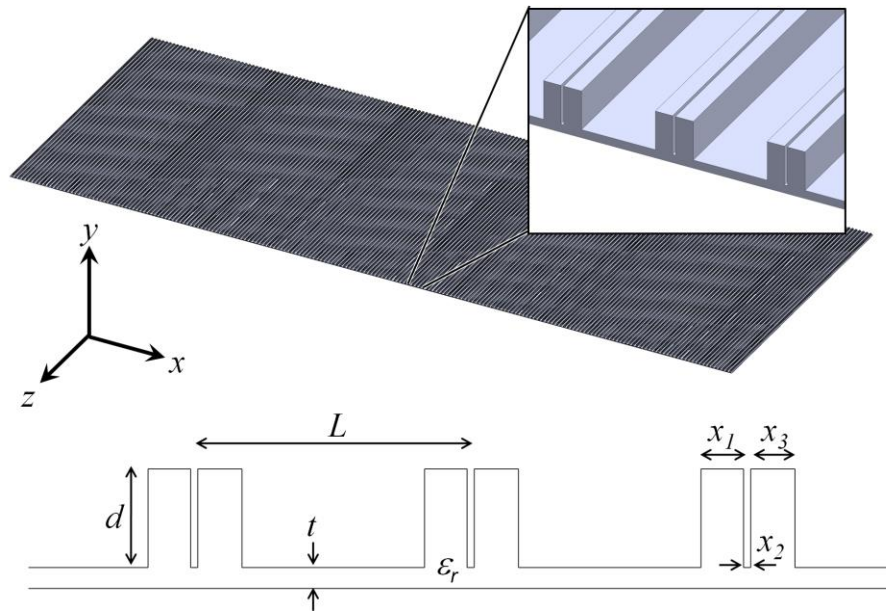


Description of the Problem

The grating shown below was designed to operate at 8.0 GHz. For this assignment, assume the device is infinitely periodic in the x -direction, is of infinite extent in the z -direction, and is finite in the y -direction. The device resides in air and all the device parameters are provided below.



$$\lambda_d = c_0 / (8.0 \text{ GHz})$$

$$x_1 = 0.1040 \lambda_d$$

$$x_2 = 0.0175 \lambda_d$$

$$x_3 = 0.1080 \lambda_d$$

$$L = 0.6755 \lambda_d$$

$$d = 0.2405 \lambda_d$$

$$t = 0.0510 \lambda_d$$

$$\mu_r = 1.0$$

$$\epsilon_r = 10.0$$

In Homeworks 7-9, you are going to develop a 2D FDFD code to simulate this device. The program will be able to simulate both the E mode and the H mode at any frequency and at any angle of incidence. You must follow the block diagram from the notes exactly.

Problem #1: Dashboard for FDFD-2D Simulation

Begin a new MATLAB program with the following header:

```
% Homework #7, Problem 1
% EE 5337 - COMPUTATIONAL ELECTROMAGNETICS
%
% This MATLAB script file implements the FDFD method
% to model transmission and reflection from a grating.

% INITIALIZE MATLAB
close all;
clc;
clear all;

% OPEN FIGURE WINDOW
fig = figure('Color','w');

% UNITS
centimeters = 1;
millimeters = 0.1 * centimeters;
meters      = 100 * centimeters;
degrees     = pi/180;
seconds     = 1;
hertz       = 1/seconds;
gigahertz   = 1e9 * hertz;

% CONSTANTS
c0 = 299792458 * meters/seconds;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% DEFINE SIMULATION PARAMETERS
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% SOURCE PARAMETERS
f0    = 24.0 * gigahertz;    %operating frequency
lam0  = c0/f0;              %operating wavelength in free space
theta = 15 * degrees;      %angle of incidence
MODE  = 'H';                %electromagnetic mode, 'E' or 'H'

% GRATING PARAMETERS
fd    = 8.0 * gigahertz;    %design frequency
lamd  = c0/fd;              %design wavelength
x1    = 0.1040*lamd;        %width of tooth 1
x2    = 0.0175*lamd;        %width of slot
x3    = 0.1080*lamd;        %width of tooth 2
L     = 0.6755*lamd;        %period of grating
d     = 0.2405*lamd;        %grating depth
t     = 0.0510*lamd;        %substrate thickness
ur    = 1.0;                %relative permeability of grating
er    = 10.0;               %dielectric constant of grating

% EXTERNAL MATERIALS
ur1 = 1.0;                  %permeability in the reflection region
er1 = 1.0;                  %permittivity in the reflection region
ur2 = 1.0;                  %permeability in the transmission region
er2 = 1.0;                  %permittivity in the transmission region

% GRID PARAMETERS
NRES = 40;                  %grid resolution
BUFZ  = 2*lam0 * [1 1];    %spacer region above and below grating
NPML  = [20 20];          %size of PML at top and bottom of grid
```

Problem #2: Calculate Optimized Grid

Add a new section to your code to calculate an optimized grid for this problem. This section will calculate both the $1\times$ and the $2\times$ grid. While your answers may differ slightly than mine, here are my parameters:

$N_x = 259$
 $N_y = 662$
 $dx = 0.0097736$
 $dy = 0.0097962$

$N_{x2} = 518$
 $N_{y2} = 1324$
 $dx2 = 0.0048868$
 $dy2 = 0.0048981$

Do not hard-code these values into your program!!! Calculate them from the parameters in your dashboard using the practices taught in the lectures.

Report your values of the above parameters.

Problem #3: Build the Device on the $2\times$ Grid

Add a new section to your code to build the device into the arrays $UR2$ and $ER2$ which represent the permeability and permittivity respectively on the $2\times$ grid. In a single figure window, visualize the relative permeability $UR2$ and the relative permittivity $ER2$ using the `subplot()` and `imagesc()` commands. Be sure your graphics are of professional quality. Your results should look something like...

