ELEC 306
Problem Set 9
Due: November 7, 2014

Homework Problems.
Work the following problems in Sadiku:

H9.1 10.78

H9.2 11.7 (First line should read "$G \ll \omega C$", not "$G \ll \omega L$".)

H9.3 11.30

H9.4 The following slotted line measurements were taken on a 50 Ω system. With load: $s = 3.2$, adjacent V_{min} occurs at 12 cm and 32 cm (high numbers on the load side); with short circuit: V_{min} occurs at 21 cm. Find the operating frequency and the load impedance.

Real Problems.

R9.1 **Lab Problem.** We now have several ways to determine the parameters of a transmission line:

1. Compute them based on geometry and materials.
2. Measure them in the time domain.
3. Measure them in the frequency domain.
4. If the line in question is a commercial product, we can read them off the data sheet.

We have everything we need to try all four of these approaches: two pieces of Belden 8219 coax, a data sheet for Belden 8219 coax, and lab equipment for making time and frequency domain measurements. The data sheet is on the 306 web page under Reference $->$ Data Sheets. The coax and the lab equipment are in A119. The pieces of coax are on the south workbench and are each marked with two strips of red tape. There is also a plastic parts box containing an assortment of BNC "jewelry" including 50, 75, and 93 ohm terminators and a shorting plug. Please return these items to the table when you have finished with them. If you aren't already familiar with the RF lab equipment, there's a tutorial on the web page under The Lab $->$ Tutorials.

Here are the things you should do with all of these ingredients:

(a) There are two important numbers which are not given in the data sheet: ϵ_r for the dielectric and the outer diameter of the shield. Estimate these based on the given values for propagation velocity and shield resistance.

(b) Based on the geometry as specified in the data sheet and your estimates from the previous part, compute R (inner conductor), L (external only), and C per meter. Compare these to the data sheet values.

(c) Compute the internal inductance of the center conductor and the shield. Are these significant compared to the external inductance?

Continued on next page.

(d) Using the data sheet values for L and C, compute Z_0 and propagation velocity.

(e) Using time domain techniques (e.g. TDR) measure Z_0 and propagation velocity. To get a signal of sufficiently short rise time, you should use the `Pulse` output of the function generator rather than the `Main` output.

(f) Using frequency domain techniques (e.g. SWR) measure Z_0 and propagation velocity.

(g) Measure the attenuation at the frequencies given in the table in the data sheet. Compare these to the nominal values in the table.

(h) For each frequency in the attenuation table, compute the skin depth and AC resistance (per unit length).

(i) Using the data sheet values for attenuation and your resistance values from the previous step, compute the loss tangent at each frequency in the table.