EE 6370 --- Antennas
Homework #8
(Due April 3, 2019)

Using NEC, analyze a 3-element array of dipoles in which all three elements are driven and operate at 1.5 GHz. The length of the elements is 10.0 cm, the spacing between the elements is 7.5 cm, and the diameter of the elements is 0.5 mm.

1. Use NEC with 11 segments per dipole to compute the admittance matrix for the array:

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} \\ Y_{21} & Y_{22} & Y_{23} \\ Y_{31} & Y_{32} & Y_{33} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

   I would make three separate NEC calculations to obtain the admittance matrix. For calculation 1, let $V_1 = 1$, $V_2 = 0$, and $V_3 = 0$, then

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} \\ Y_{21} & Y_{22} & Y_{23} \\ Y_{31} & Y_{32} & Y_{33} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} Y_{11} \\ Y_{21} \\ Y_{31} \end{bmatrix}$$

   which makes the first column of the admittance matrix the same as the currents. Similarly, you can obtain the other two columns from the last two calculations: for calculation 2, let $V_1 = 0$, $V_2 = 1$, and $V_3 = 0$; and for calculation 3, let $V_1 = 0$, $V_2 = 0$, and $V_3 = 1$. Make a table of the magnitude and phase of the elements in the admittance matrix. (Hint: For the dipole in which the voltage at the terminals is zero, it is best to remove the source instead of making a source with a zero voltage.)

2. Invert the admittance matrix to get the impedance matrix:

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} & Z_{13} \\ Z_{21} & Z_{22} & Z_{23} \\ Z_{31} & Z_{32} & Z_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

   Make a table of the magnitude and phase of the elements in the impedance matrix.

3. Use the impedance matrix to compute the voltages V_n required to excite the array as an ordinary end fire array: $I_n = I_o e^{-j(n-1)kd}$ with $I_o = 0.1$ A. Make a table of the magnitude and phases of the voltages V_n.

4. Compute and make a table of the driving-point impedances of the three elements: $Z_{dn} = V_n / I_n$. How do they compare to the self impedances of the elements: Z_{nn}?

5. Compute radiated field of the end-fire array driven with the voltages V_n using NEC. Graph the 3D antenna pattern for the field on a linear scale at 1.5 GHz.

6. Compute radiated field of the end-fire array driven with the voltages $\widetilde{V}_n = Z_{nn} I_n$ using NEC. Graph the 3D antenna pattern for the field on a linear scale at 1.5 GHz. How does it compare with the pattern computed using the voltages V_n?

(see back)

7. Compute radiated field of the end-fire array driven with the voltages V_n using array theory: multiply the field from an element by the array factor. For the element pattern, assume a half wave dipole with a sinusoidal current distribution. Graph the E-plane radiated fields on a polar plot for both the NEC and array theory results.

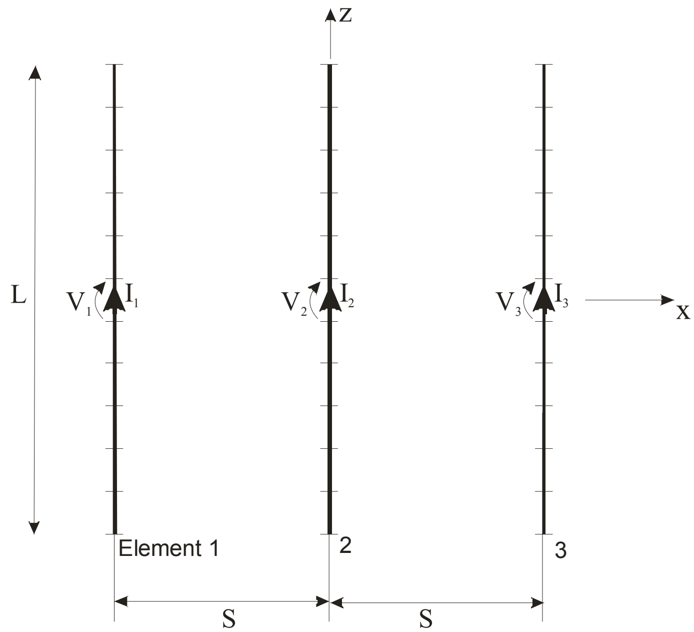

Diagram of the array geometry.