Friday, February 18, 2022

EE 483/583 Antennas for Wireless Communications
Quiz #4 (Spring 2022)

Name Key

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit. Assume $c = 2.998\times10^8$ m/s.

A 0.576 m long dipole, oriented and centered on the y-axis in free space, is made using 4 AWG (5.19 mm diameter) copper wire. It is to be driven by a voltage source, centered on the dipole, over a frequency range of 210 to 280 MHz. To prepare to simulate this antenna using NEC-2:

a) Find the shortest and longest wavelengths (cm) of interest.

$$\lambda_{short} = c/f_{high} = 2.998\cdot10^8/280\cdot10^6 = 1.070714 \text{ m} \Rightarrow \lambda_{short} = \mathbf{107.0714\ cm}$$

$$\lambda_{long} = c/f_{low} = 2.998\cdot10^8/210\cdot10^6 = 1.427619 \text{ m} \Rightarrow \lambda_{long} = \mathbf{142.7619\ cm}$$

$\lambda_{short} =$ **107.0714 cm** $\lambda_{long} =$ **142.7619 cm**

b) Find wire radius a (mm). For the worst-case scenario, is the wire considered to be 'thin'? **Yes** / No (circle correct answer)

dipole radius $a = d/2 = 5.19/2 \Rightarrow \boldsymbol{a = 2.595}$ **mm**

To be thin, check if $2\pi a/\lambda_{short} = \pi d/\lambda_{short} << 1$:

$$\pi d/\lambda_{short} = \pi(0.00519)/1.070714 = 0.015228 << 1 \Rightarrow \textbf{Yes}$$

$a =$ **2.595 mm** Quantitative justification for answer $2\pi a/\lambda_{short} = 0.015228 << 1$

c) What is the shortest allowable segment length (cm) and corresponding number of segments for the model in the frequency range specified? Constraints- To minimize processing time, the extended kernel is to be avoided. Also, the NEC-2 model must have an integer number to segments.

First, we need $\lambda_{long}/1000 < \Delta_{min}$, $\Delta_{min} > 1.427619/1000 \Rightarrow \Delta_{min} > 1.4276$ mm.

Also, to avoid the EK command, we need

$$\Delta_{min}/a \geq 8 \Rightarrow \Delta_{min} \geq 8a = 8(2.595 \text{ mm}) \Rightarrow \Delta_{min} \geq 20.76 \text{ mm!}$$

Next, the dipole must have an odd integer number of segments to be center-fed.

$\ell/\Delta_{min} = 0.576/0.02076 = 27.746 \Rightarrow$ The next lower **odd** integer is $\boldsymbol{N_{min} = 27}$.

Based on this, we calculate $\Delta_{min} = 0.576/27 = 0.0213333$ m $\Rightarrow \boldsymbol{\Delta_{min} = 2.1333}$ **cm**

$\Delta_{min} =$ **2.1333 cm** $N_{min} =$ **27**

d) Write the applicable geometry command to model the dipole based on based on your answer to **part c)**.

Geometry command: **GW 1 27 0.0 -0.288 0.0 0.0 0.288 0.0 0.002595**