

## Study Material

### Text Book

Elements of Electromagnetics, 7<sup>th</sup> Ed.  
Matthew N. O. Sadiku  
Oxford University Press

### Study Numerical Analysis of Slab Waveguides

Read “Notes – Slab waveguide analysis”  
[http://emlab.utep.edu/ee4386\\_5301\\_CompMethEE.htm](http://emlab.utep.edu/ee4386_5301_CompMethEE.htm)

## MATLAB Code

### Problem #1

Write a MATLAB program that calculates the electromagnetic modes of a slab waveguide. The function should have the following header which dictates the input and output variables. Do not include any other input or output variables. Provide your MATLAB code at the end the assignment in an Appendix.

```
% HW9_Probl.m
%
% This MATLAB program calculates the modes in a slab waveguide.
%
% EE 4347 Applied Electromagnetics
% Instructor: Dr. Raymond C. Rumpf

% INITIALIZE MATLAB
close all;
clc;
clear all;

% OPEN FIGURE WINDOW
figure('Color','w');
hold on;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% DASHBOARD
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

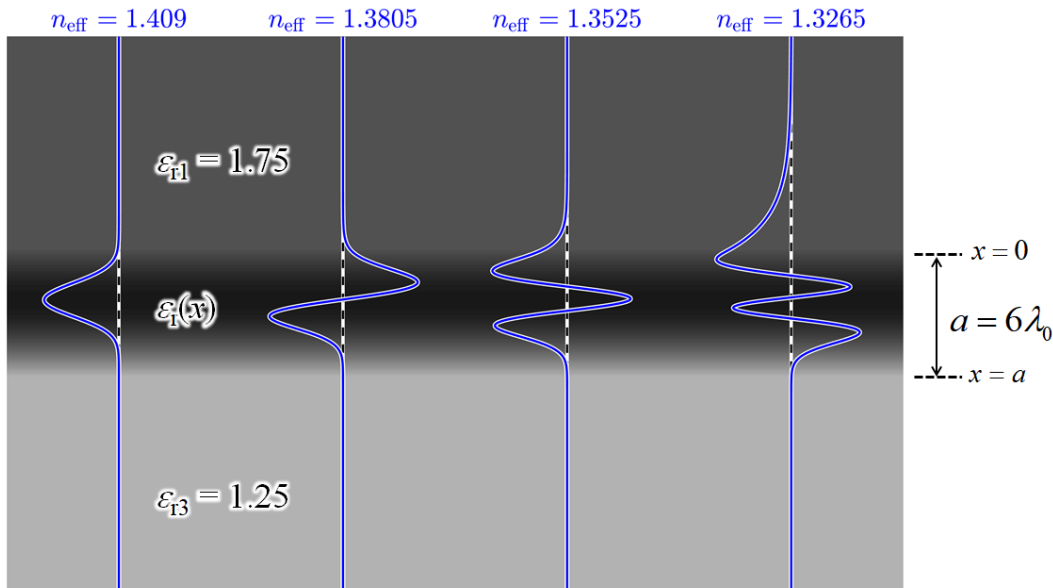
% WAVELENGTH
lam0 = 1;

% SLAB PARAMETERS
a = 6*lam0;
er1 = 1.75;
er2 = 2.25;
er3 = 1.25;

% GRID
NRES = 20;
nmax = sqrt(max([er1 er2 er3]));
SPACER = 10*lam0 * [1 1];
```

## Problem #2

Benchmark your program by replicating the results for the slab waveguide shown below. Plot only the guided modes, superimpose them into a representation of the slab waveguide, and place them in order of their effective refractive index  $n_{\text{eff}}$ . Label each mode with its effective refractive index. Provide your diagrams in your homework assignment.



$$\epsilon_r(x) = \epsilon_{r1} + (\epsilon_{r3} - \epsilon_{r1}) \frac{x}{a} + (\epsilon_{r2} - \epsilon_{r1}) \sin\left(\frac{\pi x}{a}\right) \quad \epsilon_{r2} = 2.25$$

## Waveguide Analysis

### Problem #3

Starting with Problem #2, plot the 5<sup>th</sup> and 6<sup>th</sup> modes in addition to the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> modes and explain the results.

### Problem #4

If  $a = 5.0$  cm, determine the range of frequencies over which the slab waveguide in Problem #2 is single-mode using your MATLAB code.

### Problem #5

Plot the effective refractive index of the slab waveguide in Problem #4 over the full range of frequencies that the waveguide is single-mode.

### Problem #6

If  $\epsilon_{r1} = 1.5$  in Problem #4, what is the new cutoff frequency of the slab waveguide?