UNIVERSITY OF CALIFORNIA
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EEECS117, Spring 2010 **T. K. Gustafson**

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Due : Feb 9 1010

Based upon Chapter two of Ulaby

Problem Set No. 2

Problem Number one) Short transmission Line
To emphasize the importance of delay on transmission lines and to become acquainted with LTSpice simulation consider the following:
1) A transmission line with a time delay of .01 nsec. and characteristic impedance $Z_o = 500\Omega$.
2) A load which is a resistor with R = 25 Ω.
3) An excitation (generator) which is a single square pulse with an amplitude of 1 V, and a duration of 1 nsec. It has zero resistance.

a) Simulate this with LTSpice. Show a plot of the load voltage as a function of time. Plot the result for 2 nsec.
b) Explain the result in a) by a "lumped circuit" model. (What values of L (Henries) and C (Farads) apply ?). Calculate the response
c) Problem 2.1 of Ulaby.

Problem Number two) Long Transmission Line
a) Increase the time delay of the transmission line 3 nsec. Keep the same Z_o and load resistor. Plot the load voltage for 200 nsec.
b) Calculate the first three pulses
c) Calculate the exponential decay of the pulses.
d) Draw the bounce diagram for the first two pulses at the load.
Note that with LTSpice you can also look at the reflected pulse from the load where you see the reversal in sign of the reflected pulse. Also be sure you understand the current pulses accompanying the votage pulses.

Problem Number three) Matching
Add a 500 Ω resistor in series with the generator.
a) Re-simulate for the conditions in problem 2.
b) How many pulses are observed at the load? Explain why.

Problem Number four) Matching with a quarter wave section
Ulaby Problem 2.22

Also calculate C and L.

Problem Number five) Smith Chart Basic Calculations
Ulaby Problem 2.28

Problem Number six) Basic reflection coeffs on a transmission line
Consider a coaxial cable 15 cm in length having inside conductor diameter of 2.95 mm and an inside conductor diameter of .9 mm . The relative dielectric constant of the dielectric is 2.29. Let the cable be excited with the signal generator at z= - 15 cm having an internal resistance of 50 Ω and let the cable be terminated in a load consisting of a 50 Ω resistor in parallel with a capacitor.
a) Find the reflection coefficient at the input of the cable (S_{11}) over a frequency range of .1 GHz to 1 GHz.when the capacitance is very small so that both load and generator end are matched.
b) Likewise find the reflection coefficient at the output of the cable when the 50 Ω load is associated with signal generator.
c) What are S_{12} and S_{21}.
d) Where on a Smith chart are a) through c)
e) Repeat a) through c) if the capacitance is .01 nF You can (should) do this by using simulation software to plot the scattering parameters on a Smith chart (I used qucs but you might choose others).