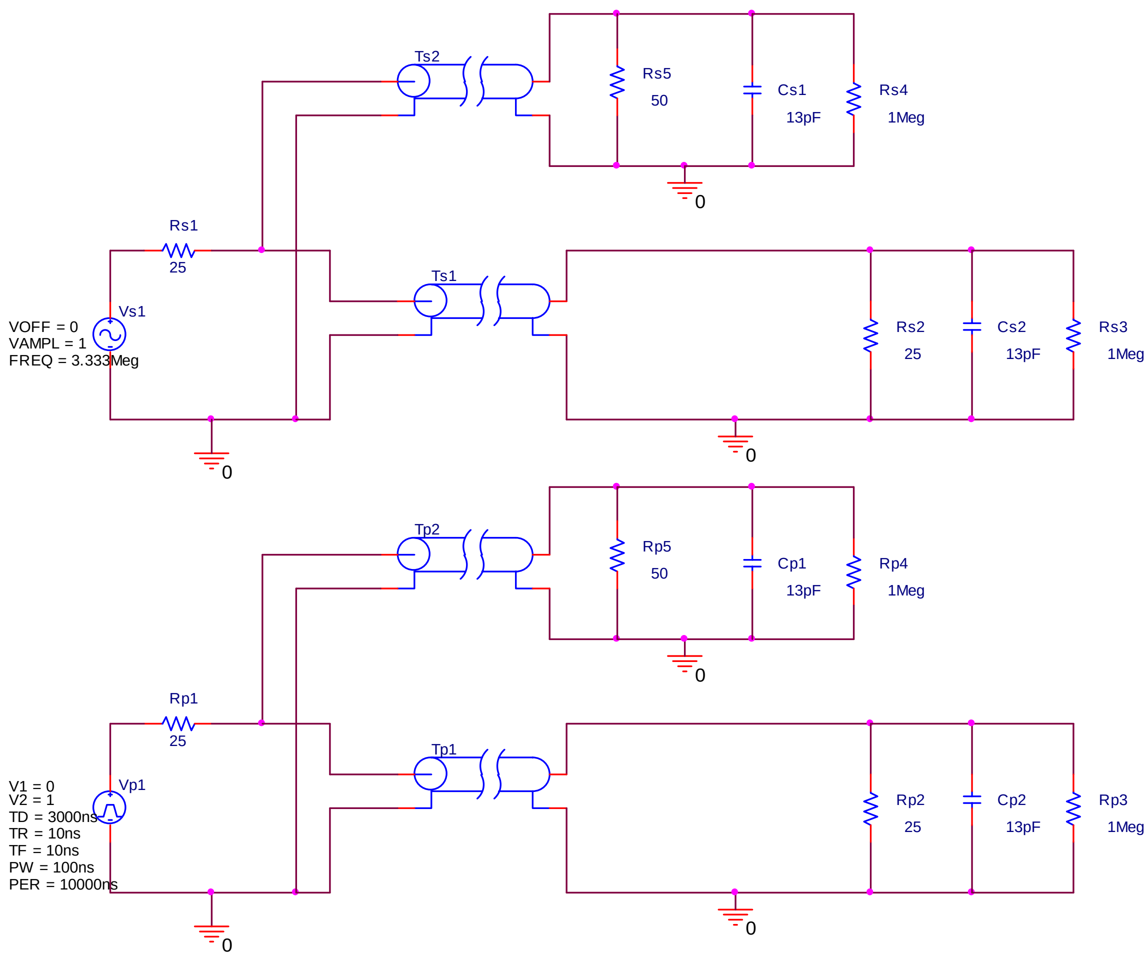
Homework 2

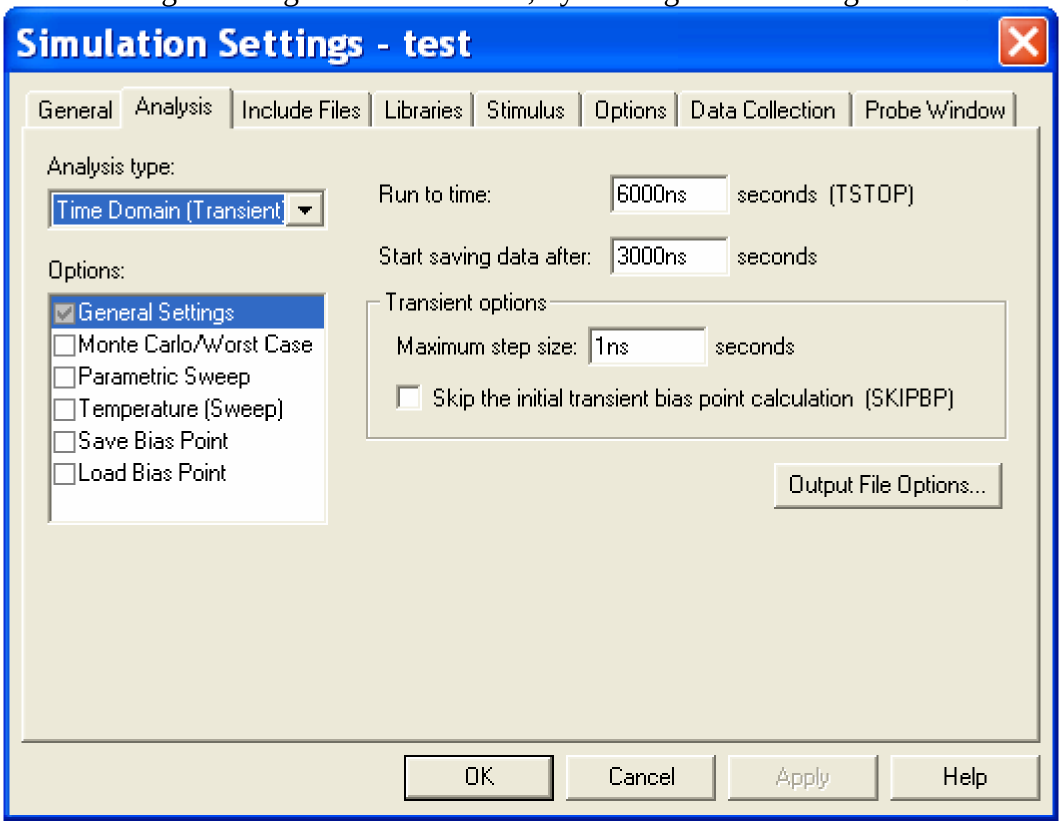
Due 1 February 2005

1. PSpice Simulation of Transmission Line

We want to consider the same lossless transmission line used in two different applications. All lines have a characteristic impedance of 50 Ohms. The top cable T2 connects the function generator to a scope channel. This cable is quite short. Assume that it is an RG58/U cable of length 2 meters. The bottom cable T1 has a length of 100 meters. When setting up these circuits in PSpice, you will need to specify the characteristic impedance and the delay time for each line. This configuration is meant to be realistic so the input resistance and capacitance of the scope is shown in each case. The short cables are terminated properly with 50 Ohms. (We did not do this in the studio experiment, but should have to get the best possible results.) The longer cable is improperly terminated with 25 Ohms and the function generator also has an internal impedance of 25 Ohms. Can you recall how to make a 25 Ohm resistor if we only have 50 and 93 Ohm terminators?



The two applications involve different voltage sources: a sinusoidal input voltage (VSIN) and a pulsed voltage (VPULSE). The sinusoidal source has a magnitude of 1 V with a frequency of 3.333 MHz. The pulsed source produces a single pulse of 1 V with a width of 100ns. We have put a delay of 3000ns on this pulse so that we can analyze the circuits starting after 3000ns. We have also specified a period of 10000ns, so we will see only one pulse from the source. We do this so that the circuit can reach steady state conditions. Otherwise we will see a lot of transients even in the sinusoidal case. We set up the simulation to begin storing data after 3000ns, by making the following choices.



The small maximum step size gives smooth plots and we look only at 3000ns of time starting at 3000ns. Set up these circuits as shown and these simulation settings. Generate separate plots of (1) the voltages observed on the scope channels for the sinusoidal case and (2) the voltages observed on the scope channels for the pulsed case. This gives us the input and output voltages observed on the long transmission line. After doing the next two problems, you will return to these plots and explain why they are correct.

2. Input Impedance of a Line

This question relates to the sinusoidal voltage.

a. Determine the input impedance of both lines.
b. From the input impedance, determine the input power to each line.
c. From the input power to each line, determine the power delivered to each load.
d. From the power delivered to each load, determine the voltage observed at each scope channel. 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.

3. Pulses on a Transmission Line

This question relates to the pulsed voltage.

a. Determine the voltage input to the lines from the voltage divider relationship that characterizes the initial line voltages.
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 5% of the initial pulse height.
d. Sketch the voltages observed at the input and output ends of the line.

4. Comparison Between Modeling and Theory

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