Endsem Report

GALI USHASRI Roll No-EE20B033

1 Pseudo-code

start program
call current function
Allocate some variables to given values and find vectors z,u,I,J
Find Rz,Ru,P,PB,Q,QB
Find J using (M-Q)*J=Im*QB equation.
Find I by using known values like current at ends and at centre.
Find I using given formula(assumed I)
Plot these 2 currents and compare.

2 Introduction

We have a long wire carrying a current I(z) in dipole antenna with half length 0f 50cm(=l) so, wavelength = 2m. Next, we need to determine the currents in the two wires of the antenna. Next, we have the expressions to calculate the value of currents.

$$I = I_m sin(k(l - z))$$

$$0 \leq z \leq l$$

$$I = I_m sin(k(l + z))$$

$$-l \leq z < 0$$

In the next process, we calculate the magnetic vector potential by approximating the integrals (in terms of summation); we next find out P_{ij} and P_B.

$$A_{z,i} = \sum_j P_{ij} I_j + P_B I_N = \sum_j I_j (\frac{\mu_0}{4\pi} \frac{exp(-jkR_{ij})}{R_{ij}} dz'_j)$$

$$P_B = \frac{\mu_0}{4\pi} \frac{exp(-jkR_{iN})}{R_{iN} dz'_j}$$

Then, we use the Ampere's circuital law to calculate H_ϕ. Again, we get it in terms of some summation involving the matrices Q_{ij} and Q_B.

$$H_\phi(r, z_i) = \sum_j Q_{ij} J_j + Q_{Bi} I_m = -\sum_j P_{ij} \frac{r}{\mu_0}\left(\frac{-jk}{R_{ij}} - \frac{1}{R_{ij}^2}\right) + P_B \frac{r}{\mu_0}\left(\frac{-jk}{R_{iN}} - \frac{1}{R_{iN}^2}\right)$$

At last we solve the matrix equation to find out the current vector J and then find out I.

$$MJ = QJ + Q_B I_m$$

3 Assignment Questions

At N=4

3.1 Question 1

According to the question, we now need to find vector z and u. And then find the current vectors I (at loactions of z) and J (at locations of u) respectively.

```
 z = np.linspace(-l, l, 2*N + 1) #defining points along antenna as array
I = np.zeros(2*N + 1) ##creating zero array to store I values
I[0], I[N], I[2*N] = 0, Im, 0  #Given endcurrents are 0 and current in th

#constructing current vector I corresponding to z
I[0:N] = Im * np.sin(k * (l + z[0:N]))
I[N : 2*N + 1] = Im * np.sin(k * (l - z[N : 2*N + 1]))

u = [j for j in range(1, 2*N)]
u.pop(N - 1)
u = np.array(u, dtype=int)
print('Vector z: ', z.round(2))
print('Vector u: ', u.round(2))
#creating current vector J corresponding to u
J = I[u]

#printing all vectors
print('Vector I: ', I.round(2))
print('Vector J: ', J.round(2))
```

By running this code we'll get these vector values as
Vector z: [-0.5 -0.38 -0.25 -0.12 0. 0.12 0.25 0.38 0.5]
Vector u: [1 2 3 5 6 7]
Vector I: [0. 0.38 0.71 0.92 1. 0.92 0.71 0.38 0.]
Vector J: [0.38 0.71 0.92 0.92 0.71 0.38]

3.2 Question 2

According to the question, we now need determine the M vector.I defined a function to determine M vector

```
# Question 2
#creating a function to compute matrix M and returning it
 def M(n,r):
     M = np.identity(2*n - 2)
     M = (1 / (2*np.pi*r)) * M
      return M

M = M(N,a)
print('Matrix M: ', M.round(2))
```

By running this,we'll gte matrix M as
Matrix 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]]

3.3 Question 3

We will determine Rz,Ru,P,PB in this question using the formulas given the assignment.

```
# Question 3
#Rz and Ru which are the distances from observer and from source
 Rz = np.zeros((2*N + 1, 2*N + 1))
for j in range(0, 2*N + 1):
     for i in range(0, 2*N + 1):
          Rz[j][i] = np.sqrt(a*a + (z[j] - z[i])*(z[j] - z[i]))

#Ru is the vector of distances to unknown currents
Ru = np.zeros((2*N - 2, 2*N - 2))
for j in range(0, 2*N - 2):
     for i in range(0, 2*N - 2):
          Ru[j][i] = np.sqrt(a*a + (u[j] * dz - u[i] * dz) * (u[j] * dz - u

RiN = Rz[N]
RiN = np.delete(RiN, [0, N, 2*N], 0)

print('Vector Rz: ', Rz.round(2))
print('Vector Ru: ', Ru.round(2))
```

From this code,we'll get Rz,Ru values as
Vector Rz: [[0.01 0.13 0.25 0.38 0.5 0.63 0.75 0.88 1.] [0.13 0.01 0.13 0.25 0.38 0.5 0.63 0.75 0.88] [0.25 0.13 0.01 0.13 0.25 0.38 0.5 0.63 0.75] [0.38 0.25

0.13 0.01 0.13 0.25 0.38 0.5 0.63] [0.5 0.38 0.25 0.13 0.01 0.13 0.25 0.38 0.5] [0.63 0.5 0.38 0.25 0.13 0.01 0.13 0.25 0.38] [0.75 0.63 0.5 0.38 0.25 0.13 0.01 0.13 0.25] [0.88 0.75 0.63 0.5 0.38 0.25 0.13 0.01 0.13] [1. 0.88 0.75 0.63 0.5 0.38 0.25 0.13 0.01]]

Vector Ru: [[0.01 0.13 0.25 0.5 0.63 0.75] [0.13 0.01 0.13 0.38 0.5 0.63] [0.25 0.13 0.01 0.25 0.38 0.5] [0.5 0.38 0.25 0.01 0.13 0.25] [0.63 0.5 0.38 0.13 0.01 0.13] [0.75 0.63 0.5 0.25 0.13 0.01]]

3.4 calculating vector potential by finding matrices P,PB

```
P = np.zeros((2*N - 2, 2*N - 2), dtype=complex)
for j in range(2*N - 2):
    for i in range(2 * N - 2):
        P[j][i] = (mu0 / (4.0 * np.pi)) * (np.exp(-1j * k * Ru[j][i])) *

#PB is the contribution to the vector potential due to current IN
PB = (mu0 / (4*np.pi)) * (np.exp(-1j*k*RiN)) * dz / RiN

print('Matrix P: ',(P*1e8).round(2))
print('Matrix PB: ',(PB*1e8).round(2))
```

By running this code,we'll get matrix values as Matrix 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]]
Matrix PB: [1.27-3.08j 3.53-3.53j 9.2 -3.83j 9.2 -3.83j 3.53-3.53j 1.27-3.08j]

3.5 Question 4

According to the question, we now need determine Q and QB using the formulas given in the assignment.

```
#Question 4
#creating matrices Qij and QB
Q = np.zeros((2*N - 2, 2*N - 2), dtype=complex)
for i in range(2*N - 2):
    for j in range(2*N - 2):
        Q[i][j] = -P[i][j] * (a / mu0) * ((-1j * k / Ru[i][j]) - (1 / pow

QB = -PB * (a / mu0) * ((-1j * k / RiN) - (1 / RiN ** 2))

print('Matrix Q: ', Q.round(2))
```

```
print('Vector QB: ', QB.round(2))
```

By running this code,we'll get matrix values as
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]]
Vector QB: [0. -0.j 0.01-0.j 0.05-0.j 0.05-0.j 0.01-0.j 0. -0.j]

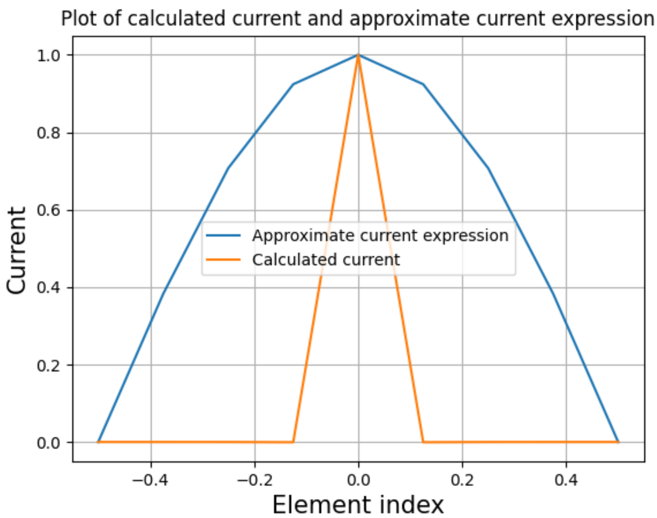
3.6 Question 5

Our final equation is

```
MJ = QJ +QB
```

Invert (M-Q) and obtain J. Use inv(M-Q) in python. Add the Boundary currents (zero at i=0, i=2N, and Im at i=N). Then plot this current vs. z and also plot the equation assumed for current at the top of this question paper. The python code used is as follows

```
J = matmul(inv(Matrix(N, a) - Q) , Q_B) * Im
```



4 Conclusion

We found different vectors z,u,I,J,Rz,Ru,P,PB,Q,QB,J and matrices for this halfwave dipole antenna First we computed current by using approximate current expression and again we calculated current by applying given boundary conditions and we compared both currents by plotting on the saem graph.