Homework 1

Due 24 January 2006 at 8:00 pm

1. Waves and Phasor Notation

Be sure that you read the following questions carefully. Also, when you convert an expression from phasor to time domain form or vice versa, convert it back, carefully following the rules, to check your answer.

a. Write the following current phasor expression in time domain form $\tilde{I} = I_o e^{j\pi}$. Note that this is just a current, not a current wave.

b. Write the following time domain current wave expression in phasor form $i(z,t) = I_o \sin\left(\omega t + \frac{\omega}{u_o} z\right)$.

c. Is the expression in part b a standing or traveling wave? If it is a traveling wave, what direction does it travel and what is its velocity?

2. Plane Wave Representations

The numbers given in this problem are realistic but not real. That is, your answers should come out in a reasonable range, but the numbers are not based on a real, commercially available transmission line.

The voltage on a transmission line is given by $v(z,t) = 20\cos\left(8\pi 10^7 t - 0.32\pi z\right)$.

a. Is this a standing wave or a traveling wave? If it is a traveling wave, what direction does it travel and what is its velocity *u*?

b. What is the period of this wave *T*? What is the wavelength λ?

c. Plot this expression as a function of space at *t=0, t=T/3, t=2T/3* using Maple or Matlab or some similar program.

d. Write this voltage expression in phasor form.

e. Assume that the transmission line has a capacitance per unit length of $100\, {}^{pF}\!/_{m}$. Find the characteristic impedance of the line Z_o and then the current on the line in phasor form.

3. Verification of the Wave Solution

The time domain and phasor forms of the voltage waves in the previous problem must satisfy the corresponding form of the wave equation. Since you have determined all of the wave and transmission line parameters, you should be able to show that these expressions are correct.

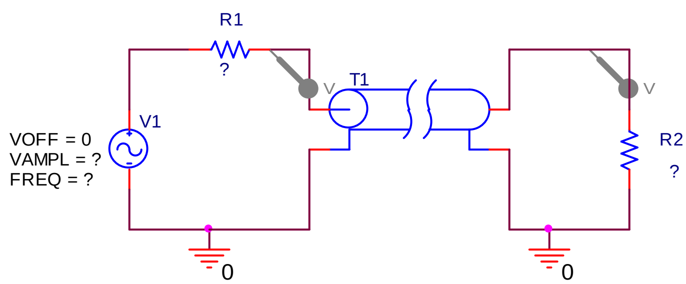
a. Verify that the time domain voltage $v(z,t)$ satisfies $\frac{\partial^2 v(z,t)}{\partial z^2} = lc\frac{\partial^2 v(z,t)}{\partial t^2}$ by evaluating the second derivatives as shown and using the values for inductance and capacitance per unit length you obtained above.

b. Also, verify that the phasor voltage $\tilde{V}$ you obtained in part d above satisfies $\frac{\partial^2 \tilde{V}}{\partial z^2} = -\omega^2 lc\tilde{V}$

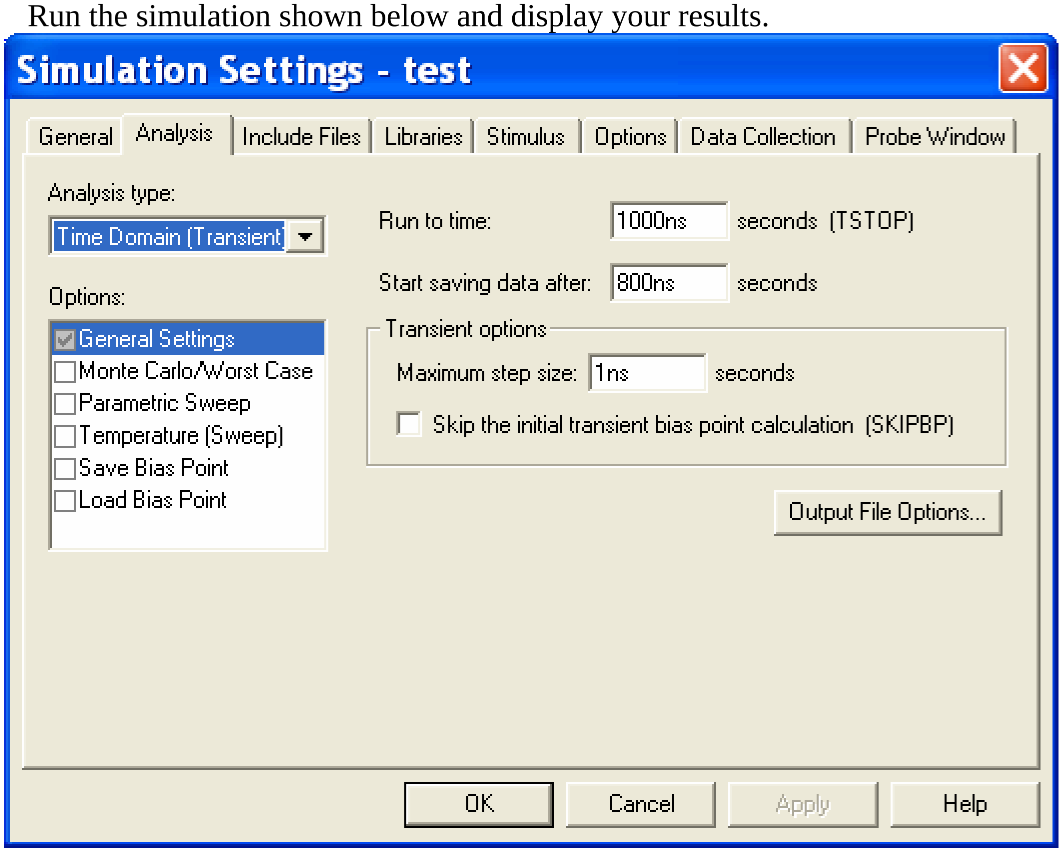
4. PSpice Simulated Experiments

PSpice can show us a lot about how the voltages look at the input and output ends of transmission lines. The simulation can, in effect, replace an experiment by giving us essentially the same results.

a. To get some practice using PSpice, set up the following simulation using the parameters of your transmission line from problem 2. That is the source, line and load impedances should all be equal to the characteristic impedance of the line you determined in problem 2. The source voltage and frequency should be selected to obtain the voltage given in problem 2 on the line. Set the offset voltage to zero. Use the lossless line model and assume the length of the line is 92.5meters. Be careful to use the zero ground, since it is the only one that works with PSpice.



Run the simulation shown below and display your results.



b. Explain why your result makes sense.