EE 305: Electromagnetic Waves
Course Project Report
Group 17

Project Overview
The project aimed to develop a MATLAB script and a graphical user interface (GUI) app to facilitate the design and analysis of a finite-length dipole strip antenna.
The main deliverables of our project are:

1. **MATLAB Script (main_script.m)**
2. **GUI app (DipoleAntennaDesigner.mlapp)**

The **main_script.m** file contains the **hard coded equations** for the design of antenna and generation of plots. The **DipoleAntennaDesigner.mlapp** uses the logic provided in the main_script.m and provides an **interactive interface** for changing the parameters of the antenna and visualising the results.

Key Features of GUI App
Our Dipole Antenna Designer app has the following features:
It has three tabs:
1. Design Tab
2. Analysis-I tab
3. Analysis-II tab

The app enables users to input dipole antenna parameters namely
- Frequency
- Length
- Width
- Maximum current phasor

in the design tab and generates in the Analysis tabs:
- A 3D mesh representation of the antenna
- Impedance plot
- 3D Radiation pattern plot
- Current distribution plot
- Azimuthal plot and Elevation plot.

Plots are interactive, allowing users to examine and analyse antenna characteristics.

Technical Implementation
The following equations have been used to generate the required plots from length (l), width (w), frequency (f), maximum of current phasor (Im).

1. **Equation for Current distribution:**

$$I(z') = \begin{cases} I_0 \sin\left[\beta\left(\frac{l}{2} - z'\right)\right], & 0 \le z' \le l/2 \\ I_0 \sin\left[\beta\left(\frac{l}{2} + z'\right)\right], & -l/2 \le z' \le 0. \end{cases}$$

2. **Equation for Impedance plot:**

$$R_{\text{dipole}} = \frac{\eta_0}{2\pi \sin^2\left(\frac{1}{2}kL\right)} \Bigg\{ \gamma_e + \ln(kL) - \text{Ci}(kL) + \tfrac{1}{2}\sin(kL)\left[+ \text{Si}(2kL) - 2\,\text{Si}(kL) \right] + \tfrac{1}{2}\cos(kL)\left[+ \text{Ci}(2kL) - 2\,\text{Ci}(kL) + \gamma_e + \ln\left(\tfrac{1}{2}kL\right) \right] \Bigg\},$$

$$X_{\text{dipole}} = \frac{\eta_0}{2\pi \sin^2\left(\frac{1}{2}kL\right)} \Bigg\{ + \text{Si}(kL) + \tfrac{1}{2}\cos(kL)\left[- \text{Si}(2kL) + 2\,\text{Si}(kL) \right] + \tfrac{1}{2}\sin(kL)\left[+ \text{Ci}(2kL) - 2\,\text{Ci}(kL) + \text{Ci}\left(\tfrac{2ka^2}{L}\right) \right] \Bigg\},$$

3. **Equation for 3D Radiation plot:**

$$F(\theta,\varphi) = \frac{\left[\cos\left(\frac{\beta l}{2}\cos\theta\right) - \cos\left(\frac{\beta l}{2}\right)\right]^2}{\sin^2\theta}.$$

4. **Equations for Azimuthal and Elevation plots:**

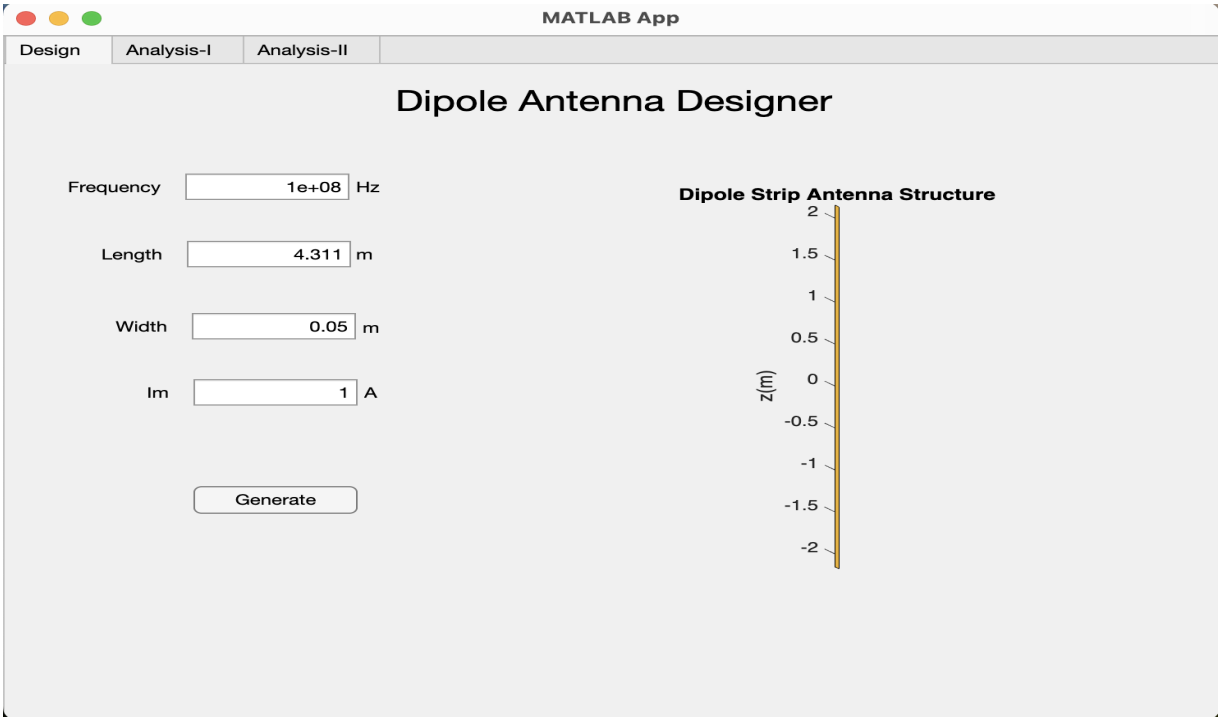
   Azimuthal plot is obtained by putting theta = 0 in F(theta,Phi) in above equation.
   Elevation plot is obtained by putting phi = 0 in F(theta,Phi) in above equation.

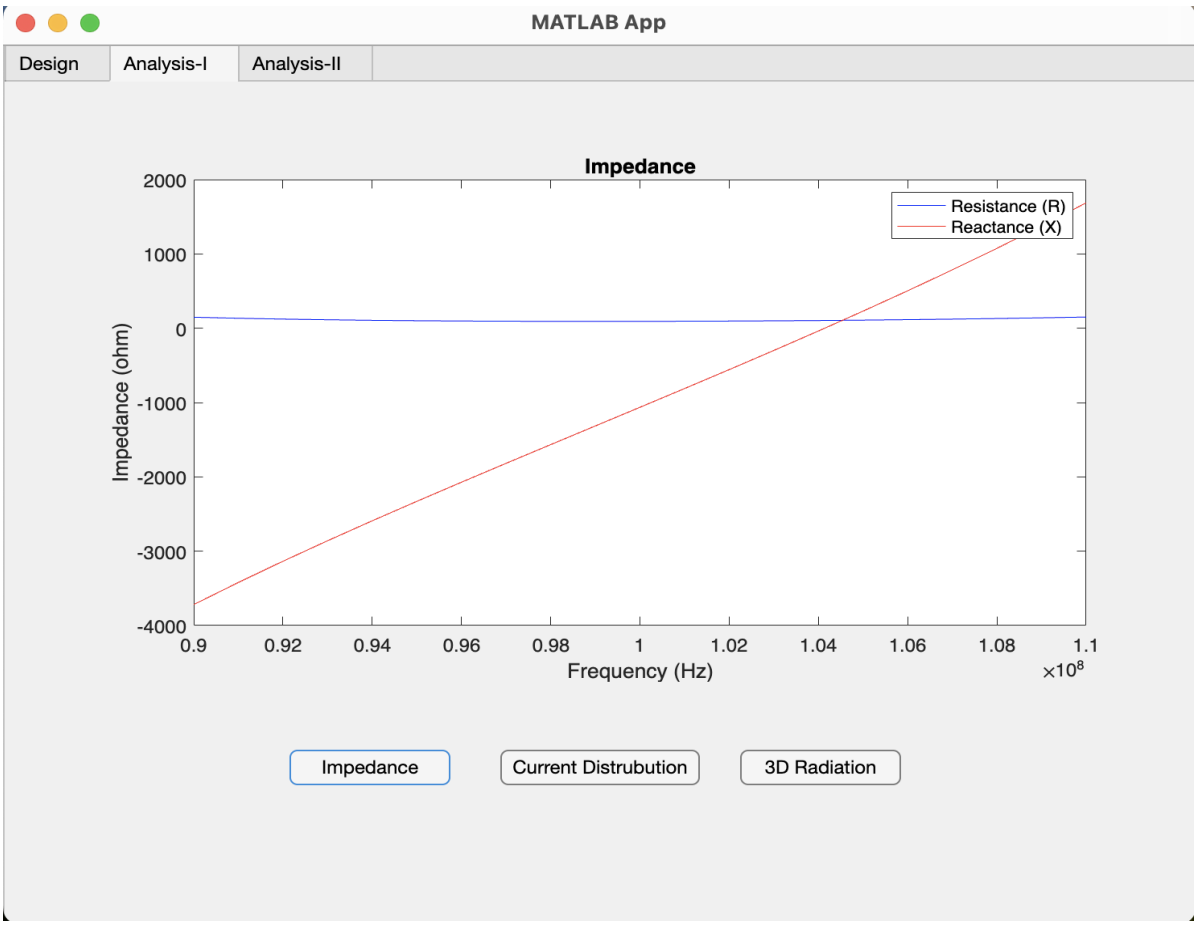
Results:

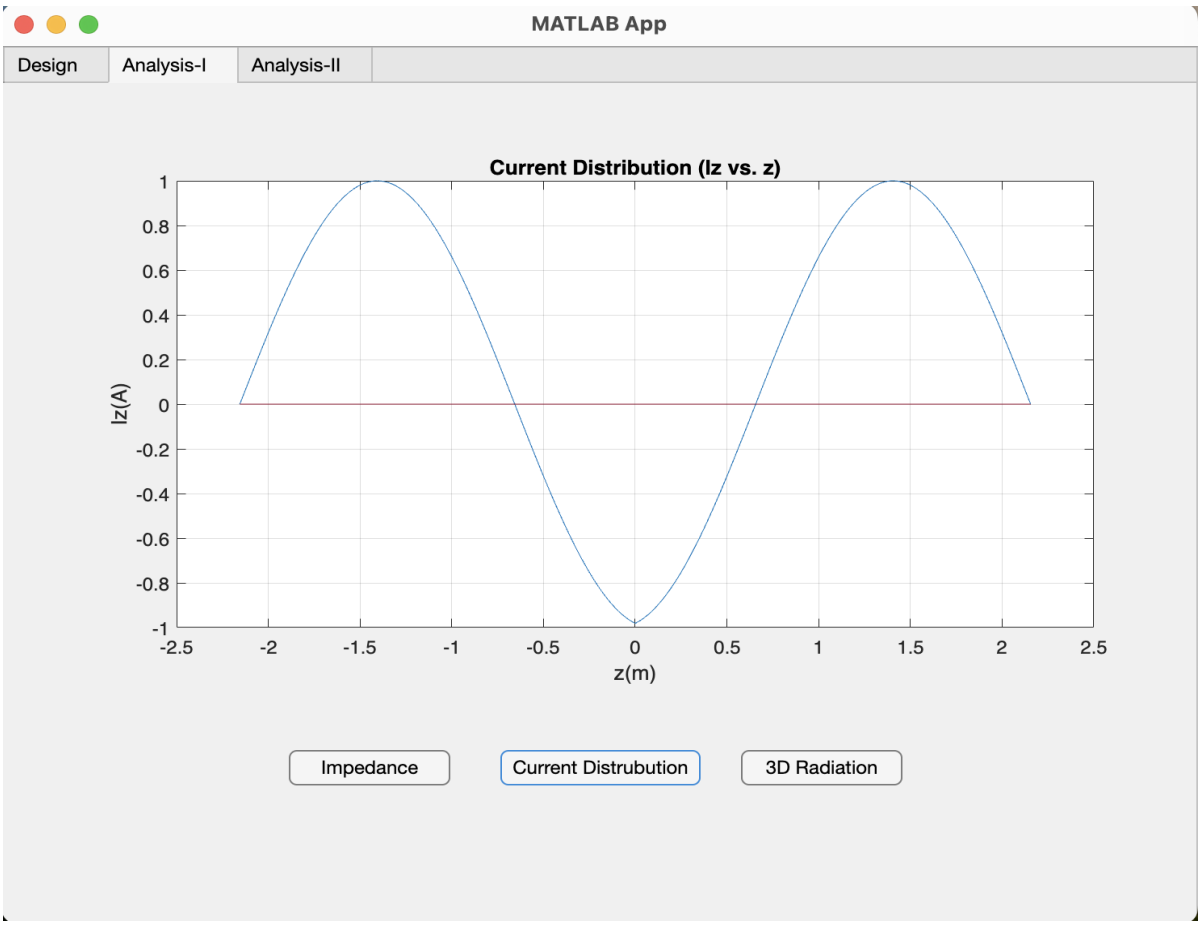
We have attached here the results for the following parameters:

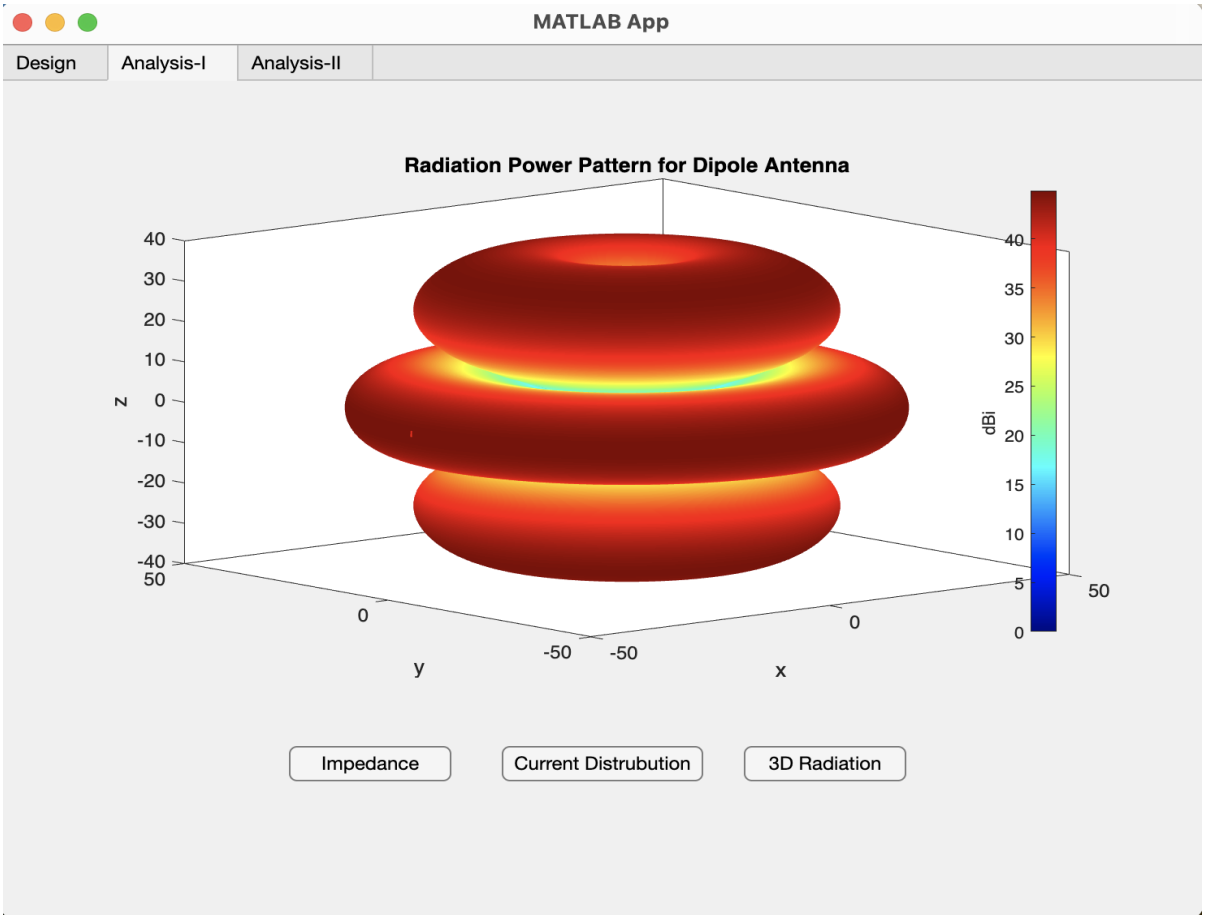
- Frequency (f) =100Mhz
- Length (l) = 4.311m(1.5 λ)
- Width (w) = 0.05m
- Current (Imax) = 1A

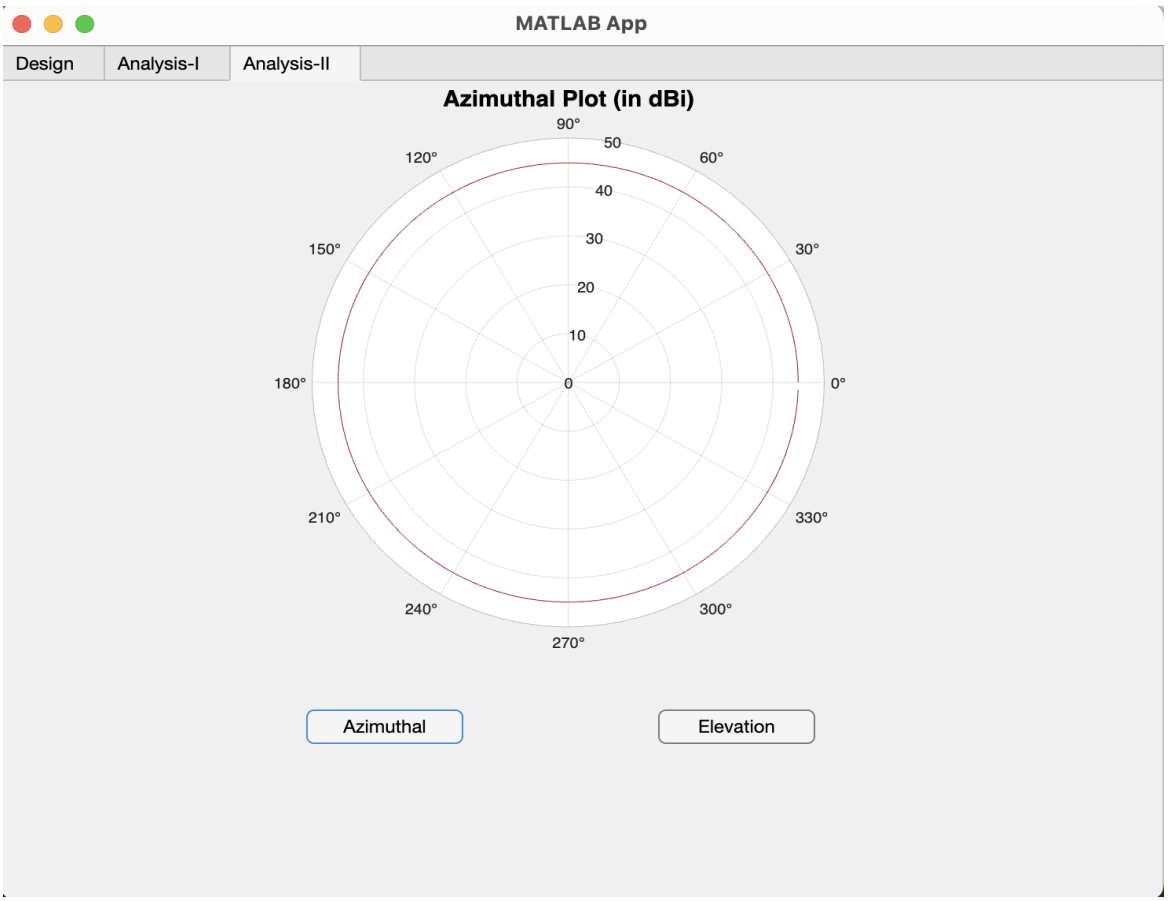
Plots:

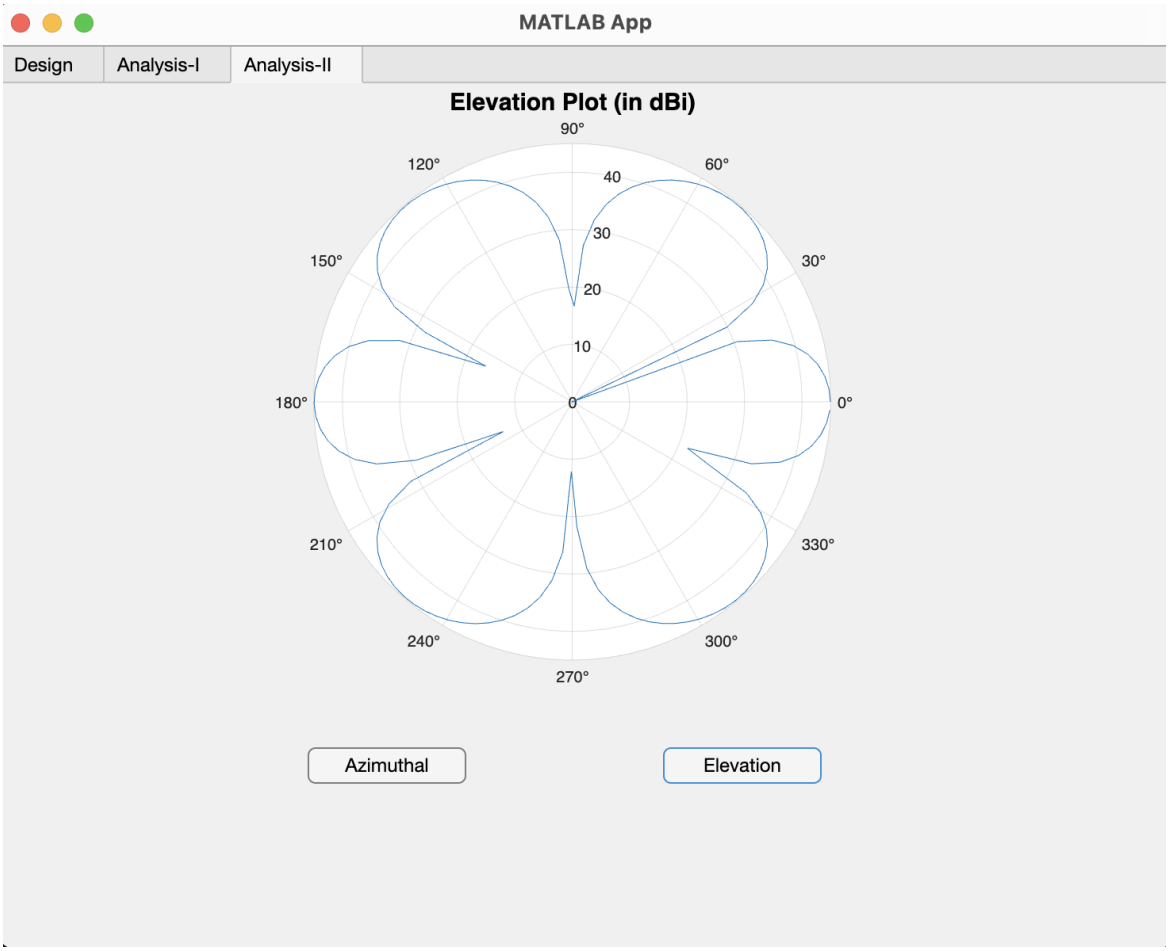

MATLAB App
Design
Analysis-I
Analysis-II
Dipole Antenna Designer
Frequency
1e+08
Hz
Length
4.311
m
Width
0.05
m
Im
1
A
Generate
Dipole Strip Antenna Structure
z(m)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2


MATLAB App
Design
Analysis-I
Analysis-II
Impedance
Resistance (R)
Reactance (X)
Impedance (ohm)
2000
1000
0
-1000
-2000
-3000
-4000
0.9
0.92
0.94
0.96
0.98
1
1.02
1.04
1.06
1.08
1.1
Frequency (Hz)
×10^8
Impedance
Current Distrubution
3D Radiation


MATLAB App
Design
Analysis-I
Analysis-II
Current Distribution (Iz vs. z)
Iz(A)
z(m)
Impedance
Current Distrubution
3D Radiation


MATLAB App
Design
Analysis-I
Analysis-II
Radiation Power Pattern for Dipole Antenna
z
y
x
dBi
Impedance
Current Distrubution
3D Radiation


MATLAB App
Design
Analysis-I
Analysis-II
Azimuthal Plot (in dBi)
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
50
40
30
20
10
0
Azimuthal
Elevation


MATLAB App
Design
Analysis-I
Analysis-II
Elevation Plot (in dBi)
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
40
30
20
10
0
Azimuthal
Elevation

References:

1. Cheng, David Keun (2014). Field and Wave Electromagnetics (Second ed., Chapter 11: Antennas and Radiating Systems.)

2. https://www.ece.mcmaster.ca/faculty/nikolova/antenna_dload/current_lectures/L09_Dipole.pdf

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