Using your solution to the previous assignment, we now want to find the magnitude of the transmission coefficient for the half-space and slab dielectrics over frequencies ranging from about 80 MHz to 2700 MHz. Students registered for EE 417 only need to do the half-space problem.

If your solution to the last assignment was correct, the work involved for this problem should be fairly minimal. You merely have to re-run your simulations for the desired number of time steps, feed the data into MATLAB, take some FFT’s, and plot the results.

Here are the specifics of what you must do:

1. Run simulations for the homogeneous dielectric (i.e., no boundary), the half-space of dielectric, and the slab dielectric (only 517 students are required to do the slab problem but 417 students may do it for extra credit). Record the field at the observation point specified in the previous assignment. The simulations should be run for 16,384 time steps. Let us call the data generated by each of these simulations inc, half, and slab.

2. Use MATLAB to find the discrete (fast) Fourier transforms of the data. A sample MATLAB session is shown on an attached sheet. Since the simulations were run at the Courant limit, we have

\[ c_0 \Delta t = \Delta x = 0.002 \text{ m}. \]

Solving for \( \Delta t \) yields \( \Delta t = 6.666 \text{ ps} \). Thus, the maximum frequency, as determined by the Nyquist limit, that can be obtained from this simulation is

\[ f_{\text{max}} = \frac{1}{2\Delta t}. \]

Since we are using 16,384 time steps, the spectral resolution is

\[ \Delta f = \frac{f_{\text{max}}}{16384/2} = 9.1553 \text{ MHz}. \]

Thus, the FFT of the data will yield an array where the first element is the spectral component at dc, the next element is the spectral component at 9.1553 MHz, the next is at \( 2 \times 9.1553 \) MHz, the next is at \( 3 \times 9.1553 \) MHz, and so on. This isn’t quite the full story since eventually we get to the negative frequencies—read the information on the MATLAB \( \text{fft} \) function for details—but we will stop before getting to them. Since we are only interested in frequencies between about 80 and 2700 MHz, we just need to consider the elements in the FFT arrays with indices between about 20 and 300.
3. Obtain the transmission coefficients by dividing the half-space or slab results by the incident field (no boundary) results. You should do this on a term-by-term basis as shown in the sample session.

4. Use MATLAB to plot your results for the half-space and slab transmission coefficients. Also plot the exact results. Plot the magnitude and phase. Note that the exact solution for the phase will require a bit of thought since the observation point is not at the interface between the dielectric and free space.