

EE2703 Final Exam

Harshavardhan Mudadla

May 12, 2022

1 Pseudo Code for Question1

We are trying to compute points to work on.

1. Divide the wire into pieces of length dz and so, we have $2N$ pieces and $2N + 1$ points.
2. Then we are going to create an array "z" of length $2N + 1$ which contains point coordinates. This is done using "*linspace*" command.
3. We will take construct array of length $2N - 2$ which will not have coordinates $-0.5, 0, 0.5$ was done by deleting it from z.
4. We are going to compute at $N = 4$.

1.1 Matrices Obtained

Vector z :

$[-0.5 \quad -0.38 \quad -0.25 \quad -0.12 \quad 0. \quad 0.12 \quad 0.25 \quad 0.38 \quad 0.5]$

Vector u :

$[-0.38 \quad -0.25 \quad -0.12 \quad 0.12 \quad 0.25 \quad 0.38]$

2 Pseudo Code for Question2

We need an equation for each unknown current. These equations are obtained by calculating the Magnetic field in two different ways.

From Ampere's Law:

1. We have $H = M * J$. We will compute H at $r = a$
2. We will construct matrix M by using "*identity*" command to get unit matrix of size $(2N - 2, 2N - 2)$

2.1 Matrices Obtained

Matrix M:

$$\begin{bmatrix} 15.92 & 0. & 0. & 0. & 0. & 0. \\ 0. & 15.92 & 0. & 0. & 0. & 0. \\ 0. & 0. & 15.92 & 0. & 0. & 0. \\ 0. & 0. & 0. & 15.92 & 0. & 0. \\ 0. & 0. & 0. & 0. & 15.92 & 0. \\ 0. & 0. & 0. & 0. & 0. & 15.92 \end{bmatrix}$$

3 Pseudo Code for Question3

From Vector potential:

1. We have to construct two Matrices P and Pb .
 P is the contribution to the vector potential due to currents unknown. It is a matrix with $2N+1$ columns and $2N+1$ rows.
 Pb is the contribution to the vector potential due to current $z = 0$. It is a column vector.
2. To construct those we are going to need Rz, Ru, RiN .
 Rz computes distances including distances to known current.
 Ru is a vector of distances to unknown currents.
 RiN is distances with respect to $z = 0$ coordinate.
3. We will have zi in which we store all the points present in z vector multiple times in different rows of order $2N+1$. We will do the same for xi , but we store it different columns. These matrices obtained using *Meshgrid* command.
4. For Rz we will get the distances using these Zi and zj .
5. Similarly we will take ui and uj with all points in u vector to obtain Ru . RiN is obtained by deleting $0, N, 2N$ indexed elements of Rz in $N+1$ th column.
6. From Ru and RiN we will get P and Pb .

3.1 Matrices Obtained

Matrix Rz :

```
[[0.01+0.j 0.13+0.j 0.25+0.j 0.38+0.j 0.5 +0.j 0.63+0.j
0.75+0.j 0.88+0.j 1. +0.j]
```

```
[0.13+0.j 0.01+0.j 0.13+0.j 0.25+0.j 0.38+0.j 0.5 +0.j
0.63+0.j 0.75+0.j 0.88+0.j]
```

```
[0.25+0.j 0.13+0.j 0.01+0.j 0.13+0.j 0.25+0.j 0.38+0.j
0.5 +0.j 0.63+0.j 0.75+0.j]
```

```
[0.38+0.j 0.25+0.j 0.13+0.j 0.01+0.j 0.13+0.j 0.25+0.j
0.38+0.j 0.5 +0.j 0.63+0.j]
```

```
[0.5 +0.j 0.38+0.j 0.25+0.j 0.13+0.j 0.01+0.j 0.13+0.j
0.25+0.j 0.38+0.j 0.5 +0.j]
```

```
[0.63+0.j 0.5 +0.j 0.38+0.j 0.25+0.j 0.13+0.j 0.01+0.j
0.13+0.j 0.25+0.j 0.38+0.j]
```

$\begin{bmatrix} 0.75+0.j & 0.63+0.j & 0.5 & +0.j & 0.38+0.j & 0.25+0.j & 0.13+0.j \\ 0.01+0.j & 0.13+0.j & 0.25+0.j \end{bmatrix}$

$\begin{bmatrix} 0.88+0.j & 0.75+0.j & 0.63+0.j & 0.5 & +0.j & 0.38+0.j & 0.25+0.j \\ 0.13+0.j & 0.01+0.j & 0.13+0.j \end{bmatrix}$

$\begin{bmatrix} 1. & +0.j & 0.88+0.j & 0.75+0.j & 0.63+0.j & 0.5 & +0.j & 0.38+0.j \\ 0.25+0.j & 0.13+0.j & 0.01+0.j \end{bmatrix}$

Matrix Ru :

$\begin{bmatrix} [0.01+0.j & 0.13+0.j & 0.25+0.j & 0.5 & +0.j & 0.63+0.j & 0.75+0.j] \\ [0.13+0.j & 0.01+0.j & 0.13+0.j & 0.38+0.j & 0.5 & +0.j & 0.63+0.j] \\ [0.25+0.j & 0.13+0.j & 0.01+0.j & 0.25+0.j & 0.38+0.j & 0.5 & +0.j] \\ [0.5 & +0.j & 0.38+0.j & 0.25+0.j & 0.01+0.j & 0.13+0.j & 0.25+0.j] \\ [0.63+0.j & 0.5 & +0.j & 0.38+0.j & 0.13+0.j & 0.01+0.j & 0.13+0.j] \\ [0.75+0.j & 0.63+0.j & 0.5 & +0.j & 0.25+0.j & 0.13+0.j & 0.01+0.j] \end{bmatrix}$

Vector RiN :

$[0.38+0.j \quad 0.25+0.j \quad 0.13+0.j \quad 0.13+0.j \quad 0.25+0.j \quad 0.38+0.j]$

Matrix P*1e8 :

$\begin{bmatrix} [124.94-3.93j & 9.2 & -3.83j & 3.53-3.53j & -0. & -2.5j \\ -0.77-1.85j & -1.18-1.18j \end{bmatrix}$

$\begin{bmatrix} 9.2 & -3.83j & 124.94-3.93j & 9.2 & -3.83j & 1.27-3.08j \\ -0. & -2.5j & -0.77-1.85j \end{bmatrix}$

$\begin{bmatrix} 3.53-3.53j & 9.2 & -3.83j & 124.94-3.93j & 3.53-3.53j \\ 1.27-3.08j & -0. & -2.5j \end{bmatrix}$

$\begin{bmatrix} -0. & -2.5j & 1.27-3.08j & 3.53-3.53j & 124.94-3.93j \\ 9.2 & -3.83j & 3.53-3.53j \end{bmatrix}$

$\begin{bmatrix} -0.77-1.85j & -0. & -2.5j & 1.27-3.08j & 9.2 & -3.83j \\ 124.94-3.93j & 9.2 & -3.83j \end{bmatrix}$

$\begin{bmatrix} -1.18-1.18j & -0.77-1.85j & -0. & -2.5j & 3.53-3.53j \\ 9.2 & -3.83j & 124.94-3.93j \end{bmatrix}$

Vector Pb*1e8:

$[1.27-3.08j \quad 3.53-3.53j \quad 9.2 \quad -3.83j \quad 9.2 \quad -3.83j \quad 3.53-3.53j \quad 1.27-3.08j]$

4 Pseudo Code for Question4

1. We have to construct two Matrices Q and Qb .

Q is the contribution due to currents unknown. It is a matrix with $2N^2$ columns and $2N^2$ rows.

Pb is the contribution due to current at $z = 0$. It is a column vector.

2. To construct those we are going to need Rz, Ru, RiN .

3. From Ru and Rin we will get Q and Qb .

4.1 Matrices Obtained

Matrix Q :

```
[[9.952e+01-0.j 5.000e-02-0.j 1.000e-02-0.j 0.000e+00-0.j 0.000e+00-0.j
  0.000e+00-0.j]
 [5.000e-02-0.j 9.952e+01-0.j 5.000e-02-0.j 0.000e+00-0.j 0.000e+00-0.j
  0.000e+00-0.j]
 [1.000e-02-0.j 5.000e-02-0.j 9.952e+01-0.j 1.000e-02-0.j 0.000e+00-0.j
  0.000e+00-0.j]
 [0.000e+00-0.j 0.000e+00-0.j 1.000e-02-0.j 9.952e+01-0.j 5.000e-02-0.j
  1.000e-02-0.j]
 [0.000e+00-0.j 0.000e+00-0.j 0.000e+00-0.j 5.000e-02-0.j 9.952e+01-0.j
  5.000e-02-0.j]
 [0.000e+00-0.j 0.000e+00-0.j 0.000e+00-0.j 1.000e-02-0.j 5.000e-02-0.j
  9.952e+01-0.j]]
```

Matrix Qb :

```
[0. -0.j 0.01-0.j 0.05-0.j 0.05-0.j 0.01-0.j 0. -0.j]
```

5 Pseudo Code for Question5

1. Our final equation is $M * J = Q * J + QbIm$
i.e., $(MQ) * J = Qb * Im$
2. We will use $inv(M - Q)$ to solve for J .
3. We construct the another vector with known currents and unknown currents.

We will get the exact curves on increasing N value.

5.1 Matrices Obtained

Icalculated :

[0. 0. 0. 0. 1. 0. 0. 0. 0.]

Iassumed :

[0. 0.38 0.71 0.92 1. 0.92 0.71 0.38 0.]

5.2 Plots

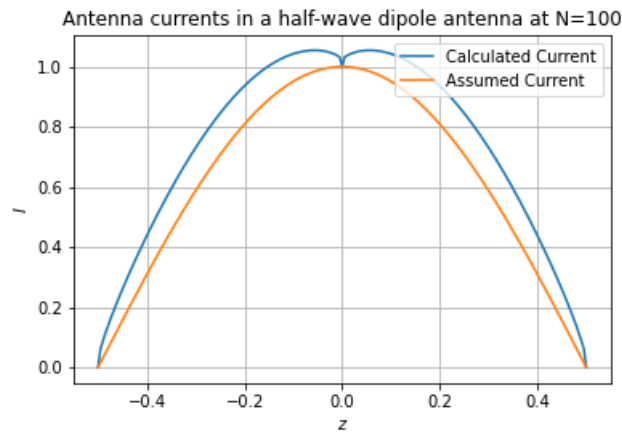


Figure 1: Antenna currents in a half-wave dipole antenna at N=10

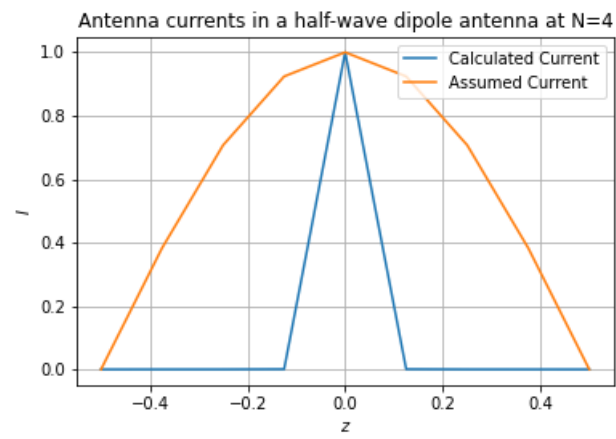


Figure 2: Antenna currents in a half-wave dipole antenna at $N=4$