Homework #10

due Thursday April 19

1. Hirose & Lonngren Chapter 9 #2
2. Hirose & Lonngren Chapter 9 #4
3. Hirose & Lonngren Chapter 9 #5
4. Hirose & Lonngren Chapter 9 #13
5. Hirose & Lonngren Chapter 9 #15
6. Download the spreadsheet WaveReflection.xls.

   The spreadsheet has 5 columns, the first is already filled with a set of equal position intervals, and the second is filled with the incident wave $y(x,t)$, $0 < x < 1$ m, evaluated at t=0, where the frequency is 2 GHz, the impedance is $Z_1 = 377\Omega$, and the wave speed is 3×10^8 m/s (for instance a coaxial cable with vacuum between the conductors), and the voltage amplitude is 0.125V.

   There is an abrupt boundary at $x = L = 1$ m to a region with impedance $Z_2 = 180\Omega$. The reflected wave and transmitted waves are correctly calculated using the equations:

$$V_{\text{ref}} \cos[k_1(2L - x) - \omega t]$$

$$V_{\text{trans}} \cos[k_2 x - \omega t + \phi_{12}]; \qquad \phi_{12} = (k_1 - k_2)L$$

   where V_{ref} and V_{trans} are the amplitudes calculated based on the relative impedances. (See Hirose and Lonngren p. 164 and 165 and your class notes.)

   (a) Create a graph that shows the incident and reflected waves from $x = 0$ to $x = L$. Vary the time from $t = 0$ to $t = T$ in increments of $0.1T$ ($T = 1/f$ is the period) and describe what you see. Find the values of the time t_{ip} and t_{op} where the incident and reflected waves are out of phase. Print out the graphs for $t = t_{ip}$ and $t = t_{op}$ and hand in for this part of the problem.

   (b) Now create the transmitted wave (from $x = L$ to $x = 2L$) and the sumwave for $0 < x < L$ and make a graph showing them. Check visually that the value and slope of the sumwave and the transmitted wave match at the boundary - if not, correct your calculation. Vary the time from $t = 0$ to $t = T$ in increments of 0.1T, and make sure you understand what you are seeing. Print out the graphs for $t = t_{ip}$ and $t = t_{op}$ and hand in for this part of the problem.