ECE 3065 Homework 1: Phasors and Smith Charts

Due Date: 27 January 2011

Note: For all problems involving a Smith Chart, the chart containing the work must be attached to your homework to receive full credit.

1. Taking careful free-space range measurements, you find that an integrated laptop computer antenna behaves as a perfect 50Ω load when connected to a 4.0cm matched coaxial cable – *when the laptop's screen lid is in the closed position.* When the screen lid is open, the antenna suddenly behaves like a $30 + j90\Omega$ load. The velocity of propagation in the cable is 2.0×10^8 m/s. The antenna is used for IEEE 802.11b wireless LAN communications, so the carrier frequency of operation is 2.450 GHz. Answer the following questions based on this scenario. (20 points)

   (a) What is the load-side reflection coefficient for the open screen lid?

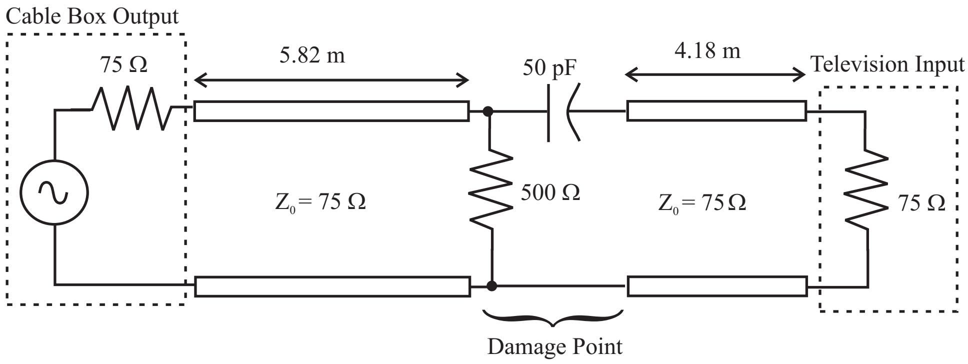
   (b) Calculate (algebraically) the equivalent impedance of the coaxial cable and mismatched antenna as seen by the output of the laptop's RF amplifier. You may assume that the RF amplifier is connected directly to the other end of the 4.25cm coaxial cable.

   (c) Repeat (b) using a Smith chart to verify your calculation.

   (d) Write a set of phasor-form equations for $\tilde{v}(z)$ and $\tilde{i}(z)$ on the mismatched line.

2. GT student Eric Tromagnetics has a cable box in the living room that he has connected to the television in his bedroom via a 75Ω coaxial cable that snakes down the hallway of the apartment, along the baseboard. The cable is exactly 10.00 meters long with a velocity of propagation of 2.0×10^8 m/s. Both the output of the cable box and the input to Eric's television set are matched to the standard CATV coaxial transmission line. (20 points)

   One day, Eric's roommate's girlfriend steps on the hallway cable with stiletto heels, which damages the cable so that it's equivalent circuit now looks like this:



How much transmitted power has been lost to Eric's television set at 100 MHz frequencies? at 400 MHz? at 900 MHz? (10 points)

Hint: Power degradation is usually reported in dB, a logarithmic scale where loss is given by

$$\text{Loss} = 10\log_{10}\left(\frac{\text{Original Power Level}}{\text{New Power Level}}\right)$$

3. Prove mathematically that the VSWR for any lossless transmission line terminating in an inductive or capacitive load is infinite (10 points).