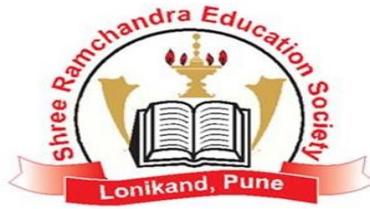


SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
DEPT. OF ELECTRONICS AND TELECOMMUNICATION



Subject: WAVE THEORY AND ANTENNA

Experiment No: 01

Title: Analysis of Half wavelength Dipole Antenna using Antenna Trainer Kit.

Date of performance:

Class: T.E

Date of Submission:

Signature

AIM: To analysis the half wavelength Dipole antenna and find following parameters related to antenna

- 1) 2D Radiation Pattern
- 2) Return Loss
- 3) Gain in dB
- 4) Front to Back Ratio
- 5) Beamwidth

Equipments Required:

Antenna Trainer Kit, Half Wavelength Dipole antenna, Directional Coupler, coaxial connectors.

Theory:

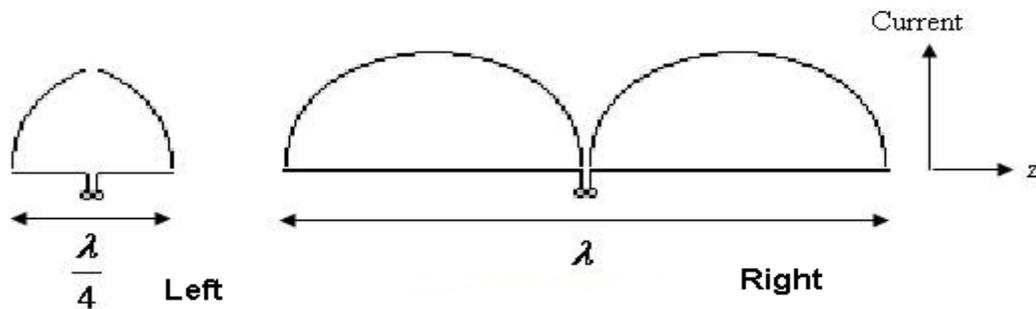
1. Dipole Antenna as Receiver:

The dipole antenna with a very thin radius is considered. The dipole antenna is similar to the short dipole except it is not required to be small compared to the wavelength (at the frequency the antenna is operating at).

For a dipole antenna of length L oriented along the z -axis and centered at $z=0$, the current flows in the z -direction with amplitude which closely follows the following function:

$$I(z) = \begin{cases} I_0 \sin \left[k \left(\frac{L}{2} - z \right) \right], & 0 \leq z \leq \frac{L}{2} \\ I_0 \sin \left[k \left(\frac{L}{2} + z \right) \right], & -\frac{L}{2} \leq z \leq 0 \end{cases}$$

This current is also oscillating in time sinusoidally at frequency f . The current distributions for the quarter-wavelength (left) and full-wavelength (right) dipole antennas are given in Figure 1. Note that the peak value of the current is not reached along the dipole unless the length is greater than half a wavelength.



It is practically identified as below....

2. Yagi-Uda Antenna as Transmitter:

The Yagi-Uda antenna or Yagi Antenna is one of the most brilliant antenna designs. It is simple to construct and has a high [gain](#), typically greater than 10 dB. The Yagi-Uda antennas typically operate in the HF to UHF bands (about 3 MHz to 3 GHz), although their [bandwidth](#) is typically small, on the order of a few percent of the center frequency.

It is practically identified as below....

Main Characteristics of an Antenna:

An antenna is chosen for a particular application according to its main physical and electrical characteristics are below...

1. Radiation pattern.
2. Gain.
3. Beam width.
4. Return loss.

1. Radiation pattern:

It is a graphical representation of radiation properties of antenna and radiation pattern of test antenna can be measured by probed antenna. It is an ability of an antenna receiving at particular angle.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The radiation pattern of an antenna is usually plotted in terms of relative power.

2. Gain:

The definition of gain of an antenna relates to the power radiated by the antenna to that radiated by an isotropic antenna (that radiates equally in all directions) and is quoted as a linear ratio or in decibels referred to an isotropic. When we say that the gain of an antenna is, for instance, 20dBi (100 in linear terms), we mean that an isotropic antenna would have to radiate 100 times more power to give the same intensity at the same distance as that particular directional antenna.

3. Beam width:

The angular distance between the half power points is defined as Bandwidth. The beamwidth of an antenna is commonly defined in two ways. The most well known definition is the 3-dB or half-power beamwidth, but the 10-dB beamwidth is also used, especially for antennas with very narrow beams. The 3-dB or half-power beamwidth (HPBW) of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The 10-dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

4. Return loss.

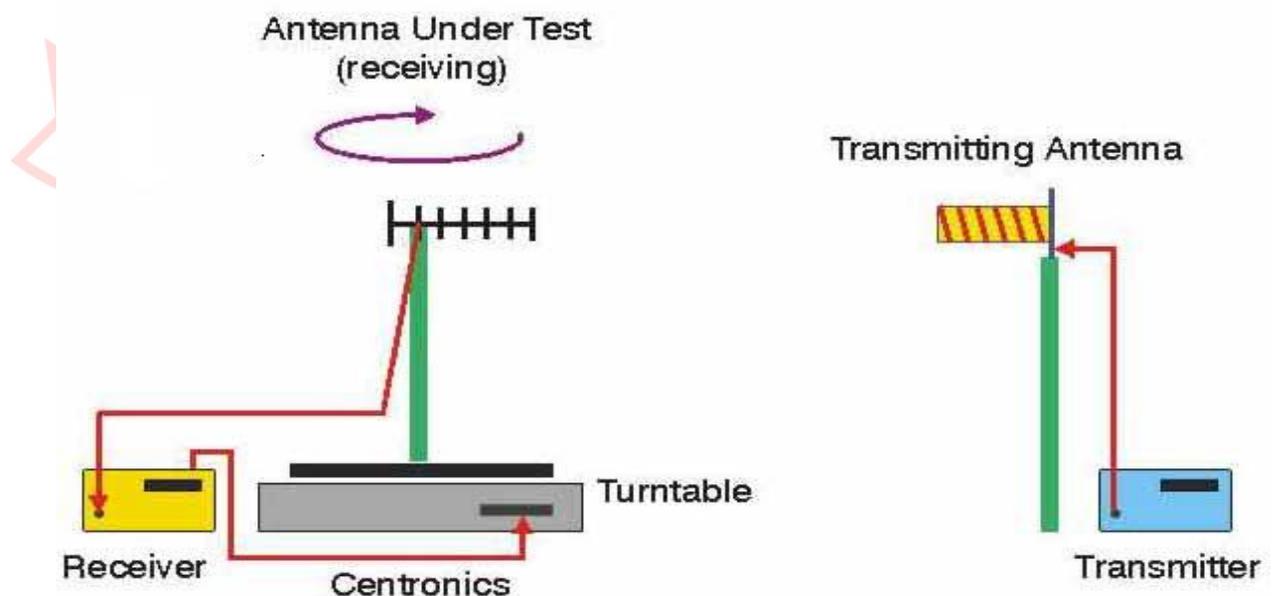
Return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is into the antenna from the

$$\text{Return Loss (in dB)} = 20 \log_{10} \frac{\text{SWR}}{\text{SWR}-1}$$

transmission line. The relationship between SWR and return loss is the following...

BLOCK DIAGRAM:

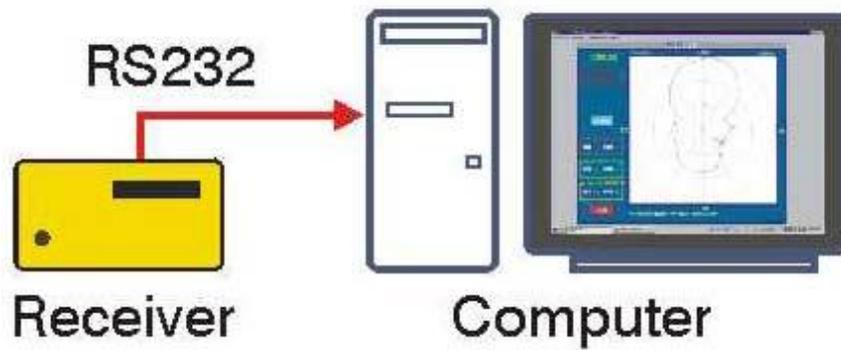
1. Antenna Measurement:



Receiving Side: Dipole Antenna is mounted on the Turntable and connected to the Receiver. Every 5 deg, the Receiver measures the dBuV and stores it in the internal array memory. Two such arrays (of 360 points each) are provided. The time taken for 360 readings is less than 4 minutes.

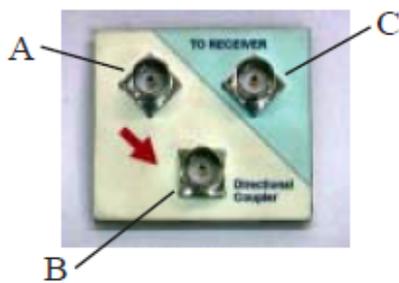
Transmitter Side: Yagi-Uda Antenna is connected to say 1.25 GHz

2. Computer Measurement:



The stored arrays can be transferred to a PC for detailed analysis using cursor measurements as well as make PC based measurements on the Antenna.

3. Directional Coupler



The Directional Coupler is shown on the left. The BNC - C is always connected to the receiver. The direction the Arrow indicates is the direction of forward voltage measurement.



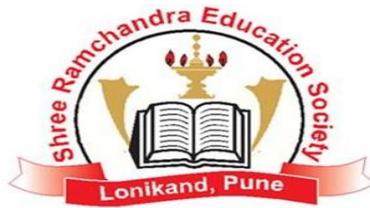
Procedure:

- 1) Mount the Half Wavelength Dipole antenna on receiver stand of antenna trainer kit; connect a coaxial cable between antenna and input section of transreceiver meter.
- 2) Mount Yagi-Uda antenna on stand of transmitter stand of antenna trainer kit, connect a coaxial cable between antenna and output section of transreceiver meter.
- 3) Apply a frequency of 1250 MHz (1.25 GHz) to transmitter antenna by varying knob on transreceiver meter.
- 4) Take the reading of field strength of receiver antenna, which indicated on transreceiver meter, note this reading as first reading for angle of 0 degree.
- 5) Rotate the receiver antenna mount with an increment of 10 degree and take respective readings.
- 6) Plot the 2D radiation pattern of antenna using observed readings.
- 7) To find VSWR of antenna connect the coaxial cable from antenna under test to input terminal of directional coupler.
- 8) Output terminal of directional coupler is connected to input terminal of transreceiver meter, and common terminal is connected to input terminal of transreceiver meter.
- 9) Press VSWR button on transreceiver meter you get value of V_i (incident Voltage).
- 10) Now reverse the direction of input & output of directional coupler and press VSWR button you get value of V_r (Reflected voltage) & VSWR.

Observations: observe the radiation pattern of antenna and find out gain, beam width, FBR and VSWR of antenna.

Conclusion: - We had analyzed half wavelength dipole antenna using trainer kit. We observe that in case of half wavelength dipole antenna we do not get a perfectly eight shape 2D radiation pattern. The reason behind this is, there are some of losses like dielectric losses, metallic losses present in surrounding of antenna, so we don't get a perfect radiation pattern. To minimize this error we provide an isolated environment for testing of antennas by using equipments like microwave anechoic chambers, shielded rooms & open area test sites.

SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
DEPT. OF ELECTRONICS AND TELECOMMUNICATION



Subject: WAVE THEORY AND ANTENNA

Experiment No: 02

Title: Analysis of Micro strip Patch Antenna (MSA) using Antenna Trainer Kit.

Date of performance:

Class: T.E

Date of Submission:

Signature

Aim: To analysis the Micro strip Patch antenna and find following parameters related to antenna

- 1) 2D Radiation Pattern
- 2) Return Loss
- 3) Gain in dB
- 4) Front to Back Ratio
- 5) Beam width

Equipments Required:

Antenna Trainer Kit, Half Wavelength Dipole antenna, Directional Coupler, coaxial connectors.

Theory:

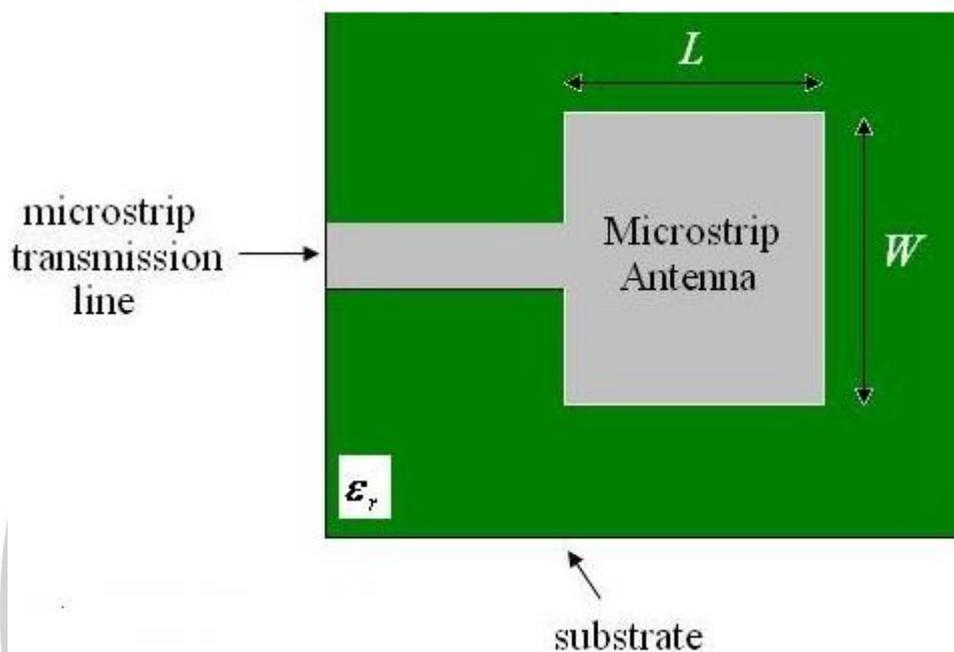
1. Micro strip Antenna as Receiver:

There are several types of micro strip antennas (also known as printed antennas) the most common of which is the micro strip patch antenna or patch antenna. A patch antenna is a narrow band, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common micro strip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible.

Micro strip antennas are also relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonant

frequency. A single patch antenna provides a maximum directive gain of around 6-9 dB. The ability to create high gain arrays in a low-profile antenna is one reason that patch arrays are common on airplanes and in other military applications

Micro strip or patch antennas are becoming increasingly useful because they can be printed directly onto a circuit board. Micro strip antennas are becoming very widespread within the mobile phone market. Patch antennas are low cost, have a low profile and are easily fabricated.



Consider the micro strip antenna shown in Figure, fed by a micro strip transmission line. The patch antenna, micro strip transmission line and ground plane are made of high conductivity metal (typically copper). The patch is of length L , width W , and sitting on top of a substrate (some dielectric circuit board) of thickness h with permittivity. The thickness of the ground plane or of the microstrip is not critically important. Typically the height h is much smaller than the wavelength of operation, but not much smaller than 0.05 of a wavelength.

It is practically identified as below....

2. Yagi Uda antenna as Transmitter:

The Yagi-Uda antenna or Yagi Antenna is one of the most brilliant antenna designs. It is simple to construct and has a high [gain](#), typically greater than 10 dB. The Yagi-Uda antennas typically operate in the HF to UHF bands (about 3 MHz to 3 GHz), although their [bandwidth](#) is typically small, on the order of a few percent of the center frequency.

It is practically identified as below....

Main Characteristics of an Antenna:

An antenna is chosen for a particular application according to its main physical and electrical characteristics are below...

1. Radiation pattern.
2. Gain.
3. Beam width.
4. Return loss.

1. Radiation pattern:

It is a graphical representation of radiation properties of antenna and radiation pattern of test antenna can be measured by probed antenna. It is an ability of an antenna receiving at particular angle.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The radiation pattern of an antenna is usually plotted in terms of relative power.

2. Gain:

The definition of gain of an antenna relates to the power radiated by the antenna to that radiated by an isotropic antenna (that radiates equally in all directions) and is quoted as a linear ratio or in decibels referred to an isotropic. When we say that the gain of an antenna is, for instance, 20dBi (100 in linear terms), we mean that an isotropic antenna would have to radiate 100 times more power to give the same intensity at the same distance as that particular directional antenna.

3. Beam width:

The angular distance between the half power points is defined as Bandwidth. The beamwidth of an antenna is commonly defined in two ways. The most well known definition is the 3-dB or half-power beamwidth, but the 10-dB beamwidth is also used, especially for antennas with very narrow beams. The 3-dB or half-power beamwidth (HPBW) of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The 10-dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

4. Return loss.

Return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is into the antenna from the

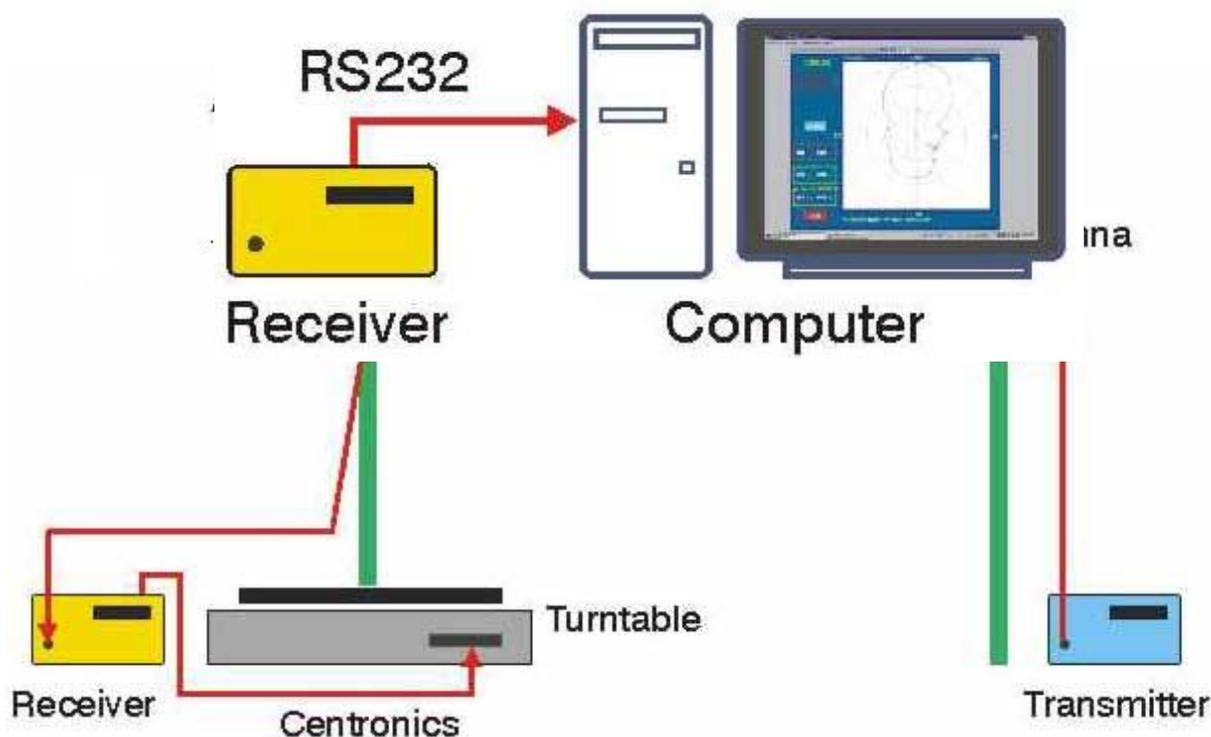
$$\text{Return Loss (in dB)} = 20 \log_{10} \frac{\text{SWR}}{\text{SWR}-1}$$

transmission line. The relationship between SWR and return loss is the following...

BLOCK DIAGRAM:

1. Antenna Measurement:

Receiving Side: Dipole Antenna is mounted on the Turntable and connected to the Receiver. Every 5 deg, the Receiver measures the dBuV and stores it in the internal array memory. Two such arrays (of 360 points each) are provided. The time taken for 360 readings is less than 4 minutes.

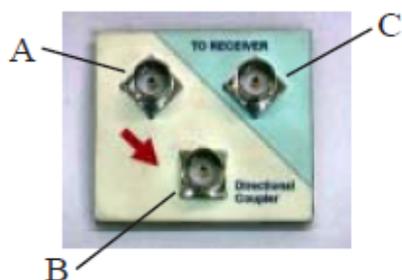


Transmitter Side: Yagi-Uda Antenna is connected to say 1.25 GHz

2. Computer Measurement:

The stored arrays can be transferred to a PC for detailed analysis using cursor measurements as well as make PC based measurements on the Antenna.

3. Directional Couple:



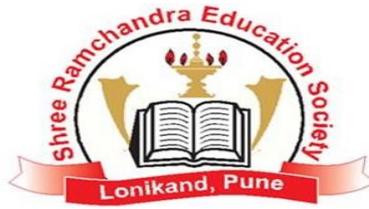
The Directional Coupler is shown on the left. The BNC - C is always connected to the receiver. The direction the Arrow indicates is the direction of forward voltage measurement.

Procedure:

- 1) Mount the Microstrip antenna on receiver stand of antenna trainer kit; connect a coaxial cable between antenna and input section of transreceiver meter.
- 2) Mount Yagi-Uda antenna on stand of transmitter stand of antenna trainer kit, connect a coaxial cable between antenna and output section of transreceiver meter.
- 3) Apply a frequency of 1250 MHz (1.25 GHz) to transmitter antenna by varying knob on transreceiver meter.
- 4) Take the reading of field strength of receiver antenna, which indicated on transreceiver meter, note this reading as first reading for angle of 0 degree.
- 5) Rotate the receiver antenna mount with an increment of 5 degree and take respective readings.
- 6) Plot the 2D radiation pattern of antenna using observed readings.
- 7) To find VSWR of antenna connect the coaxial cable from antenna under test to input terminal of directional coupler.
- 8) Output terminal of directional coupler is connected to input terminal of transreceiver meter, and common terminal is connected to input terminal of transreceiver meter.
- 9) Press VSWR button on transreceiver meter you get value of V_i (incident Voltage).
- 10) Now reverse the direction of input & output of directional coupler and press VSWR button you get value of V_r (Reflected voltage) & VSWR.

Observations: observe the radiation pattern of antenna and find out gain, beam width, FBR and VSWR of antenna.

Conclusion: - We had analyzed rectangular MSA trainer kit. We observe that in case of Micro strip antenna we do not get a perfectly eight shape 2D radiation pattern. The reason behind this is, there are some of losses like dielectric losses, metallic losses present in surrounding of antenna, so we don't get a perfect radiation pattern. To minimize this error we provide an isolated environment for testing of antennas by using equipments like microwave anechoic chambers, shielded rooms & open area test sites.



Subject: WAVE THEORY AND ANTENNA

Experiment No: 03

Title: Analysis of Half wavelength Dipole Antenna using Antenna Trainer Kit.

Date Of performance:

Class: T.E

Date of Submission:

Signature

Aim: To analysis the Yagi Uda array and find following parameters related to antenna

- 1) 2D Radiation Pattern
- 2) Return Loss
- 3) Gain in dB
- 4) Front to Back Ratio
- 5) Beamwidth

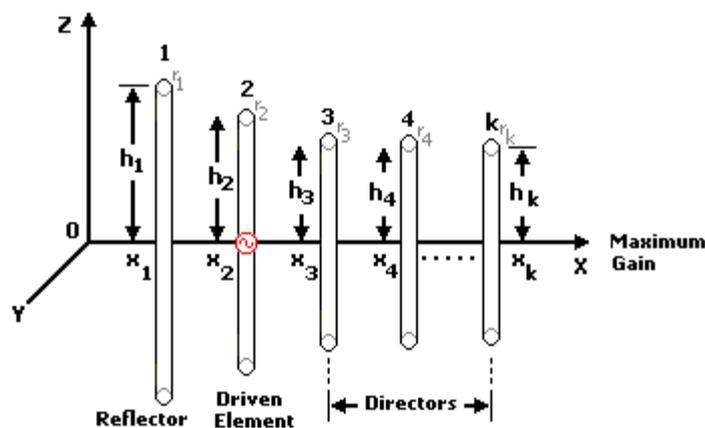
Equipments Required:

Antenna Trainer Kit, Yagi Uda array, Directional Coupler, coaxial connectors.

Theory:

1. Yagi-Uda Antenna as Receiver:

The Yagi-Uda antenna or Yagi Antenna is one of the most brilliant antenna designs. It is simple to construct and has a high [gain](#), typically greater than 10 dB. The Yagi-Uda antennas typically operate in the HF to UHF bands (about 3 MHz to 3 GHz), although their [bandwidth](#) is typically small, on the order of a few percent of the center frequency.



Geometry of a K elements Yagi-Uda

Each element is made by wire; rod or conductor tube with its own particular characteristic, very often aluminum.

$h_1, h_2, h_3 \dots h_k$ in the above graph, is the eighth of half element put symmetric to the X-axis which is called antenna boom. Then the physical length of each element k is $2h_k$. Every element has its own radius r_k , generally of the same diameter $2r_k$ by the manufacturers, but should be different. The $x_i - x_1$ values give the relative position of each element to the reflector element, $x_k - x_1$ is always the boom length of the antenna; generally x_1 is put to zero in some design description. In some design method a spacing elements $X_i - X_{i-1}$ is given instead the relative position. Element 1 is always the reflector element, the 2 is the driven element, and 3 is the first director. More than one director should be used, an antenna with ten directors is a twelve elements Yagi-Uda.

It is practically identified as below....

2. Dipole Antenna as Transmitter :

The dipole antenna with a very thin radius is considered. The dipole antenna is similar to the short dipole except it is not required to be small compared to the wavelength (at the frequency the antenna is operating at).

Main Characteristics of an Antenna:

An antenna is chosen for a particular application according to its main physical and electrical characteristics are below...

1. Radiation pattern.
2. Gain.
3. Beam width.
4. Return loss.

1. Radiation pattern:

It is a graphical representation of radiation properties of antenna and radiation pattern of test antenna can be measured by probed antenna. It is an ability of an antenna receiving at particular angle.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The radiation pattern of an antenna is usually plotted in terms of relative power.

2. Gain:

The definition of gain of an antenna relates to the power radiated by the antenna to that radiated by an isotropic antenna (that radiates equally in all directions) and is quoted as a linear ratio or in decibels referred to an isotropic. When we say that the gain of an antenna is, for instance, 20dBi (100 in linear terms), we mean that an isotropic antenna would have to radiate 100 times more power to give the same intensity at the same distance as that particular directional antenna.

3. Beam width:

The angular distance between the half power points is defined as Bandwidth. The beamwidth of an antenna is commonly defined in two ways. The most well known definition is the 3-dB or half-power beamwidth, but the 10-dB beamwidth is also used, especially for antennas with very narrow beams. The 3-dB or half-power beamwidth (HPBW) of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The 10-dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

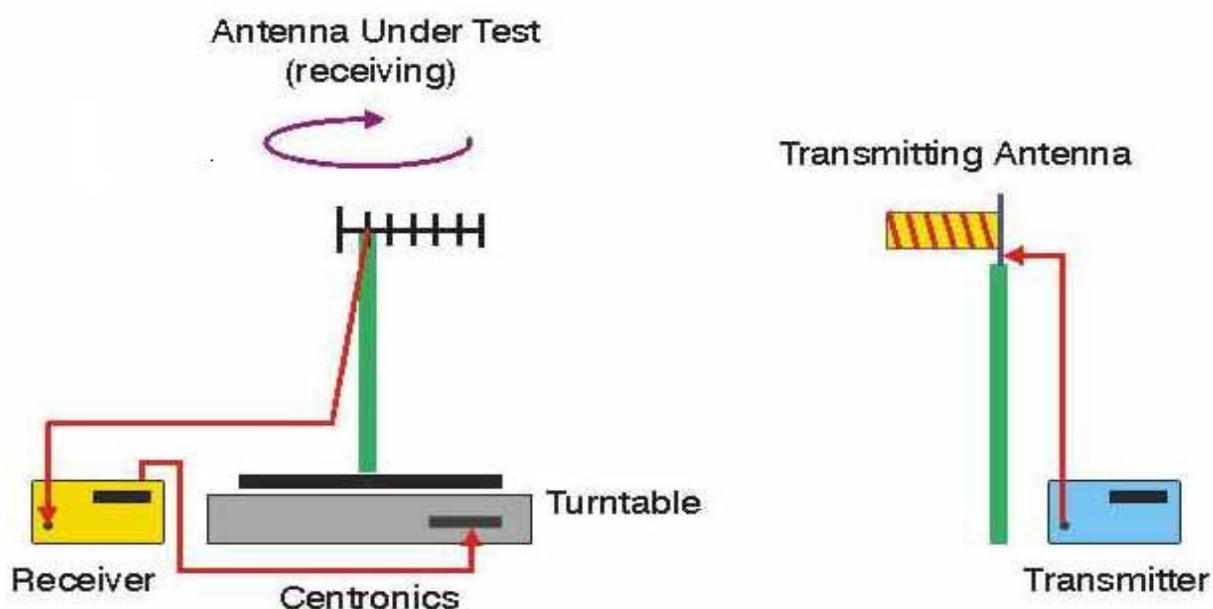
4. Return loss.

Return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is into the antenna from the transmission line. The relationship between SWR and return loss is the following...

$$\text{Return Loss (in dB)} = 20 \log_{10} \frac{\text{SWR}}{\text{SWR}-1}$$

BLOCK DIAGRAM:

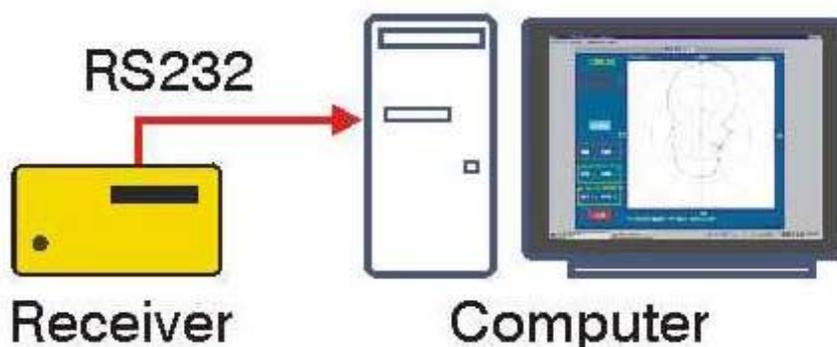
1. Antenna Measurement:



Receiving Side: Dipole Antenna is mounted on the Turntable and connected to the Receiver. Every 5 deg, the Receiver measures the dBuV and stores it in the internal array memory. Two such arrays (of 360 points each) are provided. The time taken for 360 readings is less than 4 minutes.

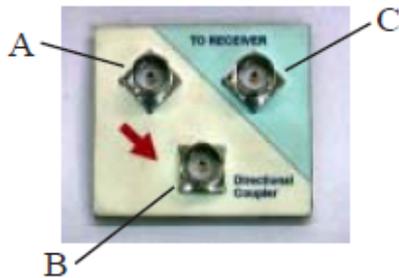
Transmitter Side: Yagi-Uda Antenna is connected, say 1.25 GHz

2. Computer Measurement:



The stored arrays can be transferred to a PC for detailed analysis using cursor measurements as well as make PC based measurements on the Antenna.

3. Directional Coupler:



The Directional Coupler is shown on the left. The BNC - C is always connected to the receiver. The direction the Arrow indicates is the direction of forward voltage measurement.

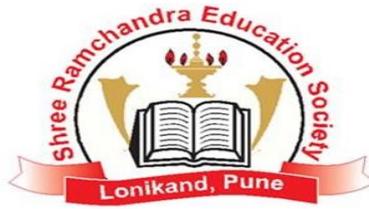
Procedure:

- 1) Mount the Yagi Uda array on receiver stand of antenna trainer kit; connect a coaxial cable between antenna and input section of transreceiver meter.
- 2) Mount Parabolic reflector antenna on stand of transmitter stand of antenna trainer kit, connect a coaxial cable between antenna and output section of transreceiver meter.
- 3) Apply a frequency of 1250 MHz (1.25 GHz) to transmitter antenna by varying knob on transreceiver meter.
- 4) Take the reading of field strength of receiver antenna, which indicated on transreceiver meter, note this reading as first reading for angle of 0 degree.
- 5) Rotate the receiver antenna mount with an increment of 5 degree and take respective readings.
- 6) Plot the 2D radiation pattern of antenna using observed readings.
- 7) To find VSWR of antenna connect the coaxial cable from antenna under test to input terminal of directional coupler,
- 8) Output terminal of directional coupler is connected to input terminal of transreceiver meter, and common terminal is connected to input terminal of transreceiver meter.
- 9) Press VSWR button on transreceiver meter you get value of V_i (incident Voltage).
- 10) Now reverse the direction of input & output of directional coupler and press VSWR button you get value of V_r (Reflected voltage) & VSWR.

Observations: observe the radiation pattern of antenna and find out gain, beam width, FBR and VSWR of antenna.

Conclusion: - We had analyzed Yagi Uda array using antenna trainer kit.

SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
DEPT. OF ELECTRONICS AND TELECOMMUNICATION



Subject: ANTENNA AND WAVE PROPAGATION

Experiment No: 04

Title: Analysis of Folded Dipole antenna using Antenna Trainer Kit.

Date Of performance:

Class: T.E

Date of Submission:

Signature

AIM: To analysis the Folded Dipole antenna and find out following parameters related to antenna.

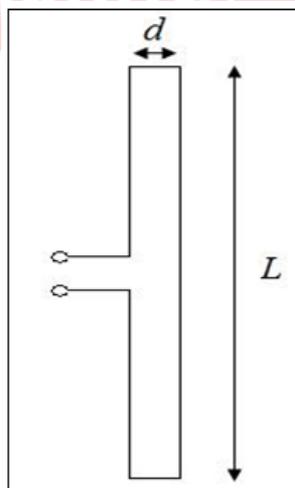
- 1) 2D Radiation Pattern
- 2) Return Loss
- 3) Gain in dB
- 4) Front to Back Ratio
- 5) Beamwidth

Equipments Required:

Antenna Trainer Kit, Folded Dipole antenna, Directional Coupler, coaxial connectors.

Theory:

- ESTD 2011
1. **Folded Dipole Antenna as Receiver:**



A folded dipole is a dipole antenna with the ends folded back around and connected to each other, forming a loop as shown in figure. Typically, the width d of the folded dipole antenna is much smaller than the length L .

Because the folded dipole forms a closed loop, one might expect the input impedance to depend on the input impedance of a short-circuited transmission line of length L . However, you can imagine the folded dipole antenna as two parallel short-circuited transmission lines of length $L/2$ (separated at the midpoint by the feed in Figure). It turns out the impedance of the folded dipole antenna will be a function of the impedance of a transmission line of length $L/2$.

Also, because the folded dipole is "folded" back on itself, the currents can reinforce each other instead of canceling each other out, so the input impedance will also depend on the impedance of a dipole antenna of length L .



It is practically identified as below....

2. Yagi-Uda Antenna as Transmitter:

The Yagi-Uda antenna or Yagi Antenna is one of the most brilliant antenna designs. It is simple to construct and has a high [gain](#), typically greater than 10 dB. The Yagi-Uda antennas typically operate in the HF to UHF bands (about 3 MHz to 3 GHz), although their [bandwidth](#) is typically small, on the order of a few percent of the center frequency.

Main Characteristics of an Antenna:

An antenna is chosen for a particular application according to its main physical and electrical characteristics are below...

1. Radiation pattern.
2. Gain.
3. Beam width.
4. Return loss.

1. Radiation pattern:

It is a graphical representation of radiation properties of antenna and radiation pattern of test antenna can be measured by probed antenna. It is an ability of an antenna receiving at particular angle.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The radiation pattern of an antenna is usually plotted in terms of relative power.

2. Gain:

The definition of gain of an antenna relates to the power radiated by the antenna to that radiated by an isotropic antenna (that radiates equally in all directions) and is quoted as a linear ratio or in decibels referred to an isotropic. When we say that the gain of an antenna is, for instance, 20dBi (100 in linear terms), we mean that an isotropic antenna would have to radiate 100 times more power to give the same intensity at the same distance as that particular directional antenna.

3. Beam width:

The angular distance between the half power points is defined as Bandwidth. The beamwidth of an antenna is commonly defined in two ways. The most well known definition is the 3-dB or half-power beamwidth, but the 10-dB beamwidth is also used, especially for antennas with very narrow beams. The 3-dB or half-power beamwidth (HPBW) of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The 10-dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

4. Return loss.

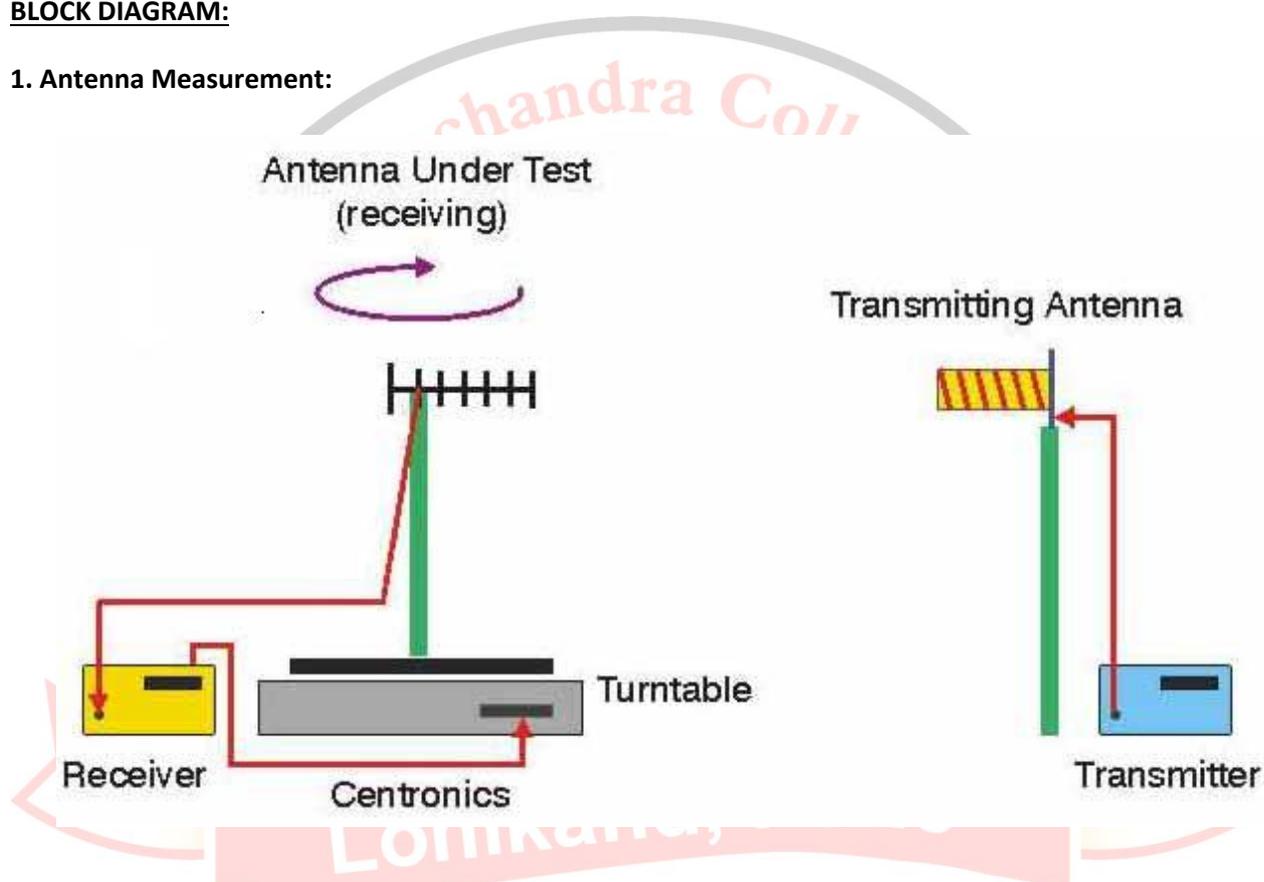
Return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is into the antenna from the

$$\text{Return Loss (in dB)} = 20 \log_{10} \frac{\text{SWR}}{\text{SWR}-1}$$

transmission line. The relationship between SWR and return loss is the following...

BLOCK DIAGRAM:

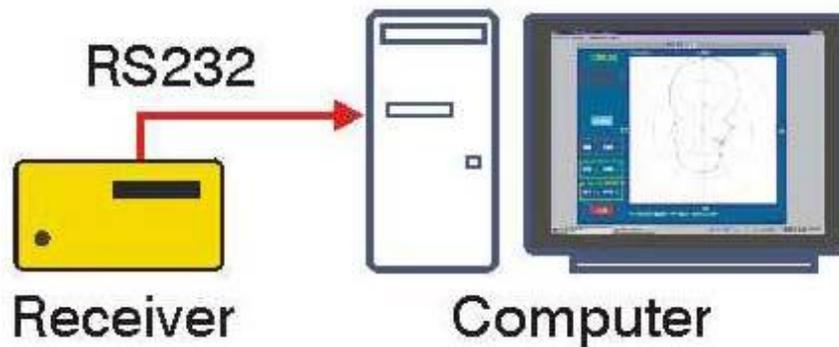
1. Antenna Measurement:



Receiving Side: Dipole Antenna is mounted on the Turntable and connected to the Receiver. Every 5 deg, the Receiver measures the dBuV and stores it in the internal array memory. Two such arrays (of 360 points each) are provided. The time taken for 360 readings is less than 4 minutes.

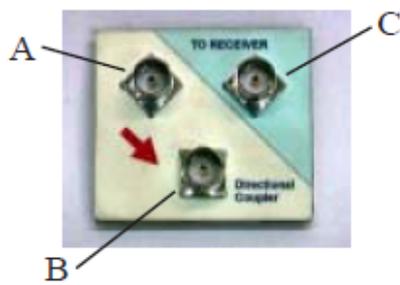
Transmitter Side: Yagi-Uda Antenna is connected to say 1.25 GHz

2. Computer Measurement:



The stored arrays can be transferred to a PC for detailed analysis using cursor measurements as well as make PC based measurements on the Antenna.

3. Directional Coupler:



The Directional Coupler is shown on the left. The BNC - C is always connected to the receiver. The direction the Arrow indicates is the direction of forward voltage measurement.

Procedure to get Polar Plot and Beam width:

1. Mount the Transmitting Antenna on the stand connect it to the Antenna Trainer's Output.
2. Mount the Receiving Antenna on the Positioner and connect it to the Antenna Trainer's Input.
3. Connect the mains cable and connect to the main power supply and Switch on.
4. A manual rotater capable of rotating the antenna by 5 degree is used to obtain the Polar Plot. At every 5 degrees position of the antenna the dBuV reading is stored in the 72 point memory array of the Antenna Trainer (S-144 Receiver).
5. Take all the 72 readings (0 to 360 degree) by the movement of 5 degree and save it properly into the Trainer, reading have to be taken from the receiving side.
6. Continue in this sequence untill the reading no.72 (at 355 deg) is measured and stored in the memory. This completes the measurement of the Polar Plot.
7. In this manner all the 72 readings of the array can be recalled and written down on paper. These readings will remain in memory until a new Save is initiated. These readings can be printed out
7. The 3-dB or half-power beamwidth (HPBW) of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value, we can get it from the polar plot easily.

Procedure to get VSWR, Return Loss and Gain:

1. To get VSWR, need to calculate V_i and V_r i.e. incident voltage and reflected voltage with the help of Directional Coupler.
2. Dipole antenna need to connect to the output of the Directional Coupler. The input of the Directional Coupler will go to the output of the Antenna Trainer S-144. And the input from the Antenna trainer will go to the Receiver of the Directional Coupler for measurement of V_i .
3. Press VSWR switch to measure V_i in dBuV and press the connections are reversed for measurement of V_r .
4. Again Press VSWR switch to measure V_r .
5. Now interchange the input with output of Directional Coupler. And press VSWR switch again. The LCD displays the computed value of VSWR. The value of V_r may keep changing as the antenna position changes due to reflection from various surfaces.
6. This will reflect in VSWR value so need to take the minimum 10 readings and when the

$$\text{Return Loss} = \frac{\text{VSWR}-1}{\text{VSWR}+1}$$

value of VSWR is minimum then take the same and calculate the Return Loss by below formula...

7. To calculate the Gain, take any of the Antenna as reference antenna and rotate the Receiver

antenna such that you will get the Maximum reading in between -5 to +5 readings.

8. At the same reading, remove the Reference antenna and mount the actual measurement antenna to get the Gain by using the below formula...

$$\text{Gain} = \text{dBuV reading of an antenna under test} - \text{dBuV of reference antenna} + 2.16\text{dB}$$

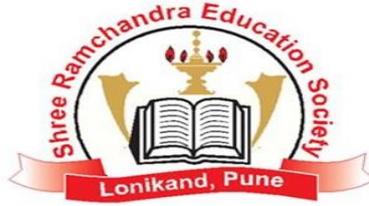
Procedure:

- 1) Mount the Folded Dipole antenna on receiver stand of antenna trainer kit; connect a coaxial cable between antenna and input section of transreceiver meter.
- 2) Mount Yagi Uda antenna on stand of transmitter stand of antenna trainer kit, connect a coaxial cable between antenna and output section of transreceiver meter.
- 3) Apply a frequency of 1250 MHz (1.25 GHz) to transmitter antenna by varying knob on transreceiver meter.
- 4) Take the reading of field strength of receiver antenna, which indicated on transreceiver meter, note this reading as first reading for angle of 0 degree.
- 5) Rotate the receiver antenna mount with an increment of 5 degree and take respective readings.
- 6) Plot the 2D radiation pattern of antenna using observed readings.
- 7) To find VSWR of antenna connect the coaxial cable from antenna under test to input terminal of directional coupler,
- 8) Output terminal of directional coupler is connected to input terminal of transreceiver meter, and common terminal is connected to input terminal of transreceiver meter.
- 9) Press VSWR button on transreceiver meter you get value of V_i (incident Voltage).
- 10) Now reverse the direction of input & output of directional coupler and press VSWR button you get value of V_r (Reflected voltage) & VSWR.

Observations: observe the radiation pattern of antenna and find out gain, beam width, FBR and VSWR of antenna.

Conclusion: - We had analyzed Folded Dipole antenna using antenna trainer kit.

SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
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Subject: WAVE THEORY AND ANTENNA

Experiment No: 05

Title Measurement of SWR for Different Terminations.

Date Of performance:

Class: T.E

Date of Submission:

Signature

Aim: To plot the standing wave pattern & measure SWR for following Terminations

- 1) Open Termination
- 2) Short Termination
- 3) Matched Termination

Equipments Required:

Transmission line analyzer, CRO with X-Y mode facility, Transmission lines.

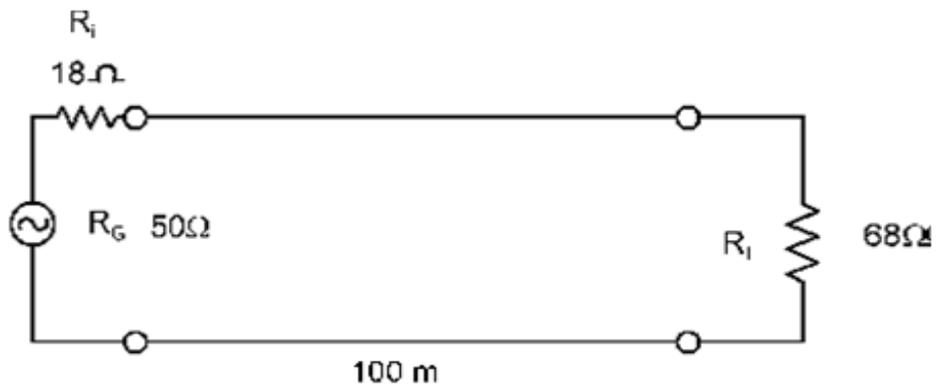
Theory:

Basic Principles of Transmission Line

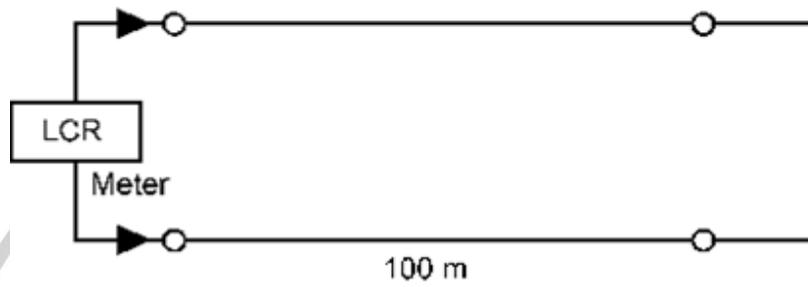
Transmission lines are a means of conveying signals or power from one point to another. From such a broad definition, any system of wires can be considered as forming one or more transmission lines. However, if the properties of these lines must be taken into account, the lines might as well be arranged in some simple, constant pattern. This will make the properties much easier to calculate, and it will also make them constant for any type of transmission line. Thus all practical transmission lines are arranged in some uniform pattern; this simplifies calculations, reduces costs and increases convenience.

To plot the standing wave pattern & measure SWR for following Terminations

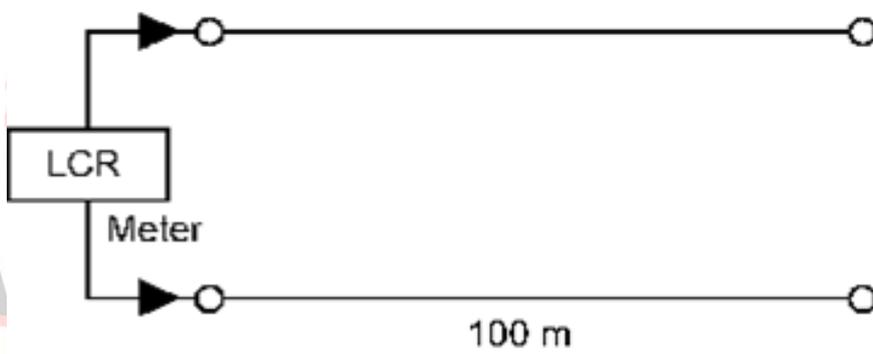
- 1) Open Termination
- 2) Short Termination
- 3) Matched Termination



1. Matched Line



2. Short Circuited Line for measuring Inductance L and Resistance R



3. Short Circuited Line for measuring Capacitance C and Conductance G

ESTI

011

Procedure:

- 1) Connect a BNC cable between swept RF source of transmission line analyzer & channel 1 of CRO.
- 2) Connect another BNC cable between detected output terminal on transmission line analyzer & channel 2 of CRO.
- 3) Connect one terminal of transmission line (e.g. 50Ω , 75Ω or lossy line) to the output terminal of transmission line analyzer.
- 4) Different types of terminations are connected to the second terminal of transmission line.
- 5) Set CRO in X-Y mode & observe the generated pattern of SWR for given transmission line.
- 6) Provide required attenuation by pressing switches with different values of attenuation.
- 7) To find VSWR of transmission line check the value of attenuation for which we get minimum SWR, find the value of VSWR for this minimum value of attenuation in Table.1.
- 8) To find impedance of transmission line connect second terminal of transmission line to the impedance terminal on transmission line analyzer, set the frequency knob to ohm.
- 9) Vary the impedance knob till you get minimum value of SWR pattern on CRO. Note the value at which the SWR is as its minimum value.
- 10) This value displayed on transmission line analyzer gives the impedance of transmission line.

Observations: observe the standing wave pattern for different terminations. Explain change in SWR pattern with different terminations & plot the patterns for different terminations on a graph paper. Note down the value of VSWR for different terminations

Table.1:-

Attenuation in dB	VSWR	Reflection Coefficient	Losses
0.25	1.06	0.027	30.7
0.5	1.12	0.057	24.9
0.75	1.19	0.087	21.2
1	1.26	0.115	18.8
1.25	1.34	0.145	16.7
1.5	1.41	0.170	15.4
1.75	1.49	0.196	14.1
2	1.58	0.225	13
2.25	1.68	0.254	11.9
2.5	1.78	0.281	11
2.75	1.88	0.305	10.3
3	1.99	0.331	9.6
4	2.51	0.430	7.3
5	3.16	0.519	5.7
6	3.98	0.586	4.4
7	5.01	0.667	3.5
8	6.31	0.726	2.8
9	7.94	0.776	2.2
10	10	0.818	1.7
11	12.6	0.853	1.4
12	15.8	0.881	1.1
13	19.9	0.904	0.9
14	25.1	0.923	0.7
15	31.6	0.939	0.5
16	39.8	0.951	0.4

$$\text{VSWR} = V_{\text{max}}/V_{\text{min}}$$

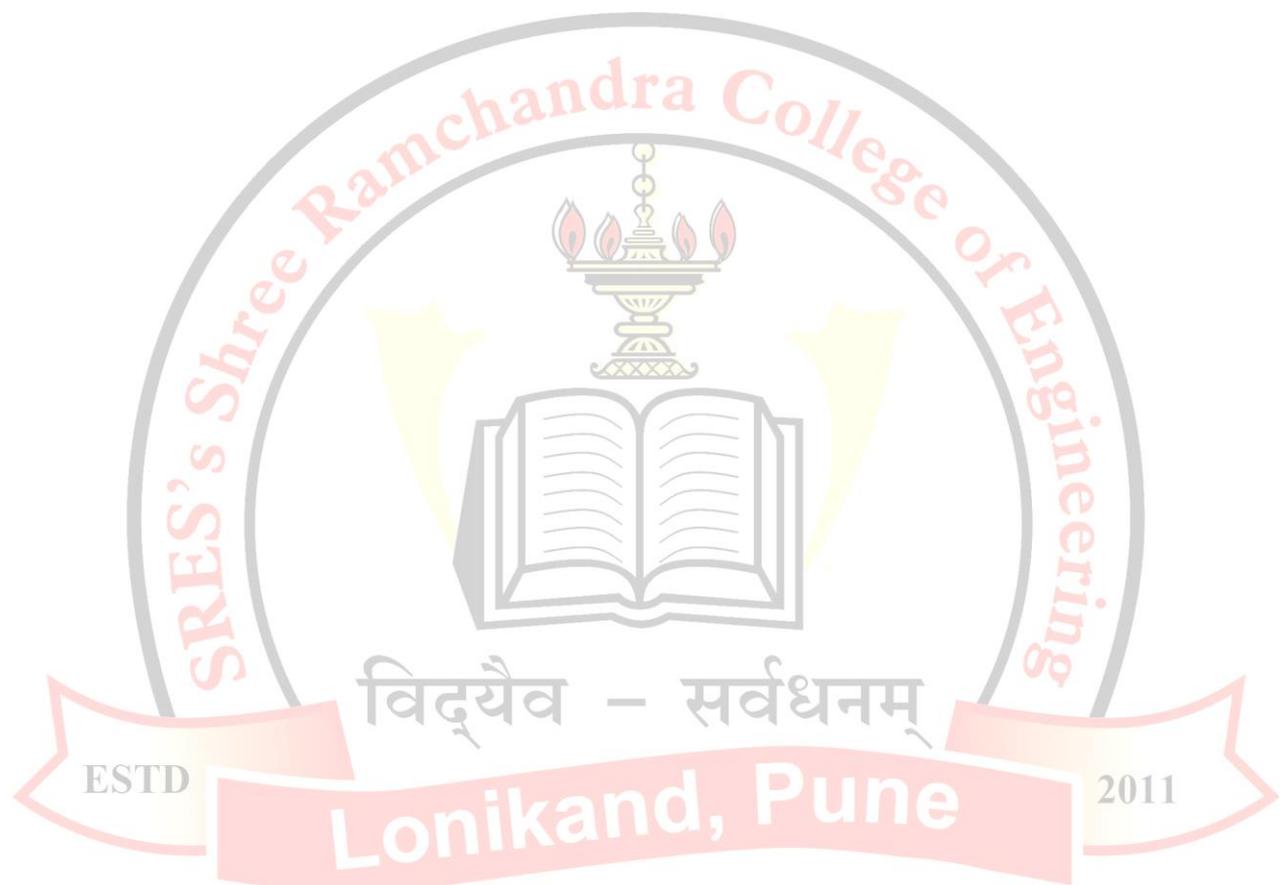
$$\text{Log (VSWR)} = \text{Log (Vmax)} - \text{Log (Vmin)}$$

$$10\log (\text{VSWR}) = 10 \log(\text{Vmax}) - 10 \log(\text{Vmin})$$

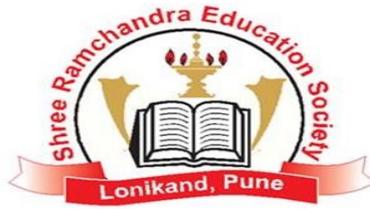
$$10\log (\text{VSWR}) = \text{Vmax in dB} - \text{Vmin in dB}$$

$$\text{Hence VSWR} = \text{antilog (Attenuator setting/10)}$$

Conclusion: - We had analyzed standing wave pattern with different terminations using transmission line analyzer. We also find value of VSWR of transmission line for different terminations



SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
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Subject: WAVE THEORY AND ANTENNA

Experiment No: 06

Title: Simulation of Half wavelength Dipole Antenna.

Date Of performance:

Class: T.E

Date of Submission:

Signature

Aim: To simulate the half wavelength Dipole antenna and find following parameters related to antenna.

- 1) 3D Radiation Pattern
- 2) 2D Radiation Pattern
- 3) Return Loss
- 4) Gain in dB
- 5) Directivity in dB
- 6) Losses presents & Efficiency of antenna

Equipments Required: PCAADSoftware.

Theory:-

You have to write following parameters related to antenna

ESTD

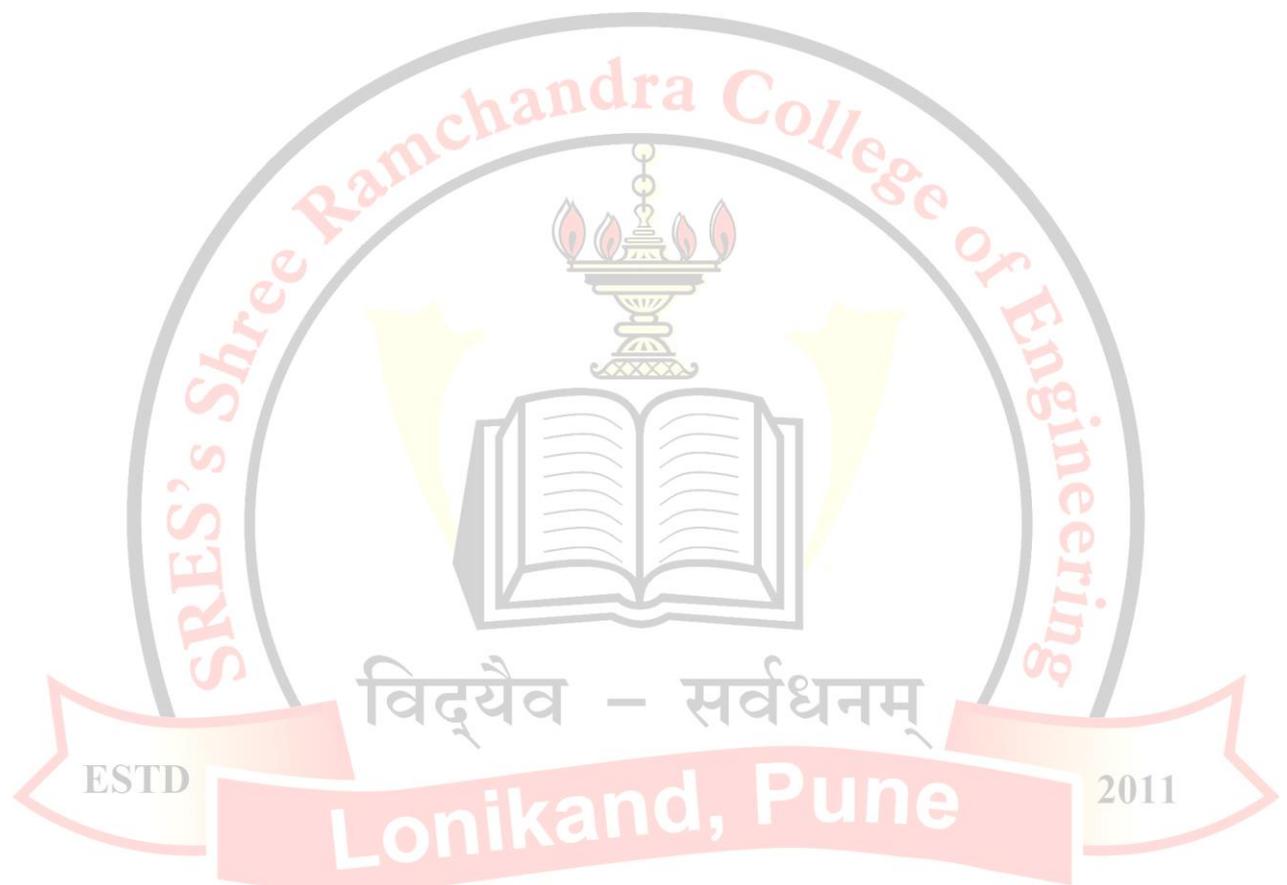
- 1) Basic type of antenna
- 2) Subtype of antenna
- 3) Operating frequency of antenna
- 4) Working principal of antenna
- 5) Theoretical parameters of antenna
- 6) Applications of antenna

Problem Statements:-

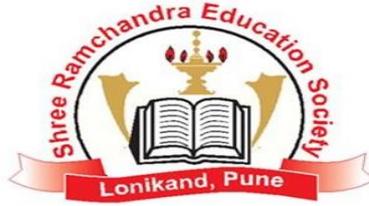
- 1) Design a simple half wavelength dipole antenna, whose wavelength is 4 m. The radius of wire used for antenna is 2 mm, apply electrical symmetry to $z=0$ plane.
- 2) Repeat above problem for a half wavelength dipole antenna of Cu material.

Observations: Compare simulated results of antenna for both cases i.e. without change in material & with change in material of antenna.

Conclusion: - We had simulated half wavelength dipole antenna using PCAADsoftware. We observe that a half wavelength dipole antenna is having perfectly eight shape 2D radiation pattern, we also observe that we get 100% efficiency & no losses in case of antenna with PEC material and there is reduction in efficiency & losses of Cu material antenna.



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Subject: WAVE THEORY AND ANTENNA

Experiment No: 07

Title: Simulation of Yagi Uda Array.

Date Of performance:

Class: T.E

Date of Submission:

Signature

Aim: To simulate the Yagi Uda array and find following parameters related to antenna.

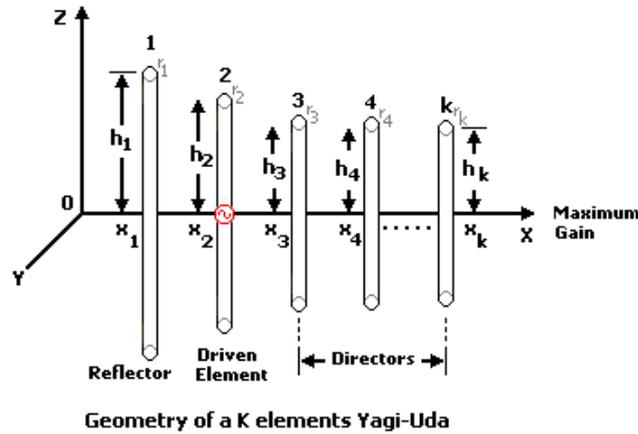
- 1) 3D Radiation Pattern
- 2) 2D Radiation Pattern
- 3) Return Loss
- 4) Gain in dB
- 5) Directivity in dB
- 6) Losses presents & Efficiency of antenna

Equipments Required: PCAAD Software

Theory:-

1. Yagi-Uda Antenna as Receiver:

The Yagi-Uda antenna or Yagi Antenna is one of the most brilliant antenna designs. It is simple to construct and has a high gain, typically greater than 10 dB. The Yagi-Uda antennas typically operate in the HF to UHF bands (about 3 MHz to 3 GHz), although their bandwidth is typically small, on the order of a few percent of the center frequency.



Each element is made by wire; rod or conductor tube with its own particular characteristic, very often aluminum.

$h_1, h_2, h_3 \dots h_k$ in the above graph, is the eighth of half element put symmetric to the X-axis which is called antenna boom. Then the physical length of each element k is $2h_k$. Every element have its own radius r_k , generally of the same diameter $2r_k$ by the manufacturers, but should be different. The $x_i - x_1$ values give the relative position of each element to the reflector element, $x_k - x_1$ is always the boom length of the antenna; generally x_1 is put to zero in some design description. In some design method a spacing elements $X_i - X_{i-1}$ is given instead the relative position. Element 1 is always the reflector element, the 2 is the driven element, and 3 is the first director. More than one director should be use, an antenna with ten directors is a twelve elements Yagi-Uda.

Problem Statements:-

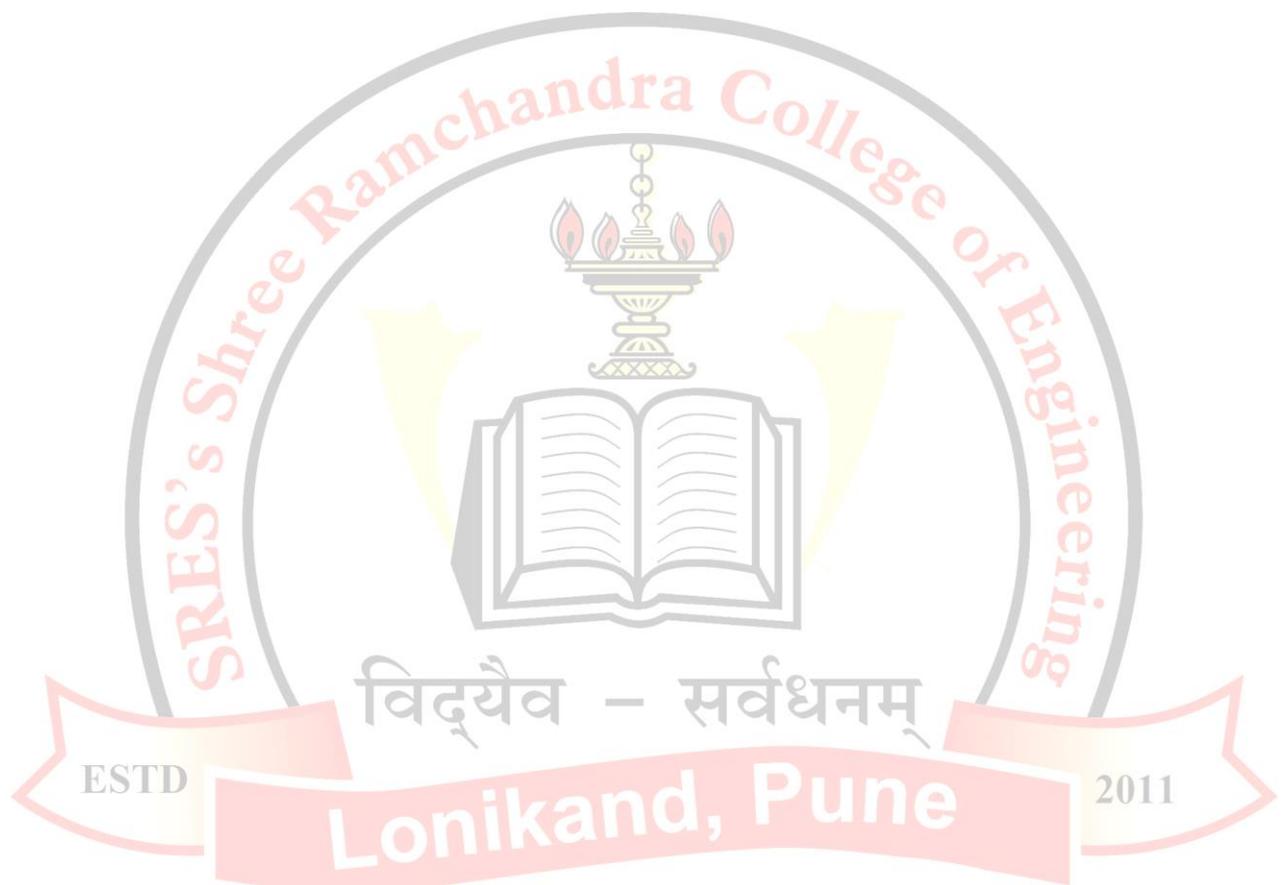
विद्यैव - सर्वधनम्

Design a 3 element Yagi Uda array operated at a frequency of 1 GHz. The length of reflector element is $0.2375 \cdot \lambda$, length of active element is $0.2265 \cdot \lambda$ & length of director is $0.2230 \cdot \lambda$. The spacing between elements of antenna is $0.3 \cdot \lambda$, the length of wire used for antenna construction is $0.00225 \cdot \lambda$, apply electrical symmetry to $z=0$ plane. Design Yagi Uda array for achieving radiation pattern in case of;

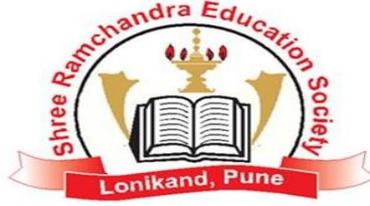
- 7) End Fire array
- 8) Broadside array.

Observations: explain what change is observed in radiation pattern with end fire & broadside array case.

Conclusion: - We had simulated Yagi Uda array using PCAAD software for both end fire & broadside array case. We found that we get a horizontal radiation pattern in case of end fire array & vertical radiation pattern with broadside array. We observe that if the spacing between reflector and active element reduces then back lobe is reduces.



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Subject: WAVE THEORY AND ANTENNA

Experiment No: 08

Title: Simulation of End Fire Array Using MATLAB .

Date Of performance:

Class: T.E

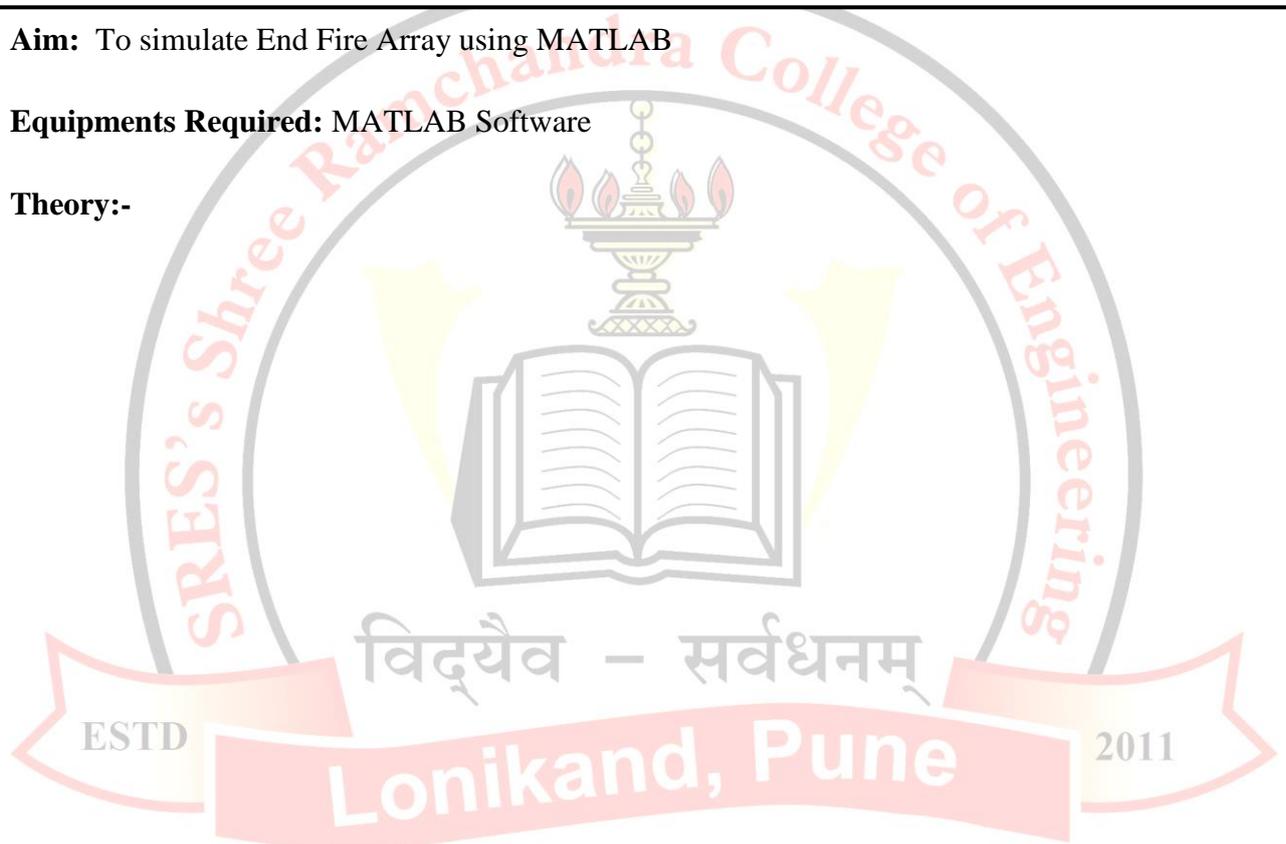
Date of Submission:

Signature

Aim: To simulate End Fire Array using MATLAB

Equipments Required: MATLAB Software

Theory:-



MATLAB Code:-

```
clc;
clear all;
close all hidden ;
f=input('Enter the operating frequency in Hz->');
N=input('Enter the number of elements(N)->');
disp('The value of wavelength lambda in meters:');
lambda=(3e8)/f %lambda=c/f , the value is in meters
disp('')
d=input('Enter the distance d in meters between the elements->');
beta=2*pi/lambda; %beta = 2pi/lambda
disp('')
disp('The progressive phase angle beta in degrees is->')
alfa= -beta.*d
disp('')
theta=0:0.01:2*pi; % Scale - 0 to 360
psi=(beta.*d.*cos(theta)+alfa); % value of sai
z1=(N/2).*(psi); %calculating the nulls
z2=(1/2)*(psi); % ratio of total field to the individual field
AF=sin(z1)./(N.*sin(z2)); %nulls
W=abs(AF); %Absolute value
polar(theta,W); %Plots the polar plot.
title('Normalized E-field polar pattern of array antenna in linear scale');
figure;
af=N*AF; % for N elements
afabs=abs(af);
afdb=20*log10(afabs);
afplot=(afdb+abs(afdb))/2; % mean of absolute value & value in dB of antenna
factorESTD
polar(theta,afplot); % polar plot in dB
title('Non-normalized polar pattern of the array in dB scale');
D0=lambda/(N*d);
disp('')
disp('The value of first null beam width FNBW is in degrees : ')
FNBW=(180/pi)*2*acos(1-D0)% formula for FNBW, here acos is inverse cosine
value
disp('')
disp('The value of half power beamwidth in degrees: ');
disp('')
HPBW=(180/pi)*2*acos(1-1.391*D0/pi) % formula for HPBW
disp('')
D=4*((N*d)/lambda)
disp('')
```

$$D_{dB} = 10 \cdot \log_{10}(D)$$

Output:

Enter the operating frequency in Hz->1e9

Enter the number of elements(N)->10

The value of wavelength lambda in meters:

lambda =

0.3000

Enter the distance d in meters between the elements->0.15

The progressive phase angle beta in degrees is->

alfa =

-3.1416

The value of first null beam width FNBW is in degrees :

FNBW =

73.7398

The value of half power beamwidth in degrees:

HPBW =

48.5880

D =

20

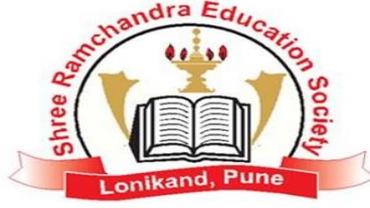
D_{dB} =

13.0103

Observations: By observing generated radiation pattern of end fire array, we know that there is maximum value of radiations (major lobe) on 0 and 180 degrees & there are side lobes present in the radiation pattern. We also find that when length of array is increases then directivity also increases but in this case side lobes are also increases. Also if we increases spacing between two elements of array (d), from a factor $\lambda/2$ then we get major lobe at an angle other than 180 degrees, and if we decreases spacing bellow $\lambda/2$ then the major lobe in direction of 180 degree decreases and major lobe in direction of 0 degree increases

Conclusion: - We had simulated end fire array using MATLAB, we also find value of Directivity, Half Power Beam Width (HPBW) & First Null Beam Width (FNBW) of end fire array.

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Subject: WAVE THEORY AND ANTENNA

Experiment No: 09

Title Simulation of Broad Side Array Using MATLAB .

Date Of performance:

Class: T.E

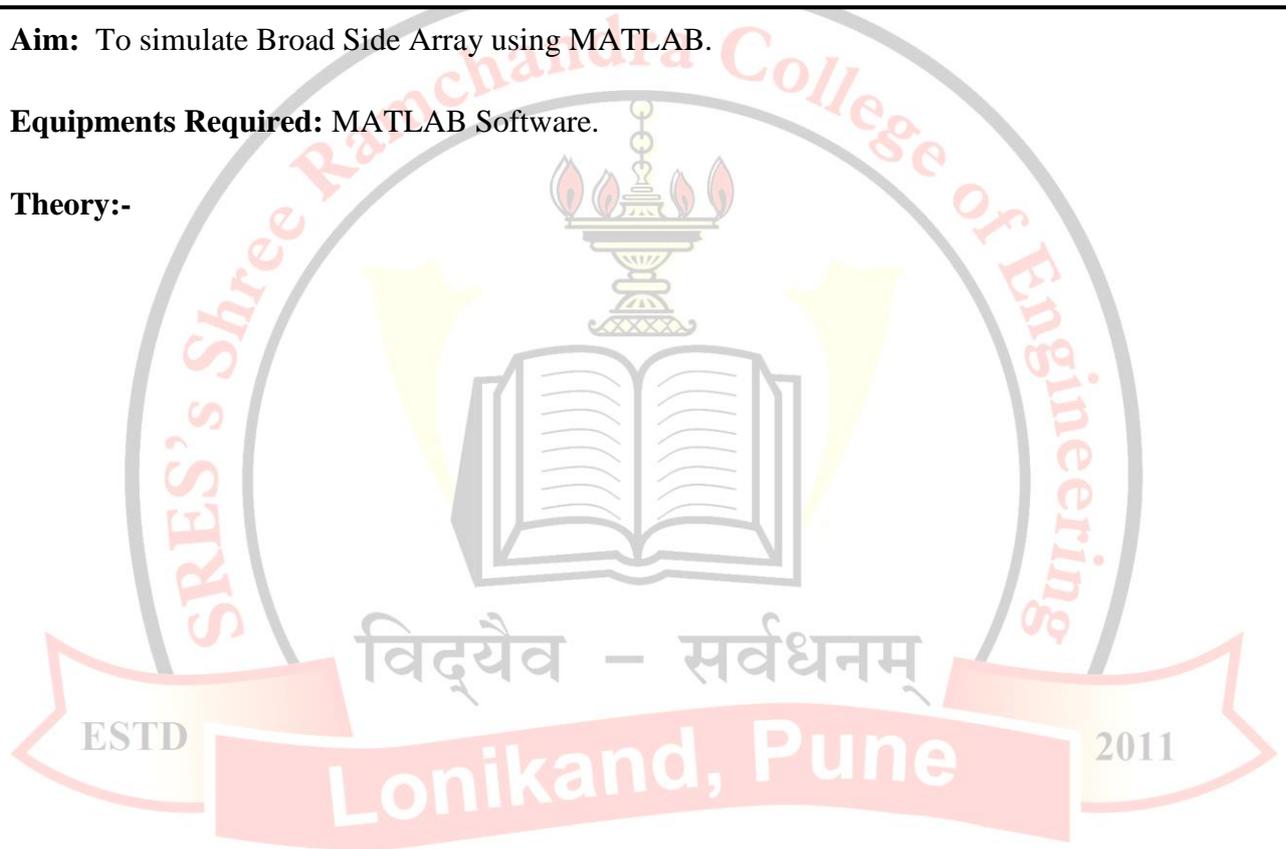
Date of Submission:

Signature

Aim: To simulate Broad Side Array using MATLAB.

Equipments Required: MATLAB Software.

Theory:-



MATLAB Code:-

```
clc;
clear all;
close all hidden ;
f=input('please enter the operating frequency in Hz->');
N=input('please enter the number of elements(N)->');
disp('The value of wavelength lambda in meters:');
lambda=(3e8)/f %lambda=c/f% the value of lamda in meters
d=input('Enter the distance d in meters between the elements->');
beta=2*pi/lambda; % equation for beta
theta=0:0.01:2*pi; % theta varies from 0 to 360
psi=(beta.*d.*cos(theta));% equation for sai
z1=(N/2).*(psi);% this gives total power radiated by an array (Et)
z2=(1/2)*(psi); % this gives power radiated by single element of array (E0)
AF=sin(z1)./(N.*sin(z2)); % equation for antenna factor
W=abs(AF); % absolute value of array factor
polar(theta,W); % plotting the polar plot which gives 2D radiation pattern
title('Normalized E-field of array antenna in linear scale');
figure;
af=N*AF; % normalized value of array factor
afabs=abs(af); % absolute value of normalized array factor
afdb=20*log10(afabs); % normalized array factor in dB
afplot=(afdb+abs(afdb))/2; % mean of two array factors
polar(theta,afplot); %plotting polar plot of normmalized radiation pattern
title('Non-normalized polar pattern of the array in dB scale');
D0=lambda/(N*d); % factor lambda/N*d
disp('')
disp('The value of first null beamwidth FNBW in degrees: ');
FNBW=(2.*D0)*(180/pi)% FNBW of broadside array, (2lambda/N*d)
disp('')
disp('The value of half power beamwidth in degrees: ');
disp('')
HPBW=(D0)*(180/pi) %HPBW of broadside array, FNBW/2 or lambda/N*d
disp('')
D=2*(N*d)/lambda)
disp('')
D_dB=10*log10(D)
```

Output:

please enter the operating frequency in Hz->1e9

please enter the number of elements(N)->10

The value of wavelength lambda in meters:

lambda =

0.3000

Enter the distance d in meters between the elements->0.15

The value of first null beamwidth FNBW in degrees:

FNBW =

22.9183

The value of half power beamwidth in degrees:

HPBW =

11.4592

D =

10

D_dB =

10

We also get two figures of broadside radiation pattern in linear & dB scale as a output.

Observations: By observing generated radiation pattern of broad side array, we know that there is maximum value of radiations (major lobe) on 90 and 270 degrees & there are side lobes present in the radiation pattern. We also find that when length of array is increases then directivity also increases but in this case side lobes are also increases & major lobe is narrower. Also if we increases spacing between two elements of array (d), from a factor $\lambda/2$ then there is increase in side lobes, and if we decreases spacing bellow $\lambda/2$ then the major lobe broader as decrease in spacing & also side lobes increases.

Conclusion: - We had simulated broad side array using MATLAB, we also find value of Directivity, Half Power Beam Width (HPBW) & First Null Beam Width (FNBW) of broad Side Array.

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Subject: WAVE THEORY AND ANTENNA

Experiment No: 10

Title : Simulation of Binomial Array Using MATLAB.

Date Of performance:

Class: T.E

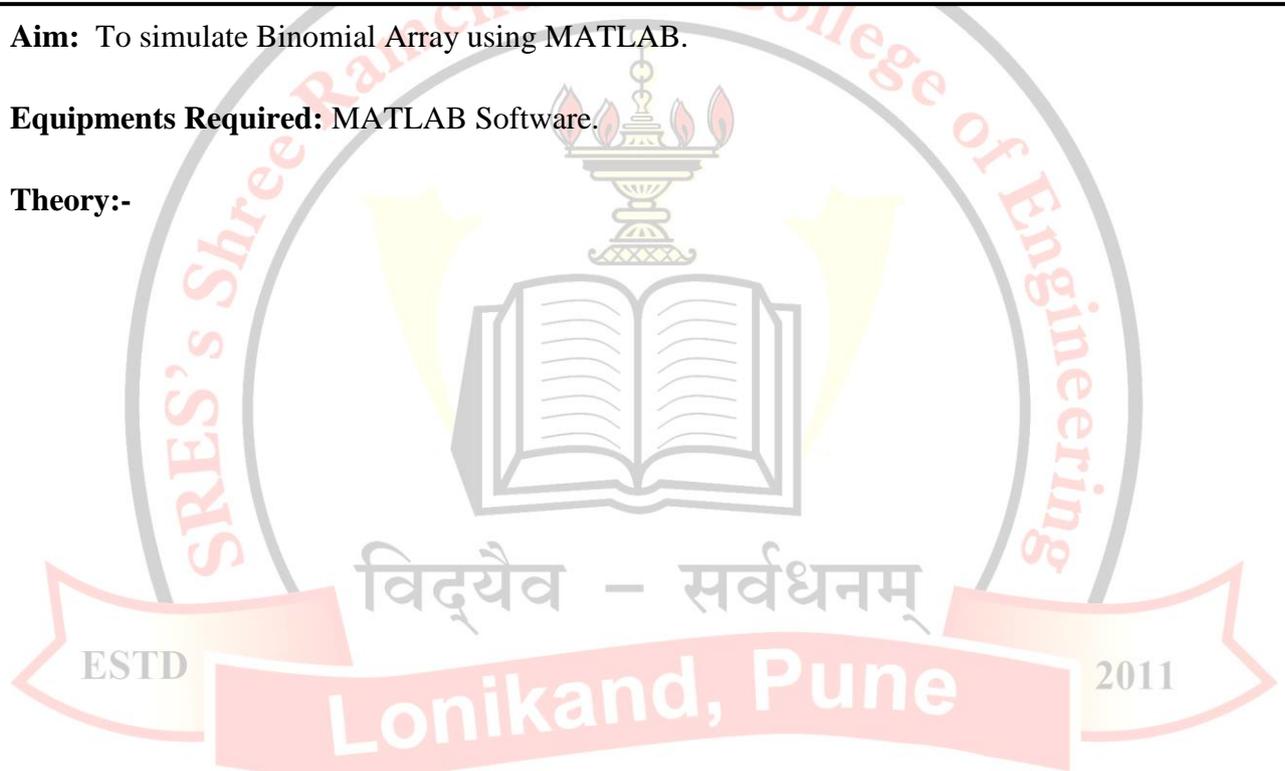
Date of Submission:

Signature:

Aim: To simulate Binomial Array using MATLAB.

Equipments Required: MATLAB Software.

Theory:-



MATLAB Code:-

```
clc;
clear all;
close all hidden ;
f=input('Enter the operating frequency in Hz->');
N=input('Enter the number of elements(N)->');
disp('The value of wavelength lambda in meters:');
lambda=(3e8)/f %lambda=c/f% the value is in meters
disp('Enter the distance between elements:');
disp('it is desirable to choose d<lambda/2->');
d=input('Enter the distance d in meters between the elements:->');
beta=2*pi/lambda;
theta=0:0.01:2*pi;
U=beta*d*cos(theta);%the U here is twice the u used in the block.
A=[0 0 0 0 0;1 0 0 0 0;1 1 0 0 0;3 1 0 0 0;3 4 1 0 0;10 5 1 0 0;10 15 6 1
0;... 35 21 7 1 0;35 56 28 8 1;126 84 36 9 1];
x=mod(N,2);
if x==0;
    AF=0;
    for n=1:5;
        AF=AF+A(N,n).*cos(((2*n-1)/2).*U);
    end
end
W=abs(AF);
w=W/max(W);
polar(theta,w)
title('Normalized E-field of array antenna in linear scale');
figure;
afdb=20*log10(W);
afplot=(afdb+abs(afdb))/2;
polar(theta,afplot);
title('Non-normalized polar pattern of the array in dB scale');
disp('')
disp('The HPBW and the directivity for the case d=lambda/2.')
HPBW=(1.06/(N-1)^0.5)*(180/pi)
D=1.77*(N)^0.5
D_db=10*log10(D)
```

Output :

Enter the operating frequency in Hz->1e9

Enter the number of elements(N)->10

The value of wavelength lambda in meters:

lambda =

0.3000

Enter the distance between elements::

it is desirable to choose $d < \lambda/2$ ->

Enter the distance d in meters between the elements:->0.15

The HPBW and the directivity for the case $d = \lambda/2$.

HPBW =

20.2445

D =

5.5972

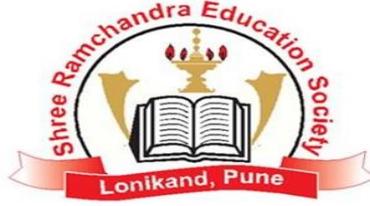
D_db =

7.4797

Observations: By observing generated radiation pattern of binomial array, we know that there is maximum value of radiations (major lobe) on 90 and 270 degrees & there are no side lobes present in the radiation pattern. We also find that when length of array is increases then directivity also increases.

Conclusion:- We had simulated binomial array using MATLAB, we also find value of Directivity, Half Power Beam Width (HPBW) & First Null Beam Width (FNBW) of binomial array.

SHREE RAMCHANDRA COLLEGE OF ENGINEERING, LONIKAND
DEPT. OF ELECTRONICS AND TELECOMMUNICATION



Subject: WAVE THEORY AND ANTENNA

Experiment No: 10

Title : Simulation of Binomial Array Using MATLAB.

Date Of performance:

Class: T.E

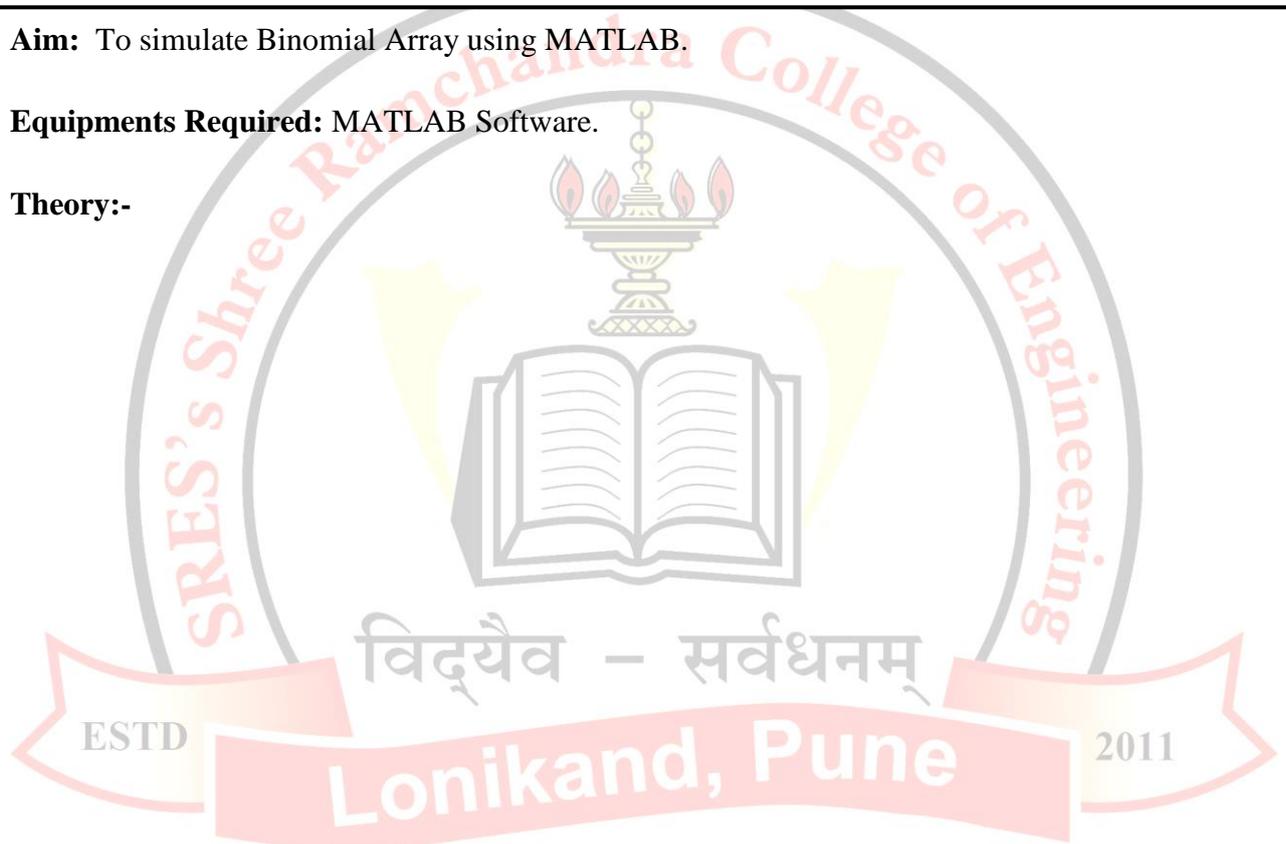
Date of Submission:

Signature:

Aim: To simulate Binomial Array using MATLAB.

Equipments Required: MATLAB Software.

Theory:-



MATLAB Code:-

```
clc;
clear all;
close all hidden ;
f=input('Enter the operating frequency in Hz->');
N=input('Enter the number of elements(N)->');
disp('The value of wavelength lambda in meters:');
lambda=(3e8)/f %lambda=c/f% the value is in meters
disp('Enter the distance between elements:');
disp('it is desirable to choose d<lambda/2->');
d=input('Enter the distance d in meters between the elements:->');
beta=2*pi/lambda;
theta=0:0.01:2*pi;
U=beta*d*cos(theta);%the U here is twice the u used in the block.
A=[0 0 0 0 0;1 0 0 0 0;1 1 0 0 0;3 1 0 0 0;3 4 1 0 0;10 5 1 0 0;10 15 6 1
0;... 35 21 7 1 0;35 56 28 8 1;126 84 36 9 1];
x=mod(N,2);
if x==0;
    AF=0;
    for n=1:5;
        AF=AF+A(N,n).*cos(((2*n-1)/2).*U);
    end
end
W=abs(AF);
w=W/max(W);
polar(theta,w)
title('Normalized E-field of array antenna in linear scale');
figure;
afdb=20*log10(W);
afplot=(afdb+abs(afdb))/2;
polar(theta,afplot);
title('Non-normalized polar pattern of the array in dB scale');
disp('')
disp('The HPBW and the directivity for the case d=lambda/2.')
HPBW=(1.06/(N-1)^0.5)*(180/pi)
D=1.77*(N)^0.5
D_db=10*log10(D)
```

Output :

Enter the operating frequency in Hz->1e9

Enter the number of elements(N)->10

The value of wavelength lambda in meters:

lambda =

0.3000

Enter the distance between elements::

it is desirable to choose $d < \lambda/2$ ->

Enter the distance d in meters between the elements:->0.15

The HPBW and the directivity for the case $d = \lambda/2$.

HPBW =

20.2445

D =

5.5972

D_db =

7.4797

Observations: By observing generated radiation pattern of binomial array, we know that there is maximum value of radiations (major lobe) on 90 and 270 degrees & there are no side lobes present in the radiation pattern. We also find that when length of array is increases then directivity also increases.

Conclusion:- We had simulated binomial array using MATLAB, we also find value of Directivity, Half Power Beam Width (HPBW) & First Null Beam Width (FNBW) of binomial array.