ECE 6380: Problem Set #5

1. Show that the FDTD central difference equations "conserve" the divergence of the fields for the polarization under consideration (E_x, E_z, and H_y). In other words, apply finite differencing to Gauss' Law for the Electric Field in a source-free region to obtain a discrete equation (use a grid stencil where the electric field is normal to the boundaries). Then, take the time derivative of that equation to recast it into an equation for H. The equation should equal zero, indicating that if the initial conditions are divergence free, the algorithm preserves that condition as time evolves. This shows that the FDTD update equations also satisfy Gauss' Law.

2. Modify the code "FDTDabc.m" on the Canvas site so that the waveguide region is driven by a TEM sinusoidal steady state source at the left end (the source used in FDTDsin.m). Then, use that code to determine the magnitude of the reflection and transmission coefficients for a dielectric slab of thickness 0.4 λ with $\varepsilon_r = 5$. (Generate results for more than one mesh.) Discuss how you determined the grid spacing, time step, reflection and transmission coefficient, and that the sinusoidal result had converged sufficiently. You may need to adjust the size of the time loop and the time window being stored by the code.