EndSemester EE2703: Analysis of Currents on Half Dipole Antenna

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Defining Constants

Pseudo code:

- Define half length of dipole - l
- Define speed of light - c
- Define permeability - mu0
- Define number of sections on each half length - N
- Define current at center of antenna - Im
- Define radius of cross-section of antenna - a
- Define wave length - wl
- Define frequency - f
- Define wave number - k
- Define length of each segment - dz

Section 1

Pseudo code:

- Define array z with 2*N + 1 values ranging from -l to l
- Define array u with 2*N - 2 values by removing the elements with indices 0,N and 2*N.

The elements inside the array z indicate the positions of all the locations on antenna.
The elements inside the array u indicate the positions of all the locations with unknown currents on antenna.

Vectors:

```
z = [-0.5  -0.38 -0.25 -0.12  0.    0.12  0.25  0.38  0.5 ]
u = [-0.38 -0.25 -0.12  0.12  0.25  0.38]
```

Section 2

Pseudo code

- Define a function
- divide an identity matrix of dimension 2*N-2 with 2*pi*a
- return matrix

The matrix obtained is from the matrix equation of ampere's law which will be later used in calculating the distribution of currents matrix.

Vectors:

```
M = [[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]]
```

Section 3

Pseudo code:

- Define a square matrix as an extension of z-array
- Define the transpose of previously defined matrix
- Subtract both the matrices
- Add a**2 to the resultant matrix
- Take the square root of each element of matrix and name it Rz
- Define a square matrix as an extension of u-array

- Define the transpose of previously defined matrix
- Subtract both the matrices
- Add a**2 to the resultant matrix and name it Ru
- Take the square root of each element of matrix and name it Ru
- Name the Nth row of Rz ad RN.
- Remove elements with index 0,N and 2*N from RN.
- Compute (mu0/(4*pi))*(exp(-k*Ru*j)/Ru)*dz and name the matrix as P
- Compute (mu0/(4*pi))*(exp(-k*RN*j)/RN)*dz and name the array as Pb

The vector Rz is a matrix containing the distance between the source and the observation point specified by the indexes of that particular element.
The vector Rz is a matrix containing the distance between the source and the observation point specified by the indexes of that particular element but only for unknown current locations.
The matrix P is the vector containing coefficients of all unknown currents with respect to their locations when vector potential is solved for currents.
The array Pb is the vector containing the coefficients of current Im with respect to their locations when vector potential is solved for currents.

Vectors:

```
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]
    [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]
    [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]
    [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]]

Ru=[[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]]

P=[[124.94-3.93j   9.2 -3.83j   3.53-3.53j  -0.   -2.5j   -0.77-1.85j  -1.18-1.18j]
   [  9.2 -3.83j 124.94-3.93j   9.2 -3.83j   1.27-3.08j  -0.   -2.5j   -0.77-1.85j]
   [  3.53-3.53j   9.2 -3.83j 124.94-3.93j   3.53-3.53j   1.27-3.08j  -0.   -2.5j ]
   [ -0.   -2.5j    1.27-3.08j   3.53-3.53j 124.94-3.93j   9.2 -3.83j   3.53-3.53j]
   [ -0.77-1.85j  -0.   -2.5j    1.27-3.08j   9.2 -3.83j 124.94-3.93j   9.2 -3.83j]
   [ -1.18-1.18j  -0.77-1.85j  -0.   -2.5j    3.53-3.53j   9.2 -3.83j 124.94-3.93j]]

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

Section 4

Pseudo code:

- Compute -(a/mu0)*P*((-k*j/Ru)+(-1/Ru**2)) and name the matrix as Q
- Compute -(a/mu0)*Pb*((-k*j/RN)+(-1/RN**2)) and name the matrix as Qb

The matrix Q is the vector containing coefficients of all unknown currents with respect to their locations when magnetic field is solved for currents. The array Qb is the vector containing the coefficients of current Im with respect to their locations when vector potential is solved for currents.

Vectors:

```
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]]

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

Section 5

Pseudo code:

- Subtract M[N,a] and Q
- Multiply the resultant matrix with Qb
- Multiply the resultant matrix with scalar Im and name it as J
- Concatenate J with currents at index 0,N and 2N and name it as I
- Create an array for assumed sinusoidal current for -l $<$ z $<$ 0
- Create an array for assumed sinusoidal current for 0 $<$ z $<$ l
- Concatenate both the arrays and call it as Ia
- Plot I and Ia

Finally we get the distribution of currents array. We will now compare the calculated and assumed values of currents in the antenna by plotting them. It can be seen that for N = 100, the calculated values are slightly higher than the assumed values.The sinusoidal assumption is valid only for small antennas. As the size of the antenna increases, the sinusoidal assumption will not be accurate.

Plots:

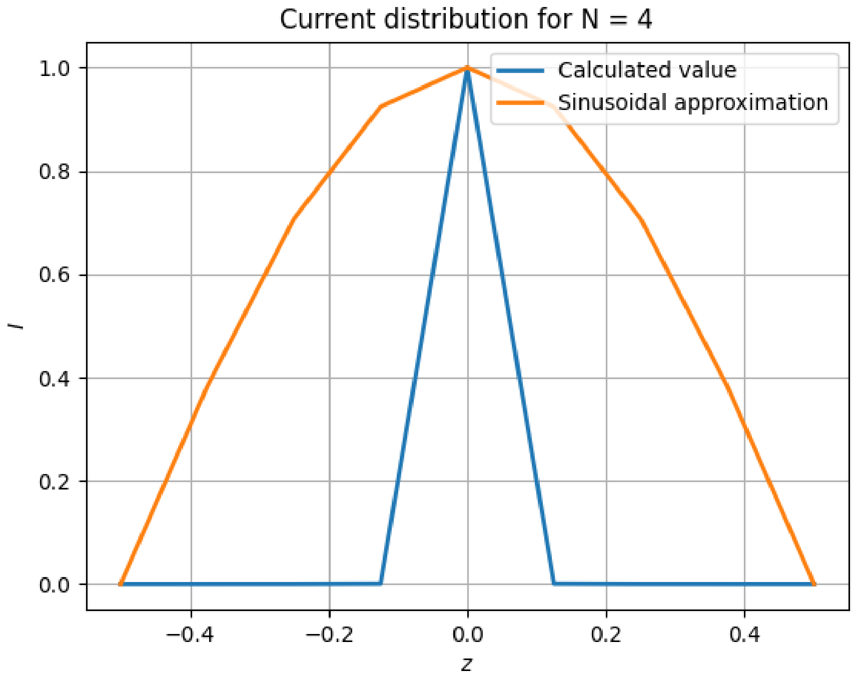

Figure 1: Current distribution for N=4

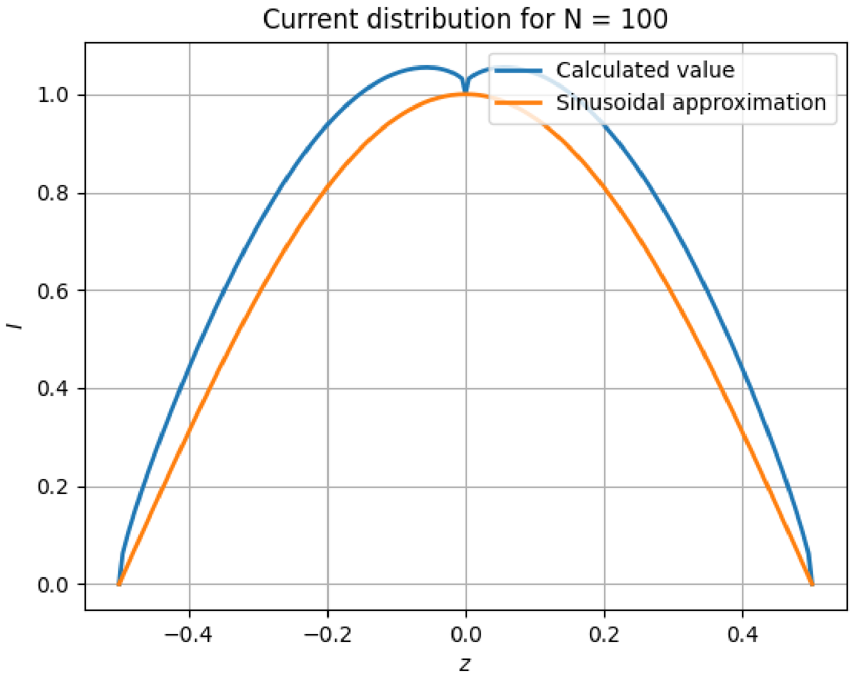

Figure 2: Current distribution for N=100