ECE 595 (Numerical Simulations) - Homework 4

Email to pbermel@purdue.edu
Please write your programs in C/C++ or MATLAB

Due March 8, 2013 at 4:30 pm

1 Consider the beam propagation method discussed in class. For this problem, you can use the code and image files available from the course website, `http://web.ics.purdue.edu/~pbermel/ece595.html`.

1a Graph the losses occuring from the Y-splitter waveguide as a function of propagation distance z, as quantified by the Poynting vector $\mathbf{S} = \mathbf{E} \times \mathbf{H}$. Is there any z-dependence of this loss? If so, why?

1b Design an asymmetric Mach-Zender interferometer by increasing the refractive index of one branch by Δn. In this case, find the smallest value of Δn such that the Mach-Zender interferometer completely reflects incoming light, and show the simulation results proving the reflection.

2 Consider solving the electromagnetic bandstructure master equation:

$$\nabla \times \left[\epsilon^{-1} \left(\nabla \times H\right)\right] = \left(\frac{\omega}{c}\right)^2 H \tag{1}$$

In this problem, you can use MIT Photonic Bands (MPB), available preinstalled on nanoHUB with a GUI: `http://nanohub.org/tools/mpb/`. Please submit your MEEP CTL (control) files.

If one starts with a 2D triangular array of air holes in a high-dielectric background ϵ:

2a Which polarization has a bandgap, and how does the relative gap size $g = \Delta\omega/\omega_{\text{mid}}$ change as ϵ ranges from 4 to 20?

2b Now create a 7x7 supercell with $\epsilon = 16$, and reduce the size rod in the middle to half its previous value. What new feature can be seen in the bandstructure, and what is its significance?