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 occurring from the Y-splitter waveguide as a function of propagation distance z, as quantified by the Poynting vector \( S = E \times H \). 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 \( \Delta n \). In this case, find the smallest value of \( \Delta n \) 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:

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

In this problem, you can use MIT Photonic Bands (MPB), available pre-installed 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 \( \epsilon \):

2a Which polarization has a bandgap, and how does the relative gap size \( g = \Delta \omega/\omega_{\text{mid}} \) change as \( \epsilon \) 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?