EXPERIMENT N0. 01

Objective: Measurement of Antenna Gain and Plotting the Polar Plot on Graph Paper

Equipment Required: Antenna Trainer with connecting cables, 5- Element Yagi- Uda antenna, dipole antenna.

Theory:

The ability of an antenna to focus radio frequency (RF) energy, either sent or received, in a specific direction relative to an ideal isotropic radiator is known as antenna gain. Antenna Gain is calculated by using the formula: Antenna Gain = 10 × log10 (Pout/Pin) where Pout is the radiated power in a specific direction (usually in watts) and Pin is the power supplied to the antenna (also in watts). Determine the power radiated by the antenna in the direction of interest. This can be done experimentally using specialized equipment such as a power meter or by simulation using antenna modelling software. The result of the calculation will give us result in the gain in decibels relative to an isotropic radiator (dBi).

What is Antenna Gain?

Antenna gain is defined as the degree of directivity of the antenna's radiation pattern. It is equal to the product of the antenna's electrical efficiency and directivity. In other words, it is a passive phenomenon in which the antenna simply redistributes power to produce more radiated power in a specific direction than an isotropic antenna would broadcast. A transmitting antenna can acquire antenna gain by making an antenna directional, that is, with superior performance in one direction than in others. The antenna gain is denoted by the symbol GdB, and its unit of measurement is decibels (dB). It is directly proportional to the aperture area, efficiency, and wavelength of the signal.

Antenna gain Formula.

GdB = 10 log10 (4πηA/λ2)

Where,

- GdB is the antenna gain,
- η is the efficiency,
- A is the physical aperture area,

- λ is the wavelength of the signal.

Procedure:

Gain measurement of an Antenna is done as follows:

1) Connect the Log Periodic to the Transmitter after fixing it on the Antenna stand.
2) Connect the Dipole Antenna to the Receiver after fixing it to the Antenna Rotator.
3) Now adjust the Dipole for maximum signal strength reading on the display.
4) Note down the reading 'say' 80 dBuV
5) Now without disturbing the setup remove the dipole and fix and connect the Antenna whose gain is to be tested in the same place as the dipole.
6) Readjust the rotator slightly and adjust for maximum dB reading on the display.
7) Note down the reading 'say'83.2dBuV.
8) The Gain of the Antenna under test is now determined as follows.
9) (dBuv of AUT-dBuV of dipole) + 2.16dB) dBi

   (83.2 dBuV-80dBuV) + 2.16dB=5.32 dBi (Isotropic gain of the Antenna)

   Isotropic gain of a Dipole as per theory is +2.16dBi

Hence using the dipole as reference, we compute the gain of the Antenna under Test.

Plotting the Polar Plot on Graph Paper done as follows:

1) Take down the 72 readings stored as per the Experiment, on paper. (The 0 deg Reading will be maximum if the initial setting for the experiment is done properly.If this is not so then repeat the experiment by reorienting the antenna with the rotator at 0 degs and rotate the base for maximum reading of signal strength. Then retake all the 72 reading once more and save them.)
2) Now take the 0 deg reading. 'say 85 dBuV. We shall consider this as the Reference reading and call it 0 dB.
3) Next subtract the 5 deg reading from the 0 deg reading. the 5 deg reading is 'say 83.4 dBuV. Hence the Reference 5 deg reading will be 85-83.4 = 1.6 Db. Please note that since the 5 deg reading is less than the reference we denote it as -1.6 dB. We do not note it as -1.6 dBuV since difference of identical units leave only the absolute difference in dB.
4) Similarly subtract all the other readings, a total of 71 each individually from the reference reading.
5) Now plot these readings on the Graph paper provided. Join all the dots to get the polar plot curve.

Result & Analysis:

Questions:

1. Calculate the antenna gain if the aperture area is 4 sq. m, the wavelength is 0.01 m, and the efficiency is 40%.
2. Calculate the antenna gain if the aperture area is 20 sq. m, the wavelength is 2 m, and the efficiency is 80%.

Conclusion:

EXPERIMENT N0. 02

Objective: Design & Analysis of Monopole & Dipole antenna performance using simulation software 4NEC2.

Simulation Software: - 4NEC2

Theory:

Dipole antennas have been widely used since the early days of radio. Simplicity and effectiveness for a wide range of communication needs are the reason for this. The dipole gets its name from its 2 halves – one on each side of its center as in Figure 1. These poles are symmetrical and made of wire.

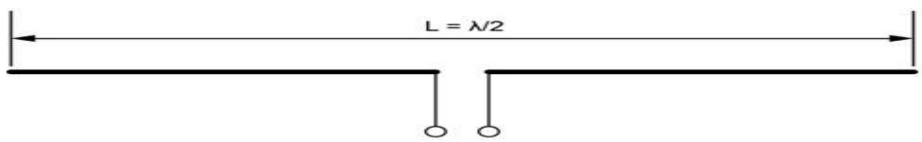


Figure 1. Dipole antenna

The monopole antenna was invented in 1895 by radio pioneer Guglielmo Marconi, who discovered it when he attached one terminal of his transmitter to a long wire suspended in the air and the other to the Earth, he could transmit for longer distances. A monopole can be visualized as being formed by replacing the bottom half of a vertical dipole antenna with a conducting plane (ground plane) at right angles to the remaining half as in Figure 2.

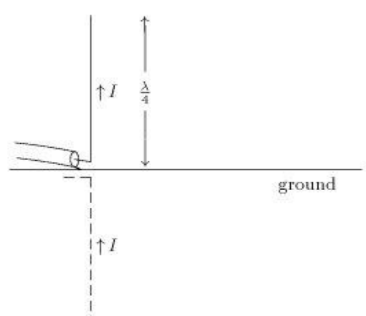


Figure 2. Monopole antenna

Problem Statement – 1:

Design of center fed dipole antenna for 300 MHz.

Calculations -1:

Problem Statement – 2:

Design of grounded monopole antenna for 300 Mhz.

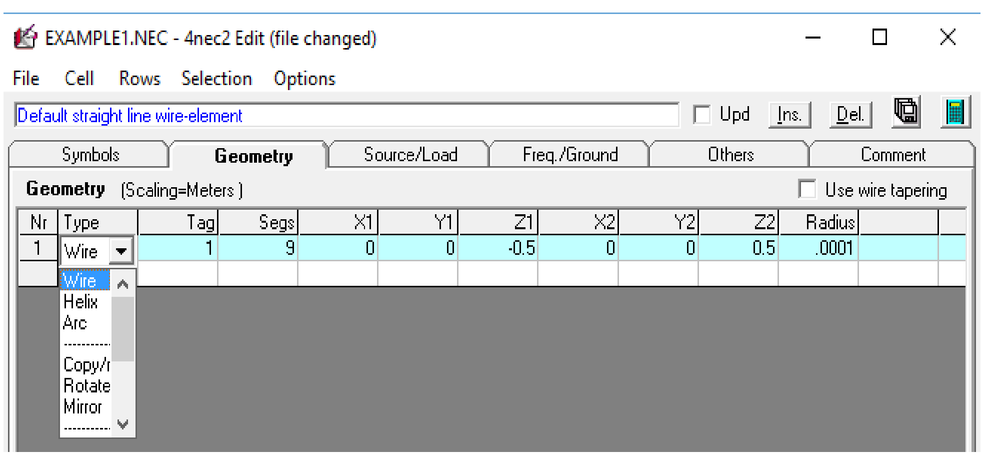
Calculations -1:

Procedure:

1.Calculate the wavelength for a frequency of 300 MHz and hence the length of dipole

2. Now enter the respective (x1,x2),(y1,y2),(z1,z2) co-ordinates of the respective wire element as shown in figure above.

NOTE - All length values in NEC file are always reads in meters.

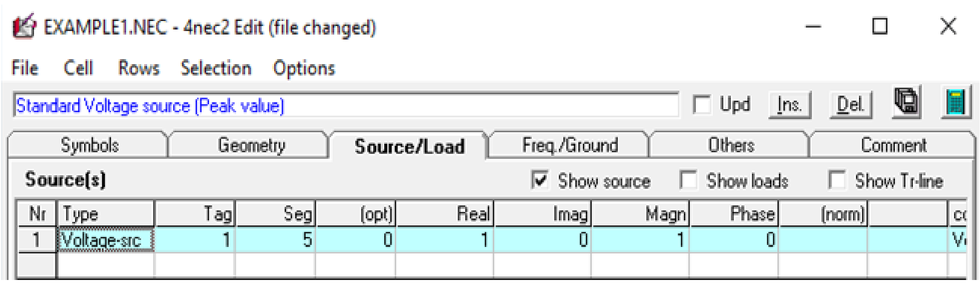


3. Under Source/load :

a) Select type= voltage-src(voltage is the type of source for antenna.)

b) Tag=1 (as it is no. given to dipole antenna in geometry section)

c) Seg=5 (It is always odd no. We have to connect voltage source at the middle of antenna i.e. the source should be at 9/2 =4.5 .ie means source is connected at segment 5 of the antenna which satisfy symmetry of radiation pattern above and below the source)



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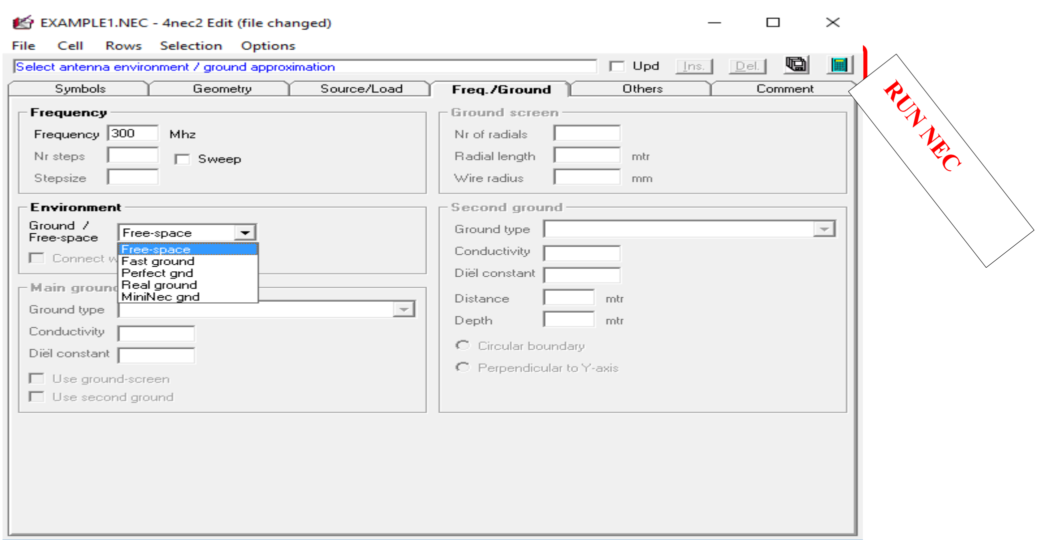
4. Frequency / Gnd

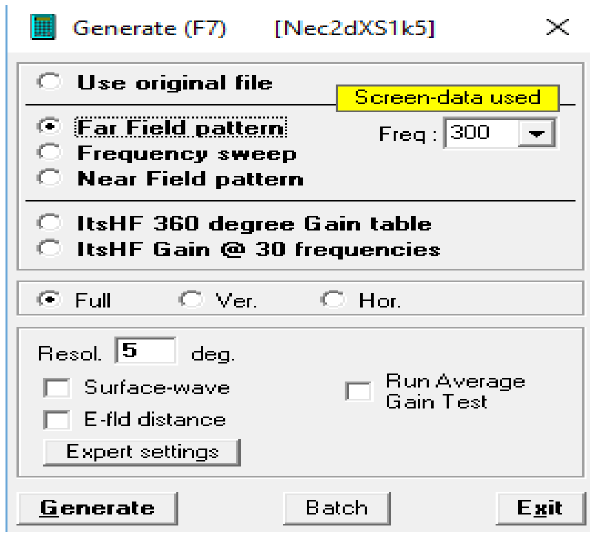
a) Frequency> select Frequency=300Mhz (input signal frequency)

b) Environment> select Ground/Free-space=Free-space.

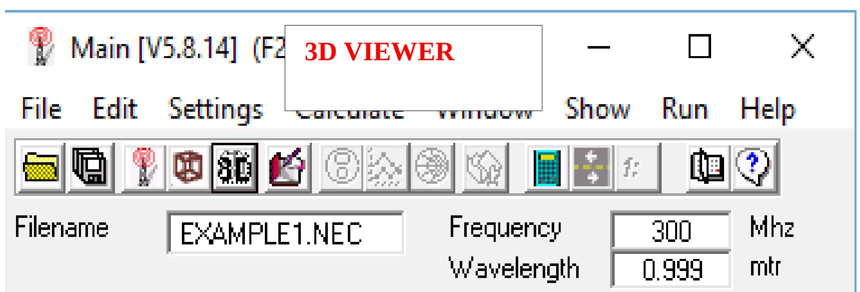
c) Then Click on Run Nec.



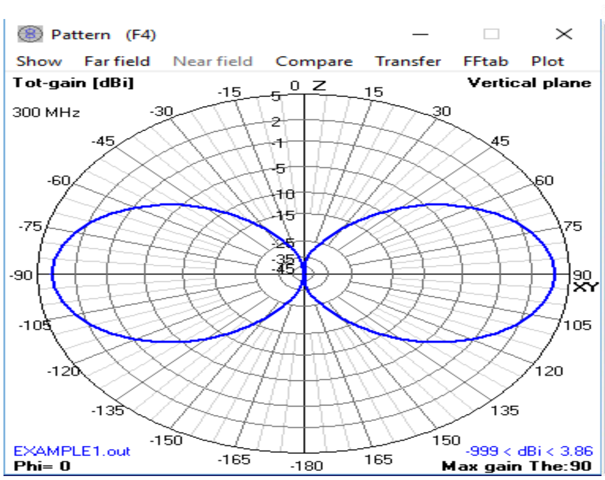
5. We get the Generate window on screen. Select Far Field pattern and click on Generate.

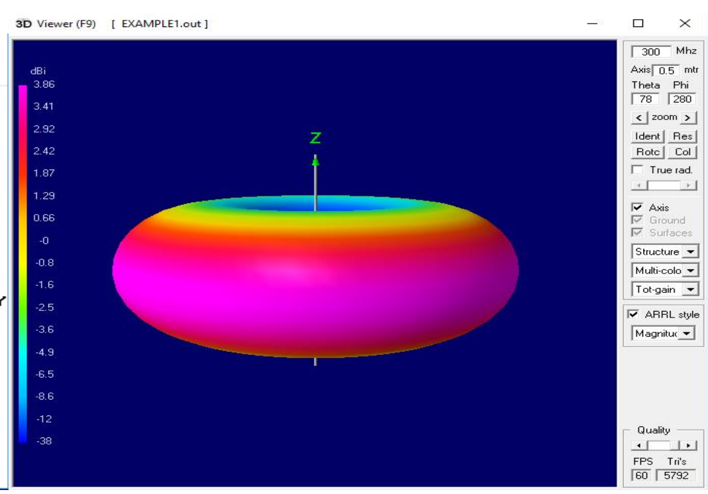


The output is generated and we get a 2D plot of the radiation pattern. In the Main window click on 3D viewer to observe radiation pattern in 3dimension.



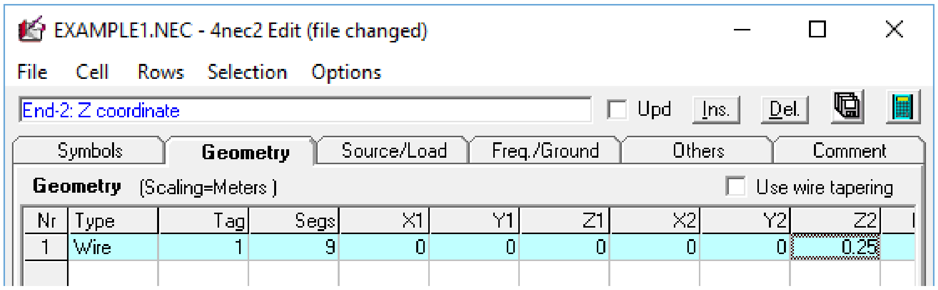
The following window is generated.

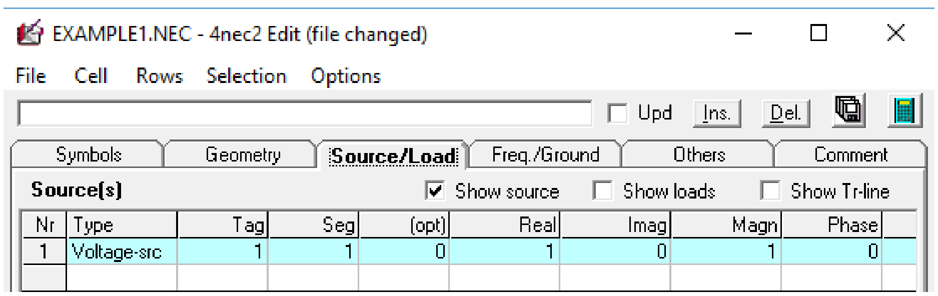




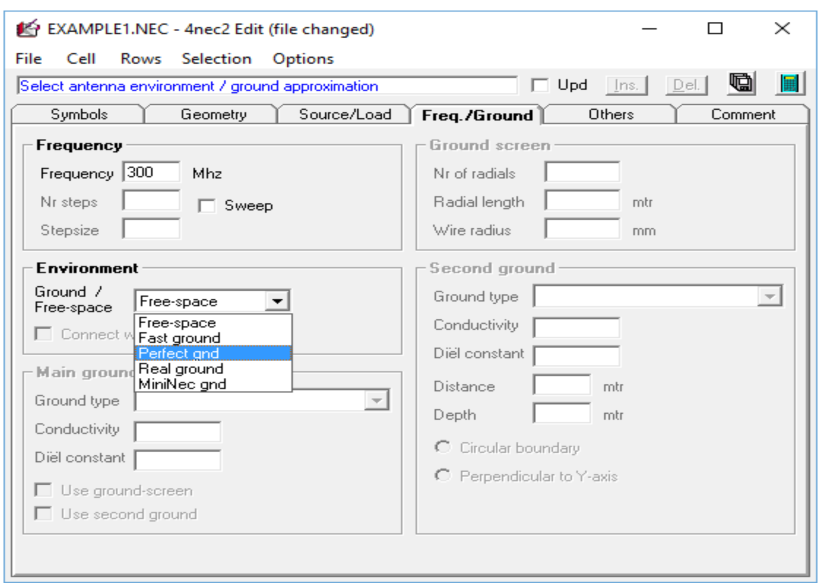
Also observe current distribution on wire antenna by changing the output parameters.

6. Same as Dipole antenna. Only change is in the length of antenna as length of monopole antenna. Therefore if antenna is place in z-direction then (z1,z2)=(0,0.25) and other components are zero.





Under Freq./Ground : Environment>Ground/Free-space>select Perfect gnd.



7. Now change the length of antenna such that it is equal to $3\lambda/2$, $5\lambda/2$ at 300 Mhz. View the radiation pattern in 2D and 3D. Comment on the variation in directivity and beamwidth.

Result & Analysis:

Questions:

1. What are the applications of dipole antenna?
2. Draw current distribution for dipole antenna of length $\lambda/2$, $3\lambda/2$
3. What is the frequency range of a dipole antenna?

Conclusion:

EXPERIMENT NO. 03

Objective: Simulation of Yagi-Uda antenna & study of its parameters using simulation software 4NEC2.

Simulation Software: - 4NEC2

Theory:

A Yagi-Uda antenna is a linear array of parallel dipoles. One element is energized directly by a feed transmission line with the others acting as parasitic radiators. The function of these elements is to enhance the radiation pattern in the source direction. Generally, the reflector will be 5% longer than the driven element (i.e. dipole) and the directors will be 5% shorter as shown in Figure 1. Optimization of the Yagi-Uda antenna can be achieved by simulating the radiation patterns for various length of the elements and the spacing between them.

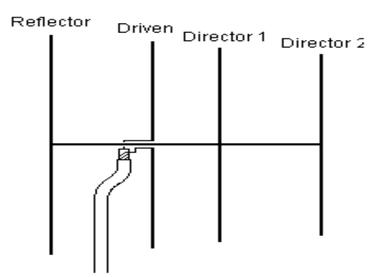


Figure 1: Dipole driven Yagi Antenna

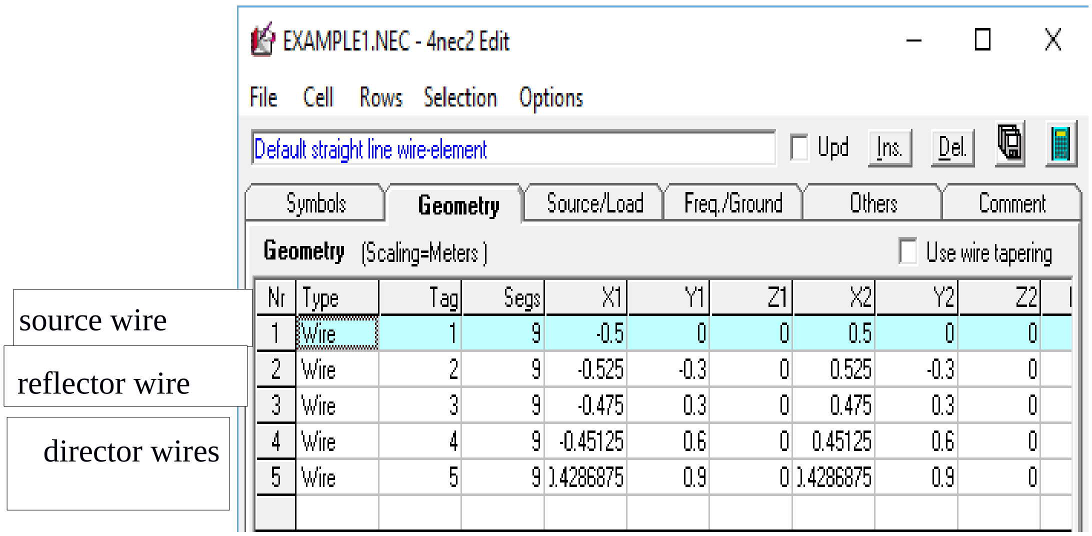
Problem Statement – 1:

Simulate a 5-element Yagi-Uda antenna for a frequency of 300 MHz using 4NEC2.

Calculation:

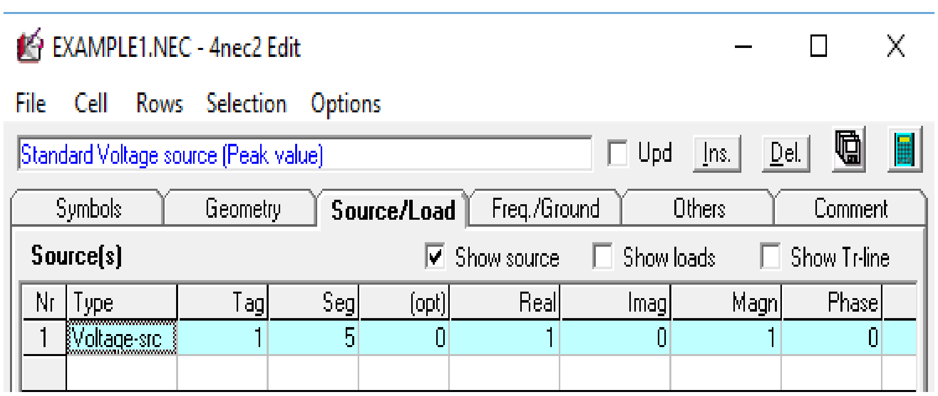
Procedure:

1. Calculate the wavelength for a frequency of 300 MHz and hence the lengths of feeder, reflectors and directors.
2. As in Yagi-Uda antenna normally there are 3 directors ,1 source and 1 reflector wire. Thus select 5 wires for respectively under Geometry.



Nr	Type	Tag	Segs	X1	Y1	Z1	X2	Y2	Z2
1	Wire	1	9	-0.5	0	0	0.5	0	0
2	Wire	2	9	-0.525	-0.3	0	0.525	-0.3	0
3	Wire	3	9	-0.475	0.3	0	0.475	0.3	0
4	Wire	4	9	-0.45125	0.6	0	0.45125	0.6	0
5	Wire	5	9	).4286875	0.9	0	).4286875	0.9	0

3. Now enter the respective (x1,x2),(y1,y2),(z1,z2) co-ordinates of the respective wire element as shown in figure above.
4. Under Source/Load: Connect voltage source to the wire1(tag1 is no. given to wire 1) at the center (seg5) of the segment (as wire 1 is divided into 9 elements).



Nr	Type	Tag	Seg	(opt)	Real	Imag	Magn	Phase
1	Voltage-src	1	5	0	1	0	1	0

5. Do a frequency sweep from 0 to 1 GHz and observe the SWR. Comment on the results.
6. Now add 1 reflector to the original design and observe the aforesaid parameters. Repeat after adding 1 director and then after adding both: a reflector and a director. Comment on your observations.

Result & Analysis:

Questions:

1. What is the frequency of Yagi-Uda antenna?
2. Why mostly folded dipole antenna is used as driven element in Yagi Uda antenna?
3. Comment on effect of no of directors on directivity.

Conclusion:

EXPERIMENT NO.04

Objective: Simulation of Helix antenna & study of its parameters using simulation software 4NEC2.

Simulation Software: - 4NEC2

Theory:

The most popular helical antenna (helix) is a travelling wave antenna in the shape of a corkscrew that produces radiation along the axis of the helix antenna. These helix antennas are referred to as axial-mode helical antennas. The benefits of this helix antenna is it has a wide bandwidth, is easily constructed, has a real input impedance, and can produce circularly polarized fields. The basic geometry of the helix antenna shown in Figure 1.

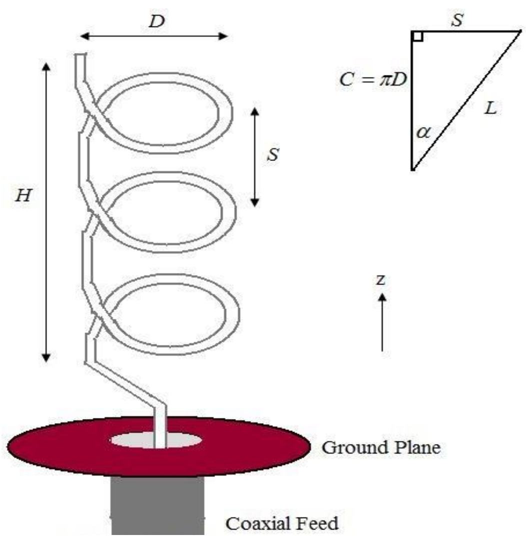


Figure 1. Geometry of Helical Antenna. [https://rb.gy/cv4v6a]

The parameters of the helix antenna are defined below.

D - Diameter of a turn on the helix antenna.

C - Circumference of a turn on the helix antenna (C=pi*D).

S - Vertical separation between turns for helical antenna.

α - pitch angle, which controls how far the helix antenna grows in the z-direction per turn, and is given by.

$$\alpha = \tan^{-1}\frac{S}{C}$$

N - Number of turns on the helix antenna.

H - Total height of helix antenna, H=NS.

The antenna in Figure 1 is a left-handed helix antenna, because if you curl your fingers on your left hand around the helix your thumb would point up (also, the waves emitted from this helix antenna are Left Hand Circularly Polarized). If the helix antenna was wound the other way, it would be a right-handed helical antenna.

The radiation pattern will be maximum in the +z direction (along the helical axis in Figure 1). The design of helical antennas is primarily based on empirical results, and the fundamental equations will be presented here.

Helix antennas of at least 3 turns will have close to circular polarization in the +z direction when the circumference *C* is close to a wavelength:

$$\frac{3\lambda}{4} \leq C \leq \frac{4\lambda}{3}$$

Once the circumference *C* is chosen, the inequalities above roughly determine the operating bandwidth of the helix antenna. For instance, if *C*=19.68 inches (0.5 meters), then the highest frequency of operation will be given by the smallest wavelength that fits into the above equation, or λ =0.75*C*=0.375 meters, which corresponds to a frequency of 800 MHz. The lowest frequency of operation will be given by the largest wavelength that fits into the above equation, or λ =1.333*C*=0.667 meters, which corresponds to a frequency of 450 MHz. Hence, the fractional BW is 56%, which is true of axial helical antennas in general.

The helix antenna is a travelling wave antenna, which means the current travels along the antenna and the phase varies continuously. In addition, the input impedance is primarily real and can be approximated in Ohms by:

$$Z_{in} = 140\frac{C}{\lambda}$$

The helix antenna functions well for pitch angles (α) between 12 and 14 degrees. Typically, the pitch angle is taken as 13 degrees.

The normalized radiation pattern for the E-field components is given by:

$$E_\theta \propto E_\phi \propto \sin\frac{\pi}{2N}\cos\theta\frac{\sin\frac{N\Omega}{2}}{\sin(\Omega/2)}$$

$$\Omega = kS(\cos\theta - 1) - \pi(2 + 1/N)$$

For circular polarization, the orthogonal components of the E-field must be 90 degrees out of phase. This occurs in directions near the axis (z-axis in Figure 1) of the helix. The axial ratio for helix antennas decreases as the number of loops *N* is added, and can be approximated by:

$$AR = \frac{2N+1}{2N}$$

The gain of the helix antenna can be approximated by:

$$G = \frac{6.2C^2NS}{\lambda^3} = \frac{6.2C^2NSf^3}{c^3}$$

In the above, *c* is the speed of light. Note that for a given helix geometry (specified in terms of *C, S, N*), the gain increases with frequency.

The Half-Power Beamwidth for helical antennas can be approximated (in degrees) by:

$$HPBW = \frac{65\lambda}{C\sqrt{\frac{NS}{\lambda}}}$$

<u>Problem Statement – 1:</u>

Simulate a helix antenna for a frequency of 300 MHz with axial length 3λ and spacing between the turns 0.25 λ using 4NEC2.

Procedure:

1. Calculate the wavelength for a frequency of 300 MHz and hence the length of helix.

2. In Geometry section select for Helix and give the dimensions of spacing, Length, radius of turn and helix wire as well as no. of segments.

3. Under Source/load:
   a. Select type= voltage-src(voltage is the type of source for antenna.)
   b. Tag=1 (as it is no. given to helix antenna in geometry section)
   c. Seg=5 (slightly above ground)
4. 4. Frequency / Gnd
   i. Frequency> select Frequency=300Mhz (input signal frequency)
   ii. Environment> select Ground/Free-space=Free-space.
   iii. Then Click on Run Nec.

Result & Analysis:

Questions:

1. Which kind of polarization is provided by helical antennas?
2. What is the range of helix antenna?
3. What are the two modes of operation of helical antenna?

Conclusion:

EXPERIMENT NO.05

Objective: To plot and analyse the radiation pattern of an End-fire array for different values of spacing between elements, progressive phase shift and no. of sources and using MATLAB.

Simulation Software: - MATLAB

Theory:

An array is said to be end fire array if the phase angle is such that it makes maximum radiation in the direction of line of array i.e. 0°& 180°.The dipoles in an end-fire array are closer together (1/8-wavelength to 1/4-wavelength spacing) than they are for a broadside array. Closer spacing between elements permits compactness of construction. For this reason an end-fire array is preferred to other arrays when high gain or sharp directivity is desired in a confined space. However, the close coupling creates certain disadvantages. Radiation resistance is extremely low, sometimes as low as 10 ohms, making antenna losses greater. The end-fire array is confined to a single frequency. With changes in climatic or atmospheric conditions, the danger of detuning exists.

Program:

```
clc
close all
clear all
phi=0:.1:2*pi;
c=3*(10^8);
f=input('enter frequency of signal:');
l=c/f;
D=input('enter the distance between two antennas:');
B=2*pi/l
Dr=B*D
d=input('give value of d:');
n=input('enter no. of point sources:')
si=abs(Dr*cos(phi)+d);
Eo=abs((sin(n*si/2))./sin(si/2));
polar(phi,Eo)
```

Result & Analysis:

Output:

Input parameters:

enter frequency of signal:1e9

enter the distance between two antennas'/2

B =20.9440 Dr =3.1416

give value of d:-Dr

enter no. of point sources:4

Output:

n =4

Field Pattern:

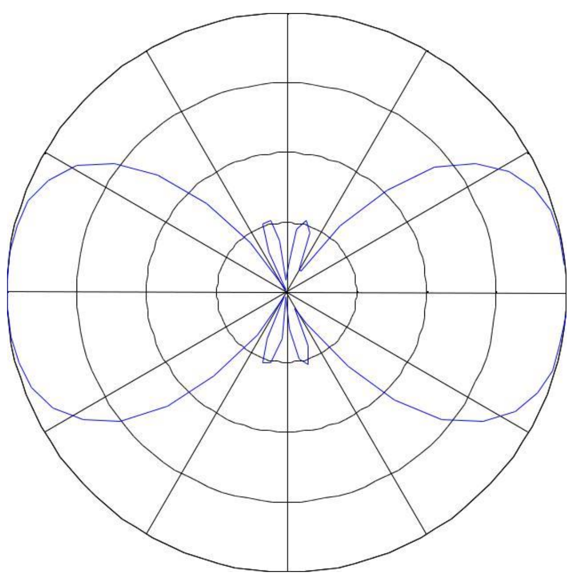


Fig.1 Radiation pattern of End fire array

Questions:

1. What is the principal direction of radiation in end-fire array?
2. What is the advantage of end fire array antenna?

Conclusion:

EXPERIMENT NO.06

Objective: To plot and analyse the radiation pattern of a Broadside array for different values of spacing between elements and no. of sources and using MATLAB.

Simulation Software: - MATLAB

Theory:

An array is said to be broad side array if phase angle is such that it makes maximum radiation perpendicular to the line of array i.e. 90˚ & 270˚.

Broadside Array- This is a type of array in which the number of identical elements is placed on a supporting line drawn perpendicular to their respective axes. Elements are equally spaced and fed with a current of equal magnitude and all in same phase. The advantage of this feed technique is that array fires in broad side direction (i.e. perpendicular to the line of array axis, where there are maximum radiation and small radiation in other direction). Hence the radiation pattern of broadside array is bidirectional, and the array radiates equally well in either direction of maximum radiation.

Program:

```
clc
close all
clear all
phi=0:.1:2*pi;
c=3*(10^8);
f=input('enter frequency of signal:');
l=c/f;
D=input('enter the distance between two antennas:');
B=2*pi/l
Dr=B*D
d=input('give value of d:');
n=input('enter no. of point sources:')
si=abs(Dr*cos(phi)+d);
Eo=abs((sin(n*si/2))./sin(si/2));
polar(phi,Eo)
```

Result & Analysis:

Output:

Input parameters:

enter frequency of signal:1e9

enter the distance between two antennas'/2

B=20.9440

Dr=3.1416

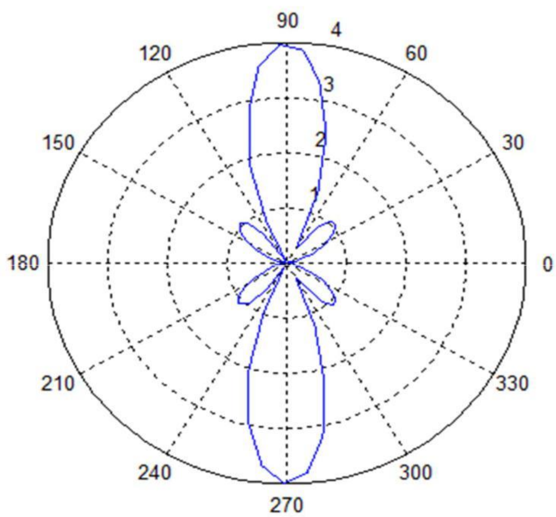
give value of d:0

enter no. of point sources:4

Output parameters:

n =4

Field Pattern:



Questions:

1. List the applications of Broadside Array antenna.
2. What is the range OF frequency for Broadside Array antenna?

Conclusion:

EXPERIMENT NO.07

Objective: To find radiation pattern of the 5 element Yagi Uda antenna and calculate the front to back ratio, half power beam width, first null beam width.

Equipment Required: - Antenna Trainer with connecting cables,5 element Yagi Uda antenna.

Theory:

Yagi Uda antenna is also termed as Yagi antenna which is a directional antenna that has either two or more parallel resonant antenna components acting as half-wave dipoles. This antenna is majorly formed by three components which are reflector, driven element, and directors, where the single driven component has a connection either with the transmitter/receiver via a transmission line or other parasitic components. In general, the parasitic elements are the reflector and a few directors (longer element). These parasitic elements (shorter elements) are not electrically connected to the transmitter or receiver but instead act as passive resonators, working in conjunction with the driven element. Yagi antennas are generally constructed to function in HF and UHF ranges, and they provide the functional frequency between 30 Megahertz to 3 Gigahertz, even when the bandwidth is very minimal.

To design a Yagi antenna, there are a few parameters to be considered which are:

- Driven component length – 0.458λ to 0.5λ
- Reflector length – 0.55λ – 0.58λ
- Director 1 length – 0.45λ
- Director 2 length – 0.40λ
- Director 3 length – 0.35λ
- Distance between the directors – 0.2λ
- Spacing between reflector to dipole – 0.35λ
- Spacing from dipole to director – 0.125λ

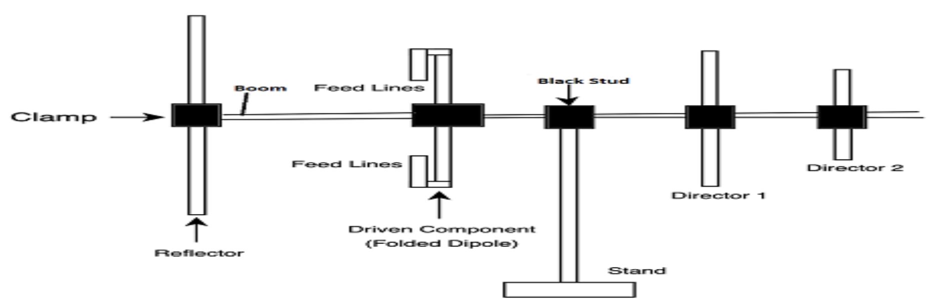


Fig.1 Yagi Uda Antenna Structure [https://rb.gy/fic556]

Advantages

1. The yagi antenna provides high gain.
2. As directors are used, it has high directional features.
3. These antennas are power efficient.
4. The construction and maintenance are not complex.
5. It has a good level of suitability for high-frequency activities The size of the structure quite large.
6. The overall cost of the system is high.
7. The small element of paraboloid causes some amount of power obstruction.

Disadvantages

1. To achieve high gains with the yagi uda antenna, the antenna becomes lengthier.
2. Gain level limits to 20 dB for a single antenna or else the device becomes too large, and beamwidth gets minimized.
3. The antenna is prone to noise, interference, and atmospheric conditions so the performance of the device gets reduced.

Procedure:

1. SET UP on Transmitter Side
   a) Fix the transmitting side antenna clamp on the table at a distance of about 2 to 3 meters from receiving Antenna.
   b) Fix the Transmitting Antenna on top of the antenna rod.
   c) Connect the antenna to the S-90G transmitter Generator -RF Source and put the equipment ON.
2. SET UP on Receiver Side
   a) Connect the Centronics connectors of S-90R Receiver Synthesizer and S-90P Positioner.
   b) Fix antenna rod on S-90P Positioner stand. Connect the mains cable of Positioner to 230 v AC outlet.
   c) Fix the Antenna on top of the antenna rod and connect the antenna cable to the input of S-90P Receiver synthesized.

3. For the plot of Loop antenna array readings connect this antenna on the positioner and note down the readings in the observation table.
4. Print the radiation pattern and calculate the parameters.

Result & Analysis:

Sr.No.	Space angle in DEG	GAIN in dB

	Practical
Front To Back Ratio (FBR)	
Half Power Beam Width (HPBW)	
Beam Width Between First Null (BWFN)	

Questions:

1. What is the formula for a parabolic reflector?
2. What is the range of parabolic reflector antenna?

Conclusion:

EXPERIMENT NO.08

Objective: To find radiation pattern of the Reflector antenna and calculate the front to back ratio, half power beam width, first null beam width.

Equipment Required: - Antenna Trainer with connecting cables., Reflector Antenna.

Theory:

Designing reflectors of many various for use in radio astronomy, microwave communication, and satellite tracking resulted in spectacular progress in the development of sophisticated analytical and experimental techniques in shaping the reflector surfaces and optimizing illumination over their apertures to maximize the gain. Although reflector antennas take many geometrical configurations, some of the most popular shapes are the plane, corner, and curved reflectors (especially the paraboloid).

Types of reflectors antenna

- Plane Reflector
- Corner Reflector
- Parabolic Reflector
- Spherical Reflector

Parabolic Reflector:

It has been shown by geometrical optics that if a beam of parallel rays is incident upon a reflector whose geometrical shape is a parabola, the radiation will converge (focus) at a spot which is known as the focal point. In the same manner, if a point source is placed at the focal point, the rays reflected by a parabolic reflector will emerge as a parallel beam. Rays that emerge in a parallel formation are usually said to be collimated. In practice, collimation is often used to describe the highly directional characteristics of an antenna even though the emanating rays are not exactly parallel.

A Parabola is a type of mathematical function know as a Quadratic Function as given below.

$$Y = aX^2+b$$

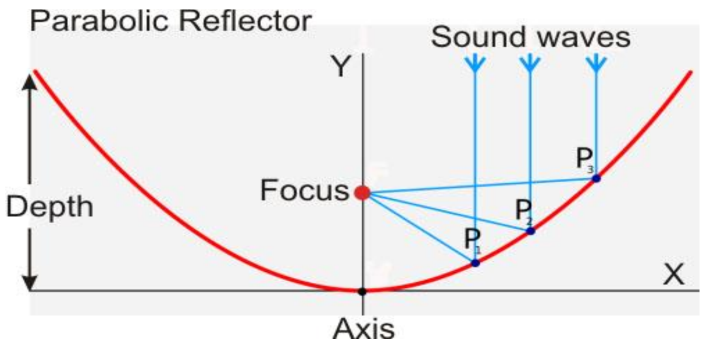


Fig.1 Parabolic Reflector [https://rb.gy/npz633]

Advantages

1. The use of parabolic reflectors reduces minor lobes.
2. It offers high gain and directivity.
3. The amount of power wastage is comparatively less than other antennas.
4. It provides flexibility in positioning the feed element.
5. The use of parabolic reflector helps to provide easy beam adjustment.

Disadvantages

1. The size of the structure quite large.
2. The overall cost of the system is high.
3. The small element of paraboloid causes some amount of power obstruction.

Procedure:

1. Mount the Transmitting Antenna (Folded Dipole) on stand and connect it to S-144 transmitter output as shown.
2. Mount the Receiving Antenna (Reflector) on the Positioner and connect it to S-144 receiver to the input. Connect the mains cable and switch on.
3. Press Save sw(6), then press 1 to rotate the stepper motor through 360 degrees with step of 5 degree so tht total 72 readings will be recorded
4. Connect printer and press Print to get polar print. Using the readings obtained calculate the parameters like front to back ratio, half power beam width, first null beam width.

Result & Analysis:

Sr.No.	Space angle in DEG	GAIN in dB

	Practical
Front To Back Ratio (FBR)	
Half Power Beam Width (HPBW)	
Beam Width Between First Null (BWFN)	

Questions:

3. What is the formula for a parabolic reflector?
4. What is the formula for directivity?
5. What is the range of parabolic reflector antenna?

Conclusion:

EXPERIMENT NO. 09

Objective To find radiation pattern of the Microstrip antenna and calculate the front to back ratio, half power beam width, first null beam width.

Equipment Required: - Antenna Trainer with connecting cables. Microstrip antenna.

Theory:

An antenna that is shaped by simply etching out a piece of conductive material above a dielectric surface is called a microstrip antenna or a patch antenna. On the ground plane of this microstrip antenna, the dielectric material is mounted, where this plane supports the entire structure. In addition, the excitation to this antenna can be provided with feed lines that are connected to the patch. Generally, these antennas are considered low-profile antennas that are used in microwave frequency applications.

Microstrip antenna design can be done with the help of an extremely thin metallic strip by arranging it on a ground plane in between a dielectric material. Here, the dielectric material is a substrate used for separating the strip from the ground plane. Once this antenna is excited, then the generated waves in the di-electric undergo reflections & the energy emitted from the metal patch edges is very low. These antenna shapes are identified by the metallic patch shape arranged on the dielectric material.

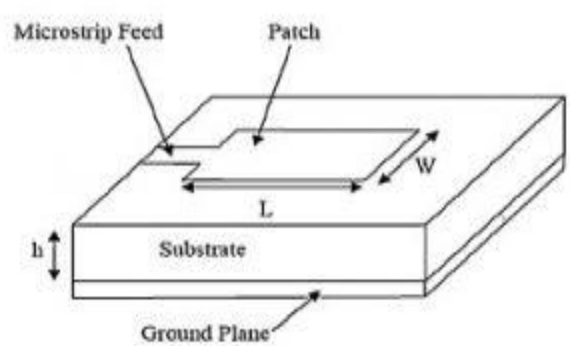


Fig.1 Microstrip Antenna Construction [https://rb.gy/7o1w71]

Advantages

- These antenna's weight is less.
- The fabrication procedure provided by this antenna is simple.
- Its installation is very easy because of its small size & volume.
- This antenna can perform double & triple-frequency operations.

- These antenna arrays can be constructed easily.
- This antenna provides a high amount of robustness above strong surfaces.
- It is simple to fabricate, customize & modify.
- In this antenna, linear & circular polarization is achievable.

Disadvantages

- This antenna provides less gain.
- The efficiency of this type of antenna is low due to conductor & dielectric losses.
- This antenna has a high range of cross-polarization radiation.
- The power handling capacity of this antenna is low.
- It has less impedance bandwidth.
- The structure of this antenna radiates from feeds & other junction points.

Procedure:

1. Mount the Transmitting Antenna (Folded Dipole) on stand and connect it to S-144 transmitter output as shown.
2. Mount the Receiving Antenna (Microstrip) on the Positioner and connect it to S-144 receiver to the input. Connect the mains cable and switch on.
3. Press Save sw(6), then press 1 to rotate the stepper motor through 360 degrees with step of 5 degree so tht total 72 readings will be recorded
4. Connect printer and press Print to get polar print. Using the readings obtained calculate the parameters like front to back ratio, half power beam width, first null beam width.

Result & Analysis:

Sr.No.	Space angle in DEG	GAIN in dB

	Practical
Front To Back Ratio (FBR)	
Half Power Beam Width (HPBW)	
Beam Width Between First Null (BWFN)	

Questions:

1. What is the range of microstrip antenna?
2. What are the applications of microstrip antenna?

Conclusion:

EXPERIMENT NO. 10

Objective: -To demonstrate the transmitting & receiving antennas radiation patterns of an antenna are equal & hence confirm the reciprocity theorem of antennas.

Equipment Required: - Antenna Trainer with connecting cables. Dipole antenna & Log-periodic antenna

Theory: -

The reciprocity theorem is the most powerful theorem in circuit & field theories both.

Reciprocity theorem states that if an emf is applied to the terminals of an antenna no. 1 & the current is measured at the terminals of another antenna no.2, then an equal current both in amplitude & phase will be obtained at the terminals of antenna no. 1 if the same emf is applied to the terminals of antenna no.2.

(OR)

If a current I_1 at the terminal of antenna no. 1 induces an emf E_{21} at the open terminal of an antenna no.2 & the current I_2 at the antenna no 2 induces an emf E_{12} at the open terminal of an antenna no. 1, then $E_{12}=E_{21}$ provided that $I_1 = I_2$

Assumptions: - It is assumed that:-

(1) Emf's are of same frequency

(2) Medium between two antennas are linear, passive & isotropic.

(3) Generator producing emf & the ammeter for measuring the current have zero impedance & or if not, then both generator & ammeter impedance are equal.

Explanation: -

1.) A transmitter of frequency f & zero impedance is connected to the terminals of antenna no.2, which is generating a current I_2 & inducing an emf E_{12} at the open terminal of an antenna no.1.

2.) Now the same transmitter is transferred to antenna no. 1 which is generating a current I_2 & inducing a voltage E_{21} at the open terminal of an antenna no.2. Thus, according to the statement on reciprocity theorem, $I_1 = I_2$ provided $E_{12} = E_{21}$

Since, ratio emf to current is impedance. Therefore the ratio of E_{12} / I_2 is given the name transfer impedance Z_{12} as in case 1, & so also the ratio E_{21}/I_1 as transfer impedance Z_{21} as in case 2. The ratio of voltage, E_1 to the current as Transfer Impedance Z_{12} or Z_T i.e $Z_T = Z_{12} = E_1/I_2$

Thus, from the reciprocity, it folllows that the two ratios i.e two impedances are equal i.e $Z_{12}= Z_{21}$ This, of course is nothing but mutual impedance Z_m between two antennas. Therefore, $Z_m = Z_{12}= Z_{21} = E_{12}/I_2 = E_{21}/I_1$ ie. $E_{12}/I_2 = E_{21}/I_1$.

Procedure:

1) Connect the Log- Periodic Antenna to the Transmitter side and the Dipole (A.U.T.) to the receiver mounted on the Stepper.
2) Take the readings of the Polar Plot for the dipole and take down the readings.
3) Now keeping everything else as is, interchange the transmitter and receiver cables to make the receiving antenna the transmitting antenna and the transmitting antenna the receiving antenna and once more take all the readings. The two plots should be nearly identical which proves that the transmitting and receiving radiation patterns are the same.

Result & Analysis:

Questions:

1) What is reciprocity theorem in antenna and its application?
2) Which property/ies of antenna is/are likely to be evidenced in accordance to Reciprocity theorem?

   a) Equality of impedances.
   b) Equality of directional patterns.
   c) Equality of effective lengths.
   d) All of the above.

Conclusion: