

Homework 2

Due 31 January 2006 at 8:00 pm

Updated 28 January

We want to consider the same lossless transmission line used in different applications. The line to be analyzed is not necessarily realistic, but it does have reasonable parameters. Assume that it has a capacitance per unit length of $c = 80 \text{ pF} / \text{m}$ and an inductance per unit length of $l = 0.2 \mu\text{H} / \text{m}$. The length of the line is 95 meters.

1. Transmission Line Characteristics

Determine the following characteristics of the line and waves on the line.

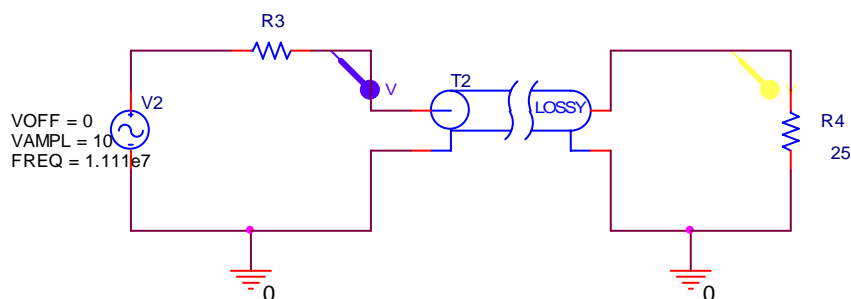
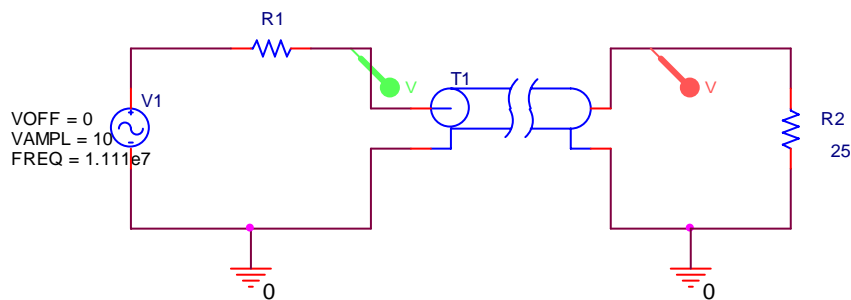
The characteristic impedance $Z_o =$

The propagation velocity $u =$

The delay time for the line $T =$

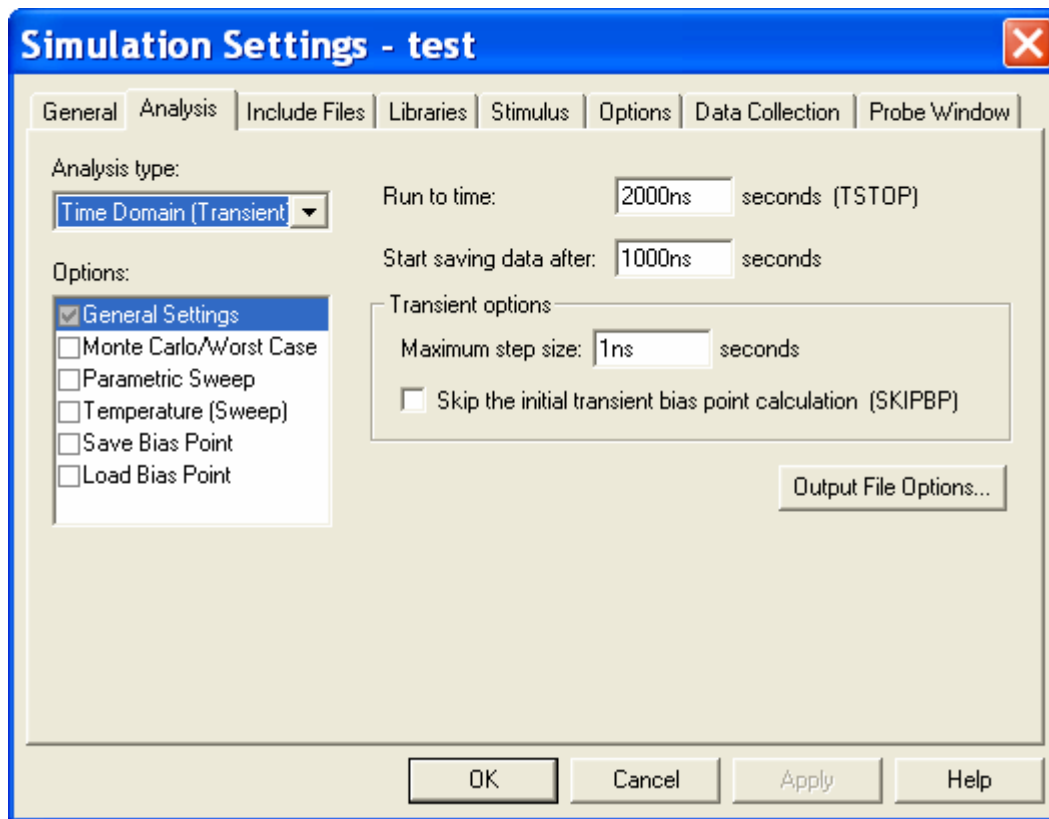
2. PSpice Simulation of the Transmission Line with Sinusoidal Input Voltage

First we will consider how the line behaves with the sinusoidal input voltage $V(t) = 10 \cos \omega t$ where the frequency $f = 11.11 \text{ MHz}$. The voltage source is assumed to be matched to the line. You will have to figure out what resistance to use for the source term from your answer to the previous question. Set up one of the following representations (your choice).



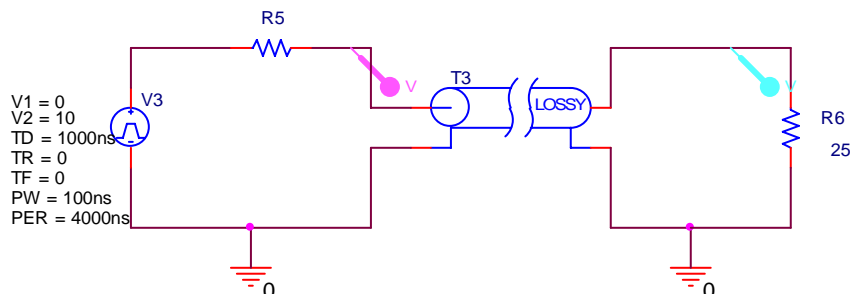
When setting up your simulation profile, use the following as your first guess. You will be asked to possibly adjust it when you address pulsed sources. Run this simulation and save the output plots for your report.

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3. PSpice Simulation of the Transmission Line with a Pulsed Source

Set up the following configuration on the same page as your sinusoidal simulation. You can have more than one circuit analyzed by PSpice as long as you don't exceed the limitations of the student version. You can use either the lossless or lossy line model. Again, this is your choice. The delay used is not necessary for this case, because there are no capacitors or inductors in the circuit. However, we will use it to be better prepared for more general problems.



Now run your simulation again, which should simulate both the sinusoidal and pulsed cases simultaneously. You should observe pulses at the input and output ends of the line. It might be helpful to show the sinusoidal and pulsed cases on two separate plots, which PSpice will allow you to do. Now adjust the simulation profile until your plot

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demonstrates that you are observing all pulses whose voltages exceed 0.5V. Change the simulation conditions only enough to show this. Your plot or plots should show both the sinusoidal case and the pulsed case. Carefully label all waves and pulses, noting where they are observed (input or output end) and their amplitude (since this is not always easy to read from the plots).

4. Input Impedance of a Line

This question relates to the sinusoidal voltage.

- a. Determine the input impedance of the line.
- b. From the input impedance, determine the input power to the line.
- c. From the input power to the line, determine the power delivered to the load.
- d. From the power delivered to the load, determine the voltage observed at the load. This should allow you to explain the magnitude of the observed voltages.
- e. Explain why the phase difference between the two voltages observed in your plots also makes sense.

5. Pulses on a Transmission Line

This question relates to the pulsed voltage.

- a. Determine the voltage input to the line from the voltage divider relationship that characterizes the initial line voltage.
- b. Determine the reflection coefficients at the load and source end for both lines.
- c. Generate the bounce diagram for both lines, showing the voltages observed until the level reaches less than 0.5V.
- d. Sketch the voltages observed at the input and output ends of the line.

6. Comparison Between Modeling and Theory

- a. Use your results for problem 2 to explain the voltages observed for the sinusoidal source.
- b. Use your results for problem 3 to explain the voltages observed for the pulsed source.

7. Experimental Verification

Set up both configurations using one of the reels of coaxial cable in the studio classroom. Be sure to terminate your cable at the scope with 25 Ohms. There are no 25 Ohm terminators, but this can easily be done. The RG58A/U cables do not have the same characteristics as the cable you analyzed. However, you should see the same qualitative results. Capture your results using the Agilent Intuilink software. Compare your experimental results with those from your analysis. That is, identify what is the same and what is different. For the pulses, you probably should terminate the short cable from the function generator to one of the scope channels. Try it both ways to see the effect. Otherwise the setup is the same as the experiment that many of you did the first day of class.