EE 483/583 Antennas for Wireless Communications
Spring 2017 Laboratory 1- Linear Dipole

Background

For this project, you will use the Numerical Electromagnetics Code, Version 2 (NEC-2) to model a linear dipole antenna. Place the dipole along the *z*-axis centered on origin. The dipole is center-driven and made of 16 AWG (diameter = 2*a*) copper wire ($\sigma_{cu} = 5.7 \times 10^7$ S/m) of total length $h = 40$ cm.

Project

1) Draw the problem geometry (CAD drawings are OK).

2) Write a NEC-2 input file to model this antenna and determine the first resonant frequency (dipole is resonant when the input reactance is zero). To do this, sweep the input frequencies from $h/\lambda = 0.25$ to $h/\lambda = 0.75$ in steps of $\Delta h/\lambda = 0.025$. Select segment lengths Δ that will work at all of the frequencies. Clearly justify your selection. On a single graph, plot the antenna input resistance R_A and reactance X_A versus h/λ. Near the resonant frequency, run frequency sweep(s), in smaller steps, to determine the resonant frequency f_r (MHz and h/λ) to within $h/\lambda = 0.0001$ or $|X_A| < 0.02\ \Omega$, whichever is smaller. On a separate graph, plot a "close-up" of R_A and X_A versus h/λ.

   Note 1: The input NEC files should be included in the logbook. The output NEC files should be available on a CD(s) or USB flash drive. The relevant filenames and disk identifier(s) should be part of the lab write-up, but need not be included in hard copy form.

   Note 2: h/λ is called the normalized frequency. Using $c = f\lambda$, we see that $h/\lambda = hf/c$ where $c = 2.998 \times 10^8$ m/s is the speed of light in free space.

3) From the information given in the NEC output file, it is also possible to determine the radiation resistance R_r and loss resistance R_L at each frequency (Hint: look at power information). At h/λ = 0.25, h/λ_r, 0.5, & 0.75, list in a table: frequency f (in MHz), normalized frequency h/λ, input resistance R_A (Ω), radiation resistance R_r (Ω), loss resistance R_L (Ω), input reactance X_A (Ω), input impedance magnitude $|Z_A|$ (Ω), and input impedance angle $\angle Z_A$ (degrees). In a separate table, find and list: f (in MHz), h/λ, R_A (Ω), X_A (Ω), input reflection coefficient Γ_A (put in polar form w/ angle in degrees), and impedance mismatch loss (unitless and dB) at these frequencies if the antenna is connected to 75 Ω transmission line.

4) At $h/\lambda = 0.25$, h/λ_r, & 0.75, write NEC-2 input file(s) to determine the current distribution along the antenna. On three (3) separate graphs (one per frequency), plot the real and imaginary components of the current, normalized by the maximum current magnitude (along the antenna at that frequency) versus z/h. Also, plot the normalized magnitude of the current versus z/h (3 separate graphs), and the phase (in degrees) of the current versus z/h (3 separate graphs) at each frequency.

5) At $h/\lambda = 0.25$, h/λ_r, & 0.75, write NEC-2 input file(s) to determine the elevation (E-plane) and azimuthal (H-plane) power gain radiation patterns (in dBi). On two (2) polar graphs, one for the elevation (E-plane) and one for the azimuthal (H-plane) traces, plot the normalized/relative power gain radiation patterns versus angle in degrees (see Fig. 4.6 in the text) scaled so that the center of the plot is at –30 dB, the outer ring is at 0 dB, and 0° is at the top. Properly annotate the plots. In a table, list the maximum power gain(s) (in dBi), angle(s) at which it occurs, and the HPBWs in the E-plane at each frequency.

6) Summarize and comment on significant results.

Due Friday, February 24, 2017 at my office or mail box in ECE department office by 4 pm.