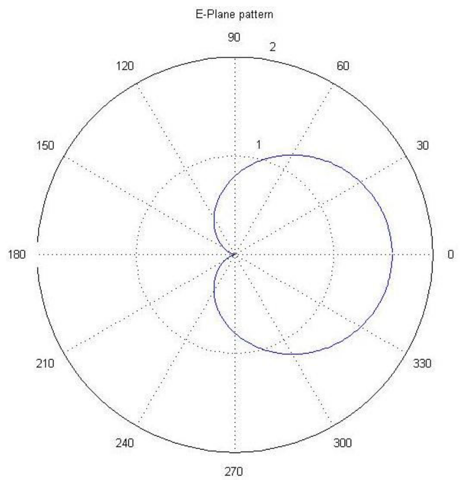

Fig 2.13 2D amplitude patterns of a **H**- plane sectoral horn for **E**-Plane.

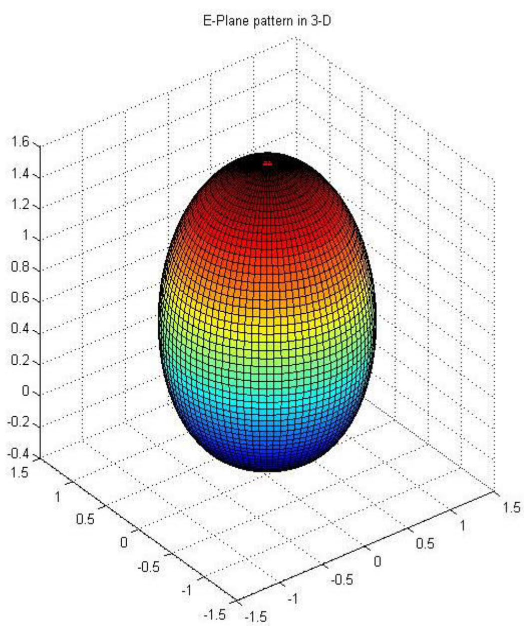

Fig 2.14 3D amplitude patterns of a **H**- plane sectoral horn for **E**-Plane.

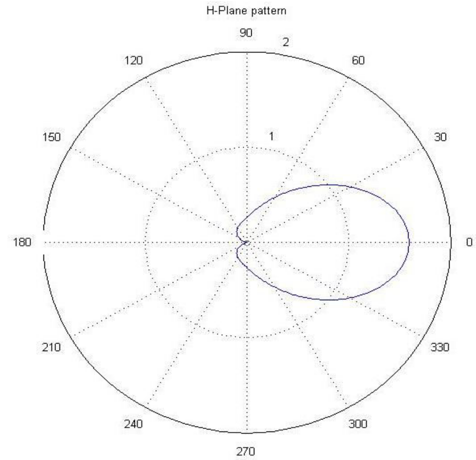

Fig 2.15 2D amplitude patterns of a **H**- plane sectoral horn for **H**-Plane.

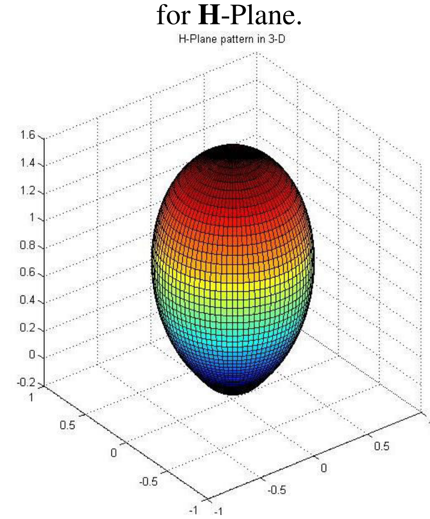

Fig 2.16 3D amplitude patterns of a **H**- plane sectoral horn for **H-**Plane.

2.3.3 Pyramidal Horn Antenna

E- and **H-**fields associated with the Pyramidal horn antenna is given as:

$$E_\theta = jkE_0\frac{e^{-jkr}}{4\pi r}\left[\sin\varphi(1+\cos\theta)I_1I_2\right] \qquad (22)$$

$$E_\varphi = jkE_0\frac{e^{-jkr}}{4\pi r}\left[\cos\varphi(1+\cos\theta)I_1I_2\right] \qquad (23)$$

$$I_1=\frac{1}{2}\sqrt{\frac{\pi\rho_2}{k}}\, e^{j(k'_x\rho_2/2k)}(\{[C(t'_2)-C(t'_1)]-j[S(t'_2)-S(t'_1)]\}+e^{j(k''_x\rho_2/2k)}\{[C(t''_2)-C(t''_1)]-j[S(t''_2)-S(t''_1)]\}) \qquad (24)$$

$$I_2=\sqrt{\frac{\pi\rho_1}{k}}\, e^{j(k^2_y\rho_1/2k)}\{[C(t_2)-C(t_1)]-j[S(t_2)-S(t_1)]\} \qquad (25)$$

Where, $E_o=1$, $\eta=120\pi$

$$t'_1=\sqrt{\frac{1}{\pi k\rho 2}}\left(-\frac{ka_1}{2}-k'_x\rho_2\right)$$

$$t'_2 = \sqrt{\frac{1}{\pi k \rho 2}}\left(+\frac{ka_1}{2} - k'_x \rho_2\right)$$

$$k'_x = k sin\theta cos\varphi + \frac{\pi}{a_1}$$

$$t''_1 = \sqrt{\frac{1}{\pi k \rho 2}}\left(-\frac{ka_1}{2} - k''_x \rho_2\right)$$

$$t''_2 = \sqrt{\frac{1}{\pi k \rho 2}}\left(+\frac{ka_1}{2} - k''_x \rho_2\right)$$

$$k''_x = k sin\theta cos\varphi - \frac{\pi}{a_1}$$

Directivity of pyramidal horn antenna is given as:

$$D_P = \frac{\pi \lambda^2}{32ab} D_E D_H \qquad (26)$$

Amplitude patterns of a pyramidal horn for **E**-Plane when frequency=3e10Hz, A1=12cm, B1=6cm, A=0.5, B=0.25, R=0.01cm, rho1=6λ, rho2=6λ.

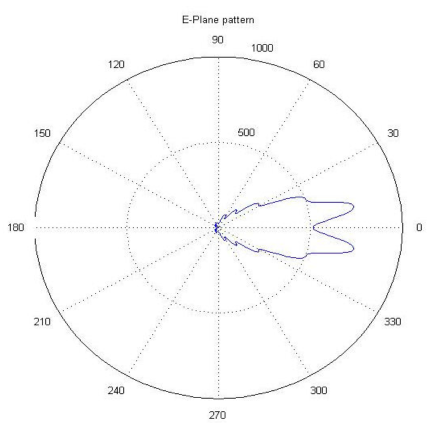

Fig 2.17 2D amplitude patterns of a pyramidal horn for **E**-Plane.

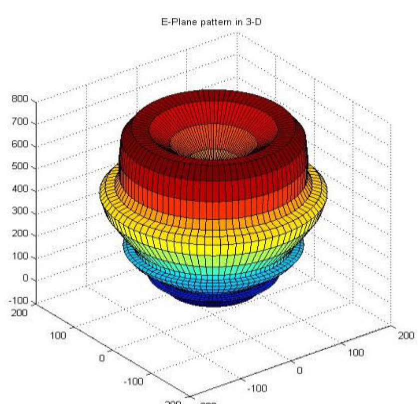

Fig 2.18 3D amplitude patterns of a pyramidal horn for **E**-Plane.

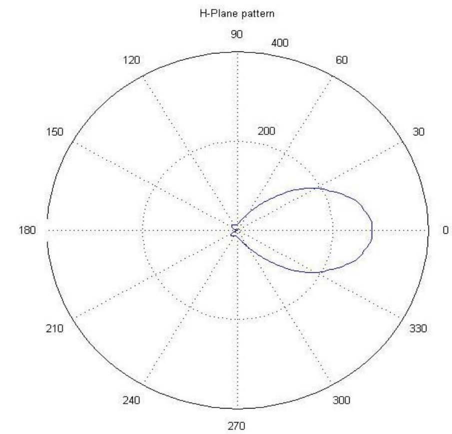

Fig 2.19 2D amplitude patterns of a pyramidal horn for **H**-Plane.

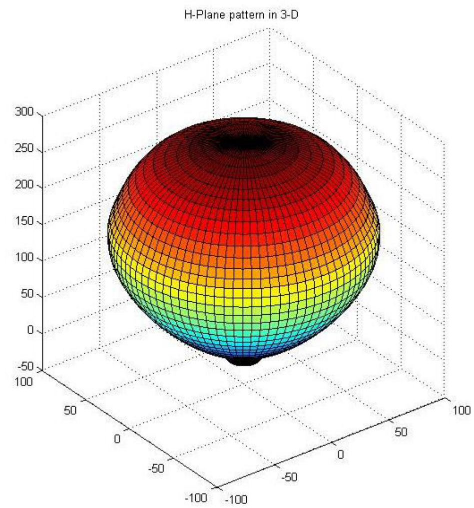

Fig 2.20 3D amplitude patterns of a pyramidal horn for **H**-Plane.

2.4 Helical Antenna

Helical Antenna is a basic simple and practical configuration of an electromagnetic radiator. It is an antenna consisting of a conducting wire wound in the form of a helix. In most cases, helical antennas are mounted over a ground plane. The feed line is connected between the bottom of the helix and the ground plane.

E- and **H-**fields associated with the Helical antenna in end fire mode is given as:

$$E = \sin\left(\frac{\pi}{2N}\right) cos\theta \frac{\sin\left[\left(\frac{N}{2}\right)\psi)\right]}{\sin\left[\frac{\psi}{2}\right]} \qquad (27)$$

Where, $\Psi = k_0 \left(Scos\theta - \frac{L_0}{p}\right)$

$P = \frac{L_0/\lambda_0}{\frac{S}{\lambda_0}+1}$ For ordinary end-fire radiation

$P = \frac{L_0/\lambda_0}{\frac{S}{\lambda_0}+\frac{(2N+1)}{2N}}$ ForHansen-Woodyard end-fire radiation.

HPBW of Helical antenna (end-fire mode) is given by

$$\text{HPBW(degrees)} \simeq \frac{52\lambda_0^{1.5}}{C\sqrt{NS}} \qquad (28)$$

Directivity of Helical antenna (end-fire mode) is given by

$$D_0\text{(dimensionless)} \simeq \frac{15NSC^2}{\lambda_0^3} \qquad (29)$$

Amplitude patterns of a Helical Antenna for **E**-Plane when frequency=3e10Hz, N=10, C=1cm, S=0.231cm

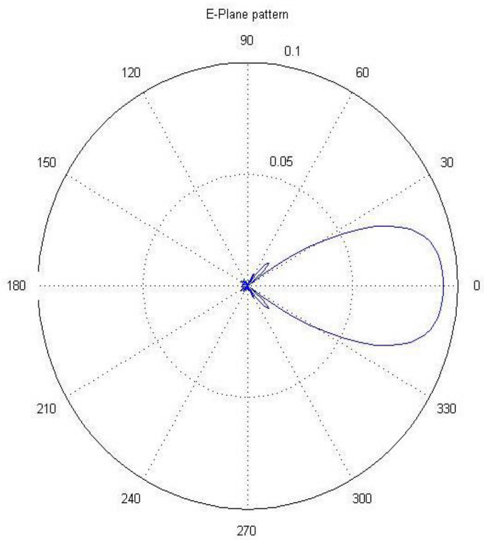

Fig 2.21 2D amplitude patterns of a helical antenna for **E**-Plane.

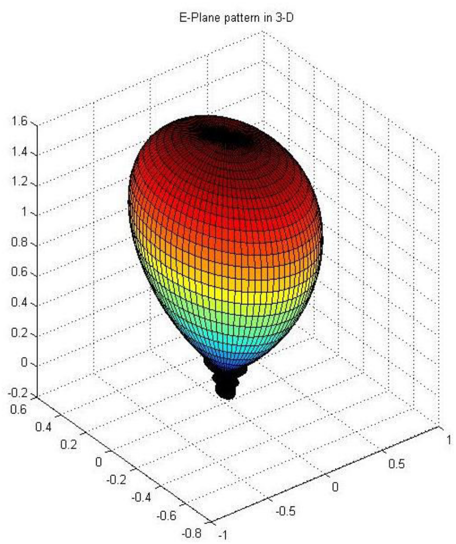

Fig 2.22 **3**D amplitude patterns of a helical antenna for **E**-Plane.

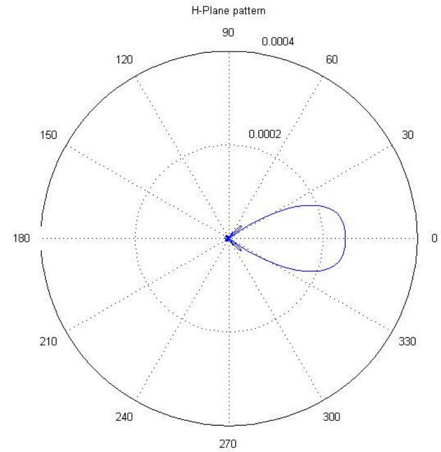

Fig 2.23 2D amplitude patterns of a helical antenna for H-Plane.

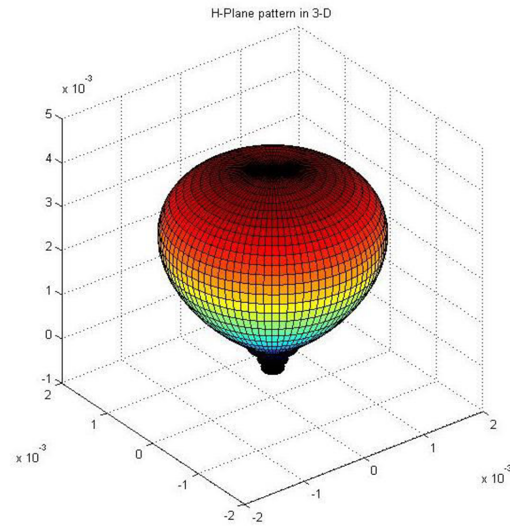

Fig 2.24 3D amplitude patterns of a helical antenna for **H**-Plane.

2.5 Travelling Wave Tube Antenna

Antennas can be designed which have traveling wave (uniform) patterns in current and voltage. This can be achieved by properly terminating the antenna wire so that the reflections are minimized if not completely eliminated. An example of such an antenna is a long wire that runs horizontal to the earth. In general, all antennas whose current and voltage distributions can be represented by one or more traveling waves, usually in the same direction, are referred to as *traveling wave* or *non resonant* antennas.

E- and **H-**fields associated with the **traveling wave antenna** is given as:

$$E \simeq j\eta\frac{klI_0 e^{-jkr}}{4\pi r} e^{-j\left(\frac{kl}{2}\right)(K-\cos\theta)} \sin\theta \frac{\sin[(kl/2)(\cos\theta-K)]}{(kl/2)(\cos\theta-K)} \qquad (30)$$

$$H_\varphi \simeq \frac{E_\theta}{\eta} \qquad (31)$$

Directivity:

$$D_0 = 4\pi U_{max}/P_{rad} = \frac{2cot^2\left[\frac{1}{2}cos^{-1}\left(1-\frac{0.371\lambda}{l}\right)\right]}{1.415+\ln\left(\frac{2l}{\lambda}\right)-C_i\,(2kl)+\frac{\sin\,(2kl)}{2kl}} \qquad (32)$$

Two and Three-dimensional amplitude patterns of traveling wave antenna for **E**-Plane when frequency=3e10Hz, L=5cm, K=1, R=1cm.

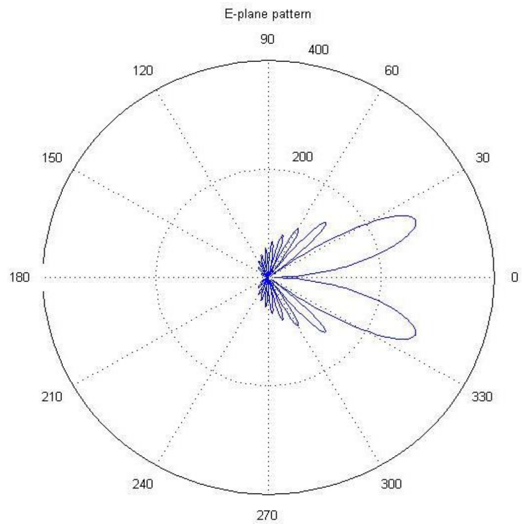

Fig 2.25 2D amplitude patterns of a TWT antenna for **E**-Plane.

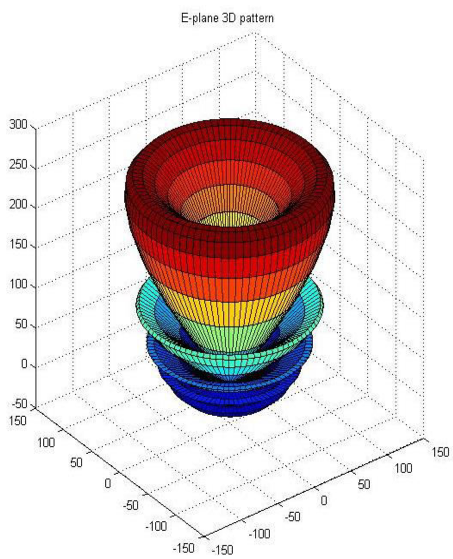

Fig 2.26 3D amplitude patterns of a TWT antenna for **E**-Plane.

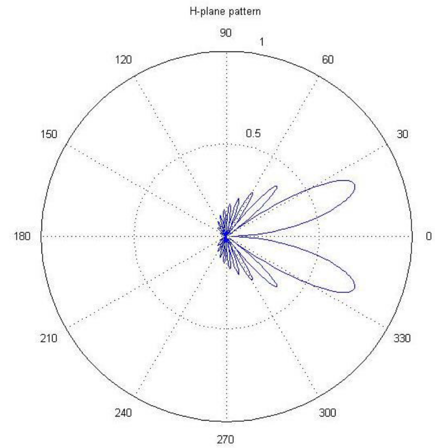

Fig 2.27 2D amplitude patterns of a TWT antenna for **H**-Plane.

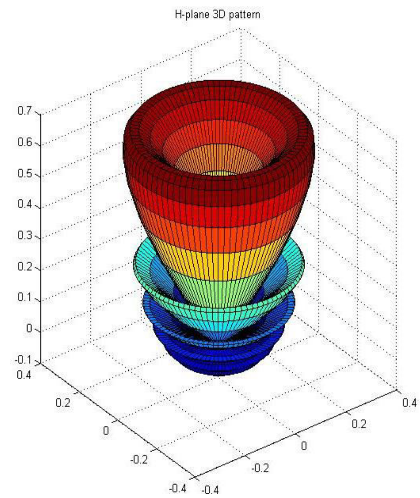

Fig 2.28 3D amplitude patterns of a TWT antenna for **H**-Plane.

2.6 Rectangular Aperture Antenna

It is probably the most common microwave antenna because of its configuration, the rectangular coordinate system is the most convenient system to express the fields at the aperture and to perform the integration. The three most common and convenient coordinate positions used for the solution of an aperture antenna.

E- and **H-**fields associated with the **rectangular aperture antenna** is given as:

E-plane ($\varphi = \frac{\pi}{2}$)

$E_r = E_\varphi = 0$

$$E_\theta = \frac{jabkE_0\,e^{-jkr}}{2\pi r}\left[\frac{\sin\left(\frac{kb}{2}sin\theta\right)}{\frac{kb}{2}sin\theta}\right] \qquad (33)$$

H-plane ($\varphi = 0$)

$E_r = E_\theta = 0$

$$E_\varphi = \frac{jabkE_0\,e^{-jkr}}{2\pi r}\left[cos\theta\,\frac{\sin\left(\frac{ka}{2}sin\theta\right)}{\frac{ka}{2}sin\theta}\right] \qquad (34)$$

Half-power beam width (degrees):

$$HPBW = \frac{50.6}{\frac{b}{\lambda}} \quad (35)$$

Directivity:

$$D_0 = 4\pi\left(\frac{ab}{\lambda^2}\right) \quad (36)$$

Amplitude patterns of a aperture antenna for **E**-Plane when frequency=3e10Hz, A=3cm, B=2cm, R=0.01cm.

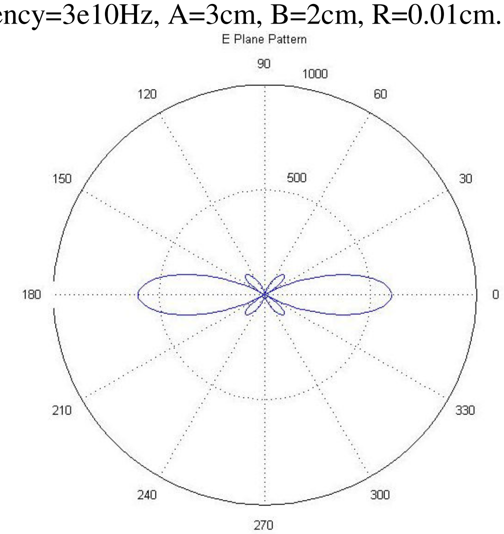

Fig 2.29 2D amplitude patterns of a rectangular aperture antenna for **E**-Plane.

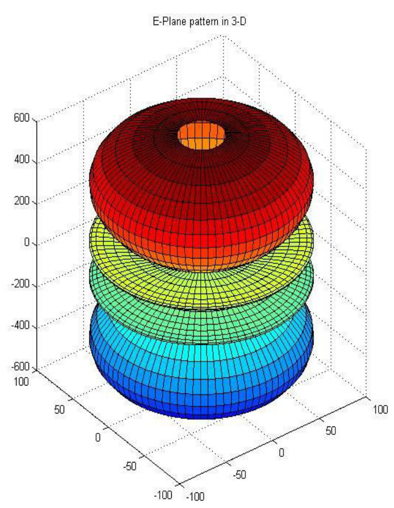

Fig 2.30 3D amplitude patterns of a rectangular aperture antenna for **E**-Plane.

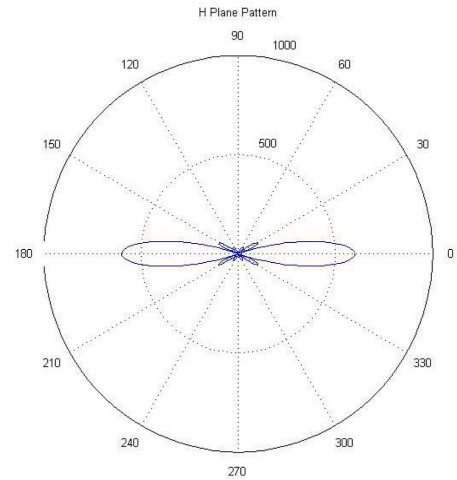

Fig 2.31 2D amplitude patterns of a rectangular aperture antenna for **H**-Plane.

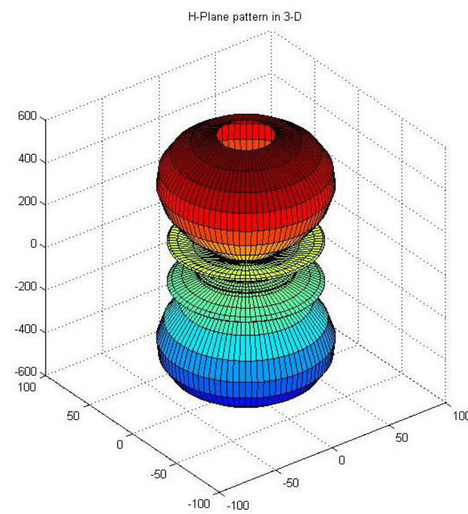

Fig 2.32 3D amplitude patterns of a rectangular aperture antenna for H-Plane.

2.7 Micro-Strip Antenna

In high-performance aircraft, spacecraft, satellite, and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints, low-profile antennas may be required. Presently there are many other government and commercial applications, such as mobile radio and wireless communications that have similar specifications. To meet these requirements, micro strip antennas can be used. These antennas are low profile, conformable to planar and non planar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces and when the particular patch shape and mode are selected, they are very versatile in terms of resonant frequency, polarization, pattern, and impedance. Major operational disadvantages of micro-strip antennas are their low efficiency, low power, poor polarization purity, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent.

The effective dielectric constant is defined *as the dielectric constant of the uniform dielectric material.* For a line with air above the substrate, the effective dielectric constant has values in the range of $1 < \epsilon_{\mathrm{reff}} < \epsilon_r$. For most applications where the dielectric constant of the substrate is much greater than unity $(\epsilon_r \gg 1)$., the value of *I*reff will be closer to the value of the actual dielectric constant ϵ_r of the substrate. For low frequencies the effective dielectric constant is essentially constant.

$$\varepsilon_{\mathrm{reff}} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-0.5} \quad (37)$$

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{\mathrm{reff}} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{\mathrm{reff}} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (38)$$

$$L_{\mathrm{eff}} = L + 2\Delta L \quad (39)$$

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r + 1}} = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (40)$$

$$L = \frac{1}{2f_r\sqrt{\varepsilon_{\mathrm{reff}}}\sqrt{\mu_0\varepsilon_0}} - 2\Delta L \quad (41)$$

$$\boldsymbol{E - Plane}(\theta = 90^0, 0^0 \le \phi \le 90^0 \ \boldsymbol{and}\ 270^0 \le \phi \le 360^0)$$

$$E^t_\phi = j\frac{k_o W V_0 e^{-jk_o r}}{\pi r}\left\{\frac{\sin\left(\frac{k_o h}{2}\cos\phi\right)}{\left(\frac{k_o h}{2}\cos\phi\right)}\right\}\cos\left(\frac{k_o L_e}{2}\sin\phi\right) \quad (42)$$

$$\boldsymbol{H - Plane}(\phi = 0^0, 0^0 \le \theta \le 180^0)$$

$$E^t_\phi \approx j\frac{k_o W V_0 e^{-jk_o r}}{\pi r}\left\{\sin\theta\frac{\sin\left(\frac{k_o h}{2}\sin\theta\right)}{\left(\frac{k_o h}{2}\sin\theta\right)}\frac{\sin\left(\frac{k_o W}{2}\cos\theta\right)}{\left(\frac{k_o W}{2}\cos\theta\right)}\right\} \quad (43)$$

Amplitude patterns of a micro-strip antenna for **E**-Plane frequency=1e10Hz, E_r=2.2, H=0.1588cm.

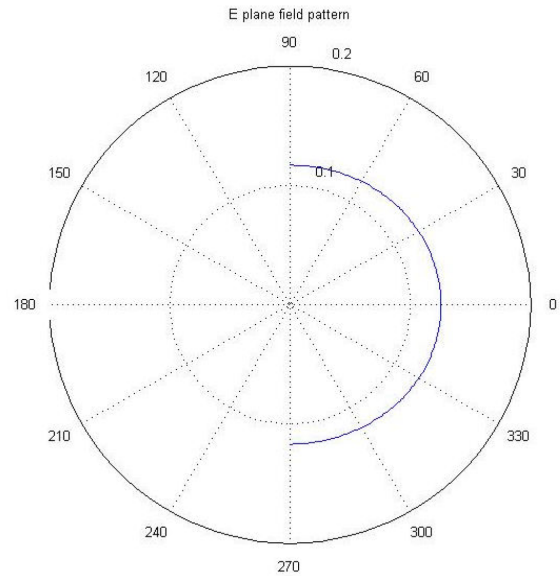

Fig 2.33 2D amplitude patterns of a Micro-strip antenna for **E**-Plane.

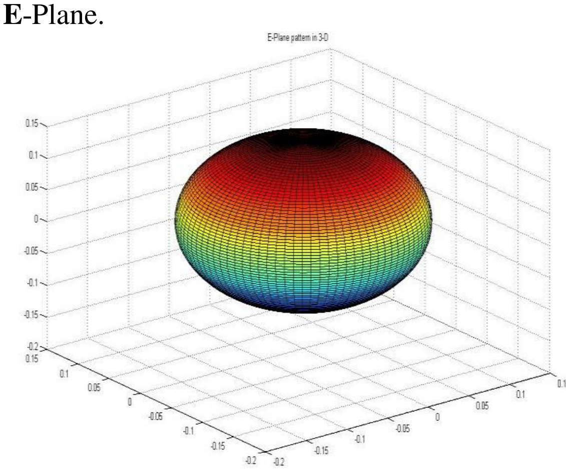

Fig 2.34 3D amplitude patterns of a Micro-strip antenna for **E**-Plane.

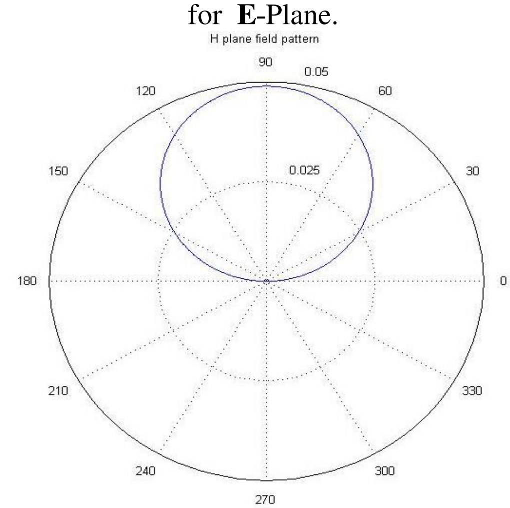

Fig 2.35 2D amplitude patterns of a Micro-strip antenna for **H**-Plane.

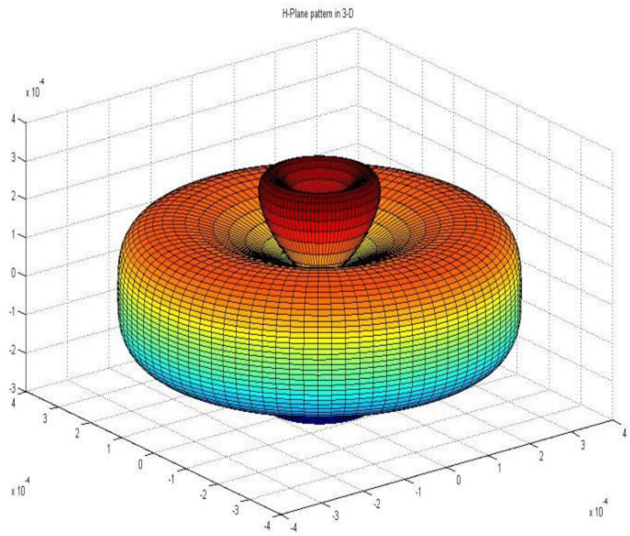

Fig 2.36 3D amplitude patterns of a Micro-strip antenna for H-Plane.

3. CONCLUSION

A novel approach for designing of Antennas is presented in this project. A user friendly GUI (Graphical User Interface) is designed for this project. The working of antenna was understood. The major parameters (such as Radiation Patterns and beam width) that affect design and application were studied.

This software finds its vast application in the research field. It is of great use for the RF engineers. It can be used to choose between the different antennas for a particular application. It can also be used to design some new and specified type of antennas as well as the new arrays, if the directivity and radiation intensity is given than by using these data we can tell the size of antenna and various other parameters.

By using this software we can find out which antenna will work better in a particular geographical area and which antenna will work with clusters. One can also perform comparisons with different types of antennas that are designed in this project.

The results that I have got is based on the calculations and software only, these results can be checked with implementing hardware for a particular antenna. We can also create a whole system for communication by the help of this software. We can transmit a wave, receive it and check errors. The comparison of the antenna for a particular application can be done in future to select the best one out of the designed antennas.

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