Endsem Report

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1 Pseudo-code

¿¿start program
¿¿call function current
¿¿Allocate some variables to given values
¿¿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 2 currents and compare.

2 Printing the matrices

At N=4 1)Array z:
2)Array u:
3)Matrix Rz:

```
Array z= [-0.5   -0.375 -0.25  -0.125  0.     0.125  0.25   0.375  0.5  ]
Array u= [-0.375 -0.25  -0.125  0.125  0.25   0.375]
matrix Rz= [[0.01      +0.j 0.12539936+0.j 0.25019992+0.j 0.37513331+0.j
  0.50009999+0.j 0.62507999+0.j 0.75006666+0.j 0.87505714+0.j
  1.00005   +0.j]
 [0.12539936+0.j 0.01      +0.j 0.12539936+0.j 0.25019992+0.j
  0.37513331+0.j 0.50009999+0.j 0.62507999+0.j 0.75006666+0.j
  0.87505714+0.j]
 [0.25019992+0.j 0.12539936+0.j 0.01      +0.j 0.12539936+0.j
  0.25019992+0.j 0.37513331+0.j 0.50009999+0.j 0.62507999+0.j
  0.75006666+0.j]
 [0.37513331+0.j 0.25019992+0.j 0.12539936+0.j 0.01      +0.j
  0.12539936+0.j 0.25019992+0.j 0.37513331+0.j 0.50009999+0.j
  0.62507999+0.j]
 [0.50009999+0.j 0.37513331+0.j 0.25019992+0.j 0.12539936+0.j
  0.01      +0.j 0.12539936+0.j 0.25019992+0.j 0.37513331+0.j
  0.50009999+0.j]
 [0.62507999+0.j 0.50009999+0.j 0.37513331+0.j 0.25019992+0.j
  0.12539936+0.j 0.01      +0.j 0.12539936+0.j 0.25019992+0.j
  0.37513331+0.j]
 [0.75006666+0.j 0.62507999+0.j 0.50009999+0.j 0.37513331+0.j
  0.25019992+0.j 0.12539936+0.j 0.01      +0.j 0.12539936+0.j
  0.25019992+0.j]
 [0.87505714+0.j 0.75006666+0.j 0.62507999+0.j 0.50009999+0.j
  0.37513331+0.j 0.25019992+0.j 0.12539936+0.j 0.01      +0.j
  0.12539936+0.j]
 [1.00005   +0.j 0.87505714+0.j 0.75006666+0.j 0.62507999+0.j
  0.50009999+0.j 0.37513331+0.j 0.25019992+0.j 0.12539936+0.j
  0.01      +0.j]]
```

4)Matrix Ru:

5)Matrix P:

```
matrix Ru= [[0.01      +0.j 0.12539936+0.j 0.25019992+0.j 0.50009999+0.j
  0.62507999+0.j 0.75006666+0.j]
 [0.12539936+0.j 0.01      +0.j 0.12539936+0.j 0.37513331+0.j
  0.50009999+0.j 0.62507999+0.j]
 [0.25019992+0.j 0.12539936+0.j 0.01      +0.j 0.25019992+0.j
  0.37513331+0.j 0.50009999+0.j]
 [0.50009999+0.j 0.37513331+0.j 0.25019992+0.j 0.01      +0.j
  0.12539936+0.j 0.25019992+0.j]
 [0.62507999+0.j 0.50009999+0.j 0.37513331+0.j 0.12539936+0.j
  0.01      +0.j 0.12539936+0.j]
 [0.75006666+0.j 0.62507999+0.j 0.50009999+0.j 0.25019992+0.j
  0.12539936+0.j 0.01      +0.j]]
matrix P= [[ 1.24938320e-06-3.92634488e-08j  9.20457911e-08-3.82619830e-08j
   3.53048939e-08-3.53492695e-08j -7.85162610e-12-2.49950003e-08j
  -7.65733196e-09-1.84733022e-08j -1.17865333e-08-1.17815974e-08j]
 [ 9.20457911e-08-3.82619830e-08j  1.24938320e-06-3.92634488e-08j
   9.20457911e-08-3.82619830e-08j  1.27386873e-08-3.07903783e-08j
  -7.85162610e-12-2.49950003e-08j -7.65733196e-09-1.84733022e-08j]
 [ 3.53048939e-08-3.53492695e-08j  9.20457911e-08-3.82619830e-08j
   1.24938320e-06-3.92634488e-08j  3.53048939e-08-3.53492695e-08j
   1.27386873e-08-3.07903783e-08j -7.85162610e-12-2.49950003e-08j]
 [-7.85162610e-12-2.49950003e-08j  1.27386873e-08-3.07903783e-08j
   3.53048939e-08-3.53492695e-08j  1.24938320e-06-3.92634488e-08j
   9.20457911e-08-3.82619830e-08j  3.53048939e-08-3.53492695e-08j]
 [-7.65733196e-09-1.84733022e-08j -7.85162610e-12-2.49950003e-08j
   1.27386873e-08-3.07903783e-08j  9.20457911e-08-3.82619830e-08j
   1.24938320e-06-3.92634488e-08j  9.20457911e-08-3.82619830e-08j]
 [-1.17865333e-08-1.17815974e-08j -7.65733196e-09-1.84733022e-08j
  -7.85162610e-12-2.49950003e-08j  3.53048939e-08-3.53492695e-08j
   9.20457911e-08-3.82619830e-08j  1.24938320e-06-3.92634488e-08j]]
```

6)Matrix PB:
7)Matrix Q:
8)Matrix QB:

```
matrix P_B= [1.27386873e-08-3.07903783e-08j 3.53048939e-08-3.53492695e-08j
 9.20457911e-08-3.82619830e-08j 9.20457911e-08-3.82619830e-08j
 3.53048939e-08-3.53492695e-08j 1.27386873e-08-3.07903783e-08j]
matrix Q= [[9.95209147e+01-0.00102798j 5.42084476e-02-0.00101222j
  8.02008034e-03-0.00096595j 1.24925031e-03-0.00079569j
  5.82883561e-04-0.00068249j 2.25969312e-04-0.0005595j ]
 [5.42084476e-02-0.00101222j 9.95209147e+01-0.00102798j
  5.42084476e-02-0.00101222j 2.77231242e-03-0.0008922j
  1.24925031e-03-0.00079569j 5.82883561e-04-0.00068249j]
 [8.02008034e-03-0.00096595j 5.42084476e-02-0.00101222j
  9.95209147e+01-0.00102798j 8.02008034e-03-0.00096595j
  2.77231242e-03-0.0008922j  1.24925031e-03-0.00079569j]
 [1.24925031e-03-0.00079569j 2.77231242e-03-0.0008922j
  8.02008034e-03-0.00096595j 9.95209147e+01-0.00102798j
  5.42084476e-02-0.00101222j 8.02008034e-03-0.00096595j]
 [5.82883561e-04-0.00068249j 1.24925031e-03-0.00079569j
  2.77231242e-03-0.0008922j  5.42084476e-02-0.00101222j
  9.95209147e+01-0.00102798j 5.42084476e-02-0.00101222j]
 [2.25969312e-04-0.0005595j  5.82883561e-04-0.00068249j
  1.24925031e-03-0.00079569j 8.02008034e-03-0.00096595j
  5.42084476e-02-0.00101222j 9.95209147e+01-0.00102798j]]
matrix Q_B= [0.00277231-0.0008922j  0.00802008-0.00096595j 0.05420845-0.00101222j
 0.05420845-0.00101222j 0.00802008-0.00096595j 0.00277231-0.0008922j ]
j= [-3.30256482e-05+1.06463792e-05j -9.54636142e-05+1.15207845e-05j
 -6.48254232e-04+1.20785421e-05j -6.48254232e-04+1.20785421e-05j
 -9.54636142e-05+1.15207845e-05j -3.30256482e-05+1.06463792e-05j]
```

9)Iassumed:

10)Iderived:

```
I_derived= [ 0.00000000e+00+0.00000000e+00j -3.30256482e-05+1.06463792e-05j
 -9.54636142e-05+1.15207845e-05j -6.48254232e-04+1.20785421e-05j
  1.00000000e+00+0.00000000e+00j -6.48254232e-04+1.20785421e-05j
 -9.54636142e-05+1.15207845e-05j -3.30256482e-05+1.06463792e-05j
  0.00000000e+00+0.00000000e+00j]
I_assumed= [1.22464680e-16 3.82683432e-01 7.07106781e-01 9.23879533e-01
 1.00000000e+00 9.23879533e-01 7.07106781e-01 3.82683432e-01
 1.22464680e-16]
```

3 Question 1

we need to Create 2 arrays which hold information about points on dipole antenna. 'z' array will contain all information but 'u' array will not contain information about points whose current is known. we define points along the antenna as an array z.And we know currents at both ends of wire and we know current at z=0. So we know current at 3 locations. The python code used is as follows

```
z=i*dz, -N<=i<=N

 dz=l/N
 z=np.zeros(2*N+1)
 i=np.arange(2*N+1)
 z=(i-N)*dz
 u = delete(z,[0,N,2*N])
```

4 Question 2

We need an equation for each unknown current. These equations are obtained by calculating the Magnetic field in two different ways. 1)from amperes law we need to form a matrix for this. The python code used is as follows

```
def Matrix(N,a):
M = (1/(2*pi*a))*identity(2*N -2)
return M
J = np.zeros(2*N-2) # current vector at points corresponding to vector u.
H_phi=Matrix(N,a)*J
```

5 Question 3

2)The second computation involves the calculation of the vector potential. we need to Compute and create vectors Rz and Ru which are the distances from observer at r + ziz, and source at z0 jz. The difference between Rz and Ru is that the former computes distances including distances to known currents, while Ru is a vector of distances tounknown currents. Also we need to compute the matrix P and PB . Note that PB is a column vector. The Qij in the equation is over all the currents. However this needs to be split into the unknown currents, Jj and the boundary currents. Only one of the boundary currents is non-zero, namely the feed current at i = N. The matrix corresponding to Jj we call Qi j, and the boundary current we call QB = QiN Create the matrices Qij and Q

```
zx, zy = meshgrid(z, z)
Rz = sqrt((zx - zy) ** 2 + ones([2 * N + 1, 2 * N + 1], dtype=complex) * a ** 2)
ux, uy = meshgrid(u, u)
Ru = sqrt((ux - uy) ** 2 + ones([2 * N - 2, 2 * N - 2], dtype=complex) * a ** 2)

RiN = delete(Rz[:][N],[0,N,2*N])
P = (mu0 / (4 * pi)) * (exp(-k * Ru * 1j) / Ru) * dz
P_B = (mu0 / (4 * pi)) * (exp(-k * RiN * 1j) / RiN) * dz

Q = -(a / mu0) * P * ((-k * 1j / Ru) + (-1 / Ru ** 2))
Q_B = -(a / mu0) * P_B * ((-k * 1j / RiN) + (-1 / RiN ** 2))
```

6 question 4

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
```