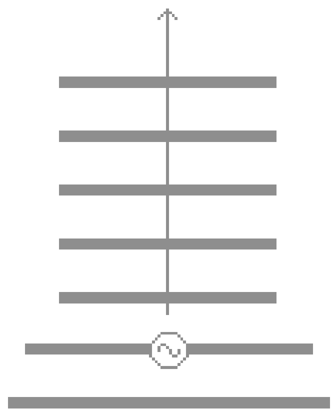
Experiment No. 7

Aim: To study and plot the radiation pattern of the yagi-uda antenna.

Theory: -



This routine analyzes a Yagi-Uda dipole array using a moment method solution that includes all mutual coupling terms. Dipole currents are expanded using piecewise sinusoidal (PWS) Modes. The routine computes input impedance, gain, front to-back ratio, and patterns for the array. The array is assumed to have one reflector element, one driven dipole element, and an arbitrary number of director elements. The length and spacing for each element is variable, but the radius is assumed to be the same for all elements.

Begin by entering the frequency, the dipole radius, the number of PWS modes on each dipole, and the number of director elements. Next, specify the lengths and spacing's of the elements using the scroll bar and text boxes. The name of each element is listed in the box to the right of the scroll bar, followed by boxes for its length and spacing from the previous element. Thus, the spacing of the first element (the reflector) is not used, and is set to zero. Use the scroll bar to scroll through the elements to set or change lengths and spacings. Patternplots can be made in the E and H-planes of the dipole, or E-theta / E-phi or Co-pol / X-pol patterns can be made at an arbitrary azimuth angle. Patterns can be plotted in polar, rectangular, or volumetric (3-D) form, and patterns can be saved as data files. Select the pattern type and parameters with the Pattern Type Select button.

When all data is entered, click the Compute button to calculate the moment method solution. The input impedance, gain, and front-to-back ratio will be listed. The specified patterns are also calculated, and may be plotted using the Plot Patterns button, or saved to data files.

Example:

Consider a Yagi array with the following specifications:

1. **Reflector length =**
2. **Fed element length =**
3. **Director length (1) =**
4. **Spacing between reflector and feed =**
5. **Spacing between feed and director =**
6. **Dipole radius =**
7. **Frequency =**
8. **9 PWS modes per element =**

Conclusion: -

Experiment No. 8

Aim: To study and plot the radiation pattern of the helical antenna.

Theory: -

Helical antenna is an example of wire antenna and itself forms the shape of a helix. This is a broadband VHF and UHF antenna.

Frequency Range

The frequency range of operation of helical antenna is around **30MHz to 3GHz**. This antenna works in **VHF** and **UHF** ranges.

Helical antenna or helix antenna is the antenna in which the conducting wire is wound in helical shape and connected to the ground plate with a feeder line. It is the simplest antenna, which provides **circularly polarized waves**. It is used in extra-terrestrial communications in which satellite relays etc., are involved.

The above image shows a helical antenna system, which is used for satellite communications. These antennas require wider outdoor space.

It consists of a helix of thick copper wire or tubing wound in the shape of a screw thread used as an antenna in conjunction with a flat metal plate called a ground plate. One end of the helix is connected to the centre conductor of the cable and the outer conductor is connected to the ground plate.

The radiation of helical antenna depends on the diameter of helix, the turn spacing and the pitch angle.

Pitch angle is the angle between a line tangent to the helix wire and plane normal to the helix axis.

$$\alpha = \tan^{-1}\left(\frac{S}{\pi D}\right)$$

where,

- **D** is the **diameter** of helix.
- **S** is the **turn spacing** (centre to centre).
- **α** is the **pitch angle**.

Modes of Operation

The predominant modes of operation of a helical antenna are −

- **Normal** or perpendicular mode of radiation.
- **Axial** or end-fire or beam mode of radiation.

Normal mode

In normal mode of radiation, the radiation field is normal to the helix axis. The radiated waves are circularly polarized. This mode of radiation is obtained if the dimensions of helix are small compared to the wavelength. The radiation pattern of this helical antenna is a combination of short dipole and loop antenna.

It depends upon the values of diameter of helix, **D** and its turn spacing, **S**. Drawbacks of this mode of operation are low radiation efficiency and narrow bandwidth. Hence, it is hardly used.

Axial mode

In **axial mode** of radiation, the radiation is in the end-fire direction along the helical axis and the waves are circularly or nearly circularly polarized. This mode of operation is obtained by raising the circumference to the order of one wavelength **(λ)** and spacing of approximately **λ/4**. The radiation pattern is broad and directional along the axial beam producing minor lobes at oblique angles.

If this antenna is designed for right-handed circularly polarized waves, then it will not receive left-handed circularly polarized waves and vice versa. This mode of operation is generated with great ease and is **more practically used**.

Advantages

The following are the advantages of Helical antenna −

- Simple design
- Highest directivity
- Wider bandwidth
- Can achieve circular polarization
- Can be used at HF & VHF bands also

Disadvantages

The following are the disadvantages of Helical antenna −

- Antenna is larger and requires more space
- Efficiency decreases with number of turns

Applications

The following are the applications of Helical antenna −

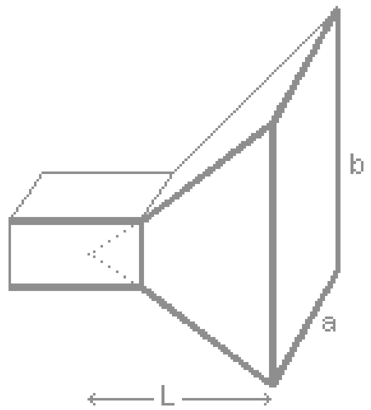
- A single helical antenna or its array is used to transmit and receive VHF signals
- Frequently used for satellite and space probe communications
- Used for telemetry links with ballastic missiles and satellites at Earth stations
- Used to establish communications between the moon and the Earth
- Applications in radio astronomy

Conclusion: -

Experiment No. 9

Aim: To study and plot the radiation pattern of the horn antenna.

Theory:



This routine computes the pattern and directivity of pyramidal pyramidal horn antenna. For horns with small apertures, accuracy is improved by computing the directivity by numerical integration of the pattern. The phase centre, for both principal planes, is also computed.

Begin by entering the frequency, the E and H-plane aperture dimensions, and the axial lengths of the horn in the E and H planes. The axial lengths are the distances from the imaginary apex of the horn in the E and H planes to the mouth of the horn (not the slant lengths) as shown in the above figure. Click the Compute button to compute the patterns and related antenna parameters. The routine prints out the maximum phase errors at the edges of the aperture (relative to the centre of the aperture), the optimum aperture dimensions, the directivity of the horn, and the E- and H-plane phase centers.

Pattern plots can be made in the E- and H-planes of the horn, or E-theta / E-phi or Co-pol / X-pol patterns can be made at an arbitrary azimuth angle. Patterns can be plotted in polar, rectangular, or volumetric (3-D) form, and patterns can be saved as data files. Select the pattern type and parameters with the Pattern Type Select button.

Example:

Consider a pyramidal horn antenna with following specifications: Frequency =

E-plane aperture dimension=

H-plane aperture dimension =

Axial length =

<u>Conclusion: -</u>

Experiment No. 10

Aim: To study and plot the radiation pattern of the parabolic reflector

Theory:

PART I:

This routine analyzes the performance of a prime-focus parabolic reflector antenna, under the assumption that the feed antenna has a rotationally symmetric power pattern that can be approximated as $\cos^n\theta$. In this case, simple (but exact) expressions can be obtained for the spillover and taper efficiencies.The effect of surface roughness can also be included.

Begin by entering the frequency, the f/D ratio, the dish diameter, and the rms surface roughness. The surface roughness dimension has a default value of zero.

Next, specify the feed pattern in one of three forms: enter either the 3 dB beamwidth, the 10 dB beamwidth, or the actual value of n = 2, 4, 6, or 8 for a pattern of the form $\cos^n\theta$. If you specify a beamwidth, the routine will calculate the closest value of n that approximates this beamwidth, and will display the value of n that it will use. The routine then computes the spillover, taper, roughness, and total aperture efficiencies, then computes the directivity of the antenna. The 3 dB beamwidth is also calculated from the directivity.

Example:

Consider a parabolic reflector with following specifications:

Dish diameter =

f/D ratio =

Feed pattern with n=

No surface roughness Frequency=

PART II:

Begin by entering the frequency, the f/D ratio, the dish diameter, and the rms surface roughness. The surface roughness dimension has a default value of zero.

Next, select the feed pattern files using the file dialog boxes. The feed pattern data must be in the format of (angle in degrees, pattern in dB), with an angle range that extends at least from -90° to 90°. The step size of the feed pattern data file is arbitrary – numerical interpolation is used when necessary. Pattern files generated by other PCAAD routines follow this format, allowing other PCAAD routines to be used to generate feed patterns for direct use in this routine. For example, a horn antenna module can be used to generate a feed pattern file, which can then be used in this routine to find the secondary patterns of the reflector. Only the feed pattern amplitude is used. The feed is assumed to be linearly polarized at $\varphi=0°$.

Example:

A prime-focus reflector has the following specifications:

Diameter =

f/D =

Frequency =

The feed is a short dipole, with an E-plane pattern of cosθ , and an H-plane pattern that is constant (these data files, named paraE.dat and paraH.dat, are supplied with PCAAD).

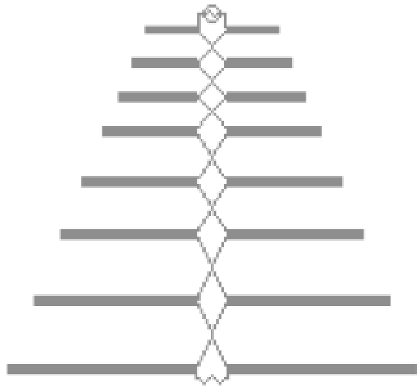
The calculated pattern in the $\varphi=45°$ plane is shown in the output, showing a maximum cross-pol level of 26 dB and a maximum sidelobe level of 20 dB.

Conclusion: -

Experiment No. 11

Aim: To study and plot the radiation pattern of the Log-Periodic antenna.

Theory:



PART I: DESIGN

This routine gives an approximate design for a log-periodic dipole array, for a specified bandwidth and gain. The routine computes the necessary number of dipoles in the array, and the spacing's, lengths, and radii for each element. First enter the lower and upper frequencies of the desired operating band. Then enter the desired gain (between 7 and 11 dB), and the radius of the largest dipole.

The routine prints out the log-periodic array scale factors, σ and τ, followed by a list of the spacing, length, and radius for each element in the array. The scroll bar in the list box can be used to scroll through the elements. Spacing's are measured from the largest dipole.

Example:

Consider an LPDA design with following specifications:

Lower frequency =

Upper frequency =

Directivity =

Largest dipole radius=

PART II: ANALYSIS

This routine performs a complete analysis of a log-periodic dipole array using a moment method solution that includes all mutual coupling terms. Dipole currents are expanded using piecewise sinusoidal (PWS) modes. The array is fed with a transmission line having alternating terminals, and analyzed using port admittance. The routine computes the input impedance at the feed port, the array directivity and gain, and the patterns for the array. As shown in the graphic, the dipoles are all parallel to the xaxis, with the main beam in the z direction. The feed is assumed to be at the terminals of the smallest dipole, and a matched load is assumed to be located at the terminals of the largest dipole. The dimensions and spacing's can be manually entered for each dipole, or you can enter the σ and τ parameters for the array and let the routine calculate all necessary dimensions. The geometry of the LPDA can be viewed in three dimensions by clicking the Show Geometry button.

Begin by entering the frequency, the feed line characteristic impedance, the number of dipoles in the array, and the number of expansion modes to be used on each dipole (this value may need to be increased for frequencies at the high end of the operating range). At this point you can click the Get Data button to enter the σ and τ parameters of the LPDA array, along with the length and radius of the first (longest) dipole in the array. The routine will then compute all necessary dimensions and spacing's for the array, and automatically enter these values (upon clicking the OK button) into the scroll boxes. Alternatively, you can manually enter the length, spacing, and radius for each dipole in the array. The dipoles are numbered starting from the largest element; the last spacing value is not used.

Pattern plots can be made in the E- and H-planes of the dipole, or E-theta / E-phi or
Co-pol / X-pol patterns can be made at an arbitrary azimuth angle. Patterns can be plotted in polar, rectangular, or volumetric (3-D) form, and patterns can be saved as data files. Select the pattern type and parameters with the Pattern Type Select button. When all data is entered,

click the Compute button to calculate the moment method solution. The input impedance, directivity, and gain (accounting for power lost in the termination resistor), and the front-to- back ratio are listed, along with the magnitude and phase of the terminal currents at each dipole (these values include the 180° reversal introduced by the feed line). This data can be used to observe how the "active region" moves along the array as frequency changes.

Example:

Consider a log periodic dipole array with following specifications:

1. Total number of elements=
2. σ =
3. **. τ =**
4. Largest dipole length =
5. **Radius =**
6. Characteristic impedance =
7. **Frequency=**

Conclusion: -