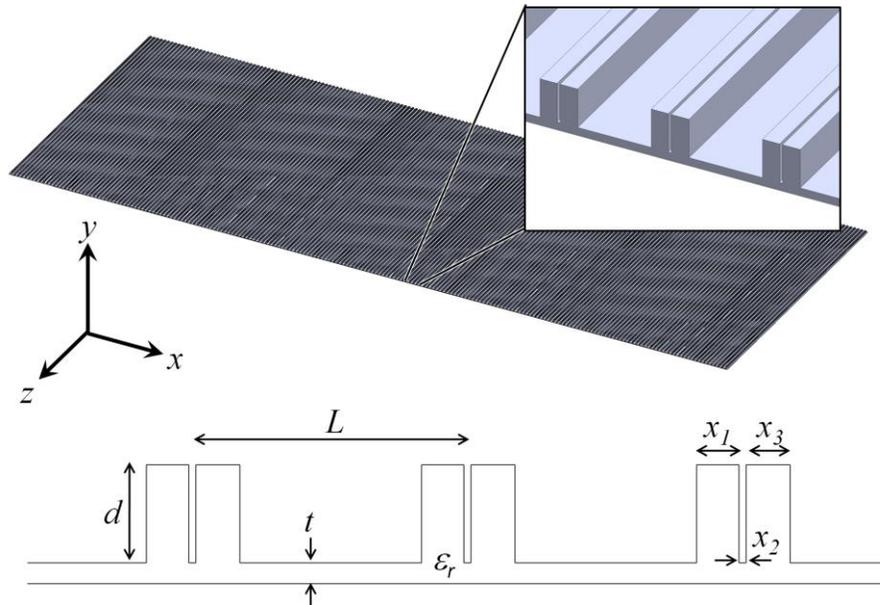## Description of the Problem

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.

$$\lambda_{d} = c_0 / (8.0 \text{ GHz})$$
$$x_1 = 0.1040 \lambda_d$$
$$x_2 = 0.0175 \lambda_d$$
$$x_3 = 0.1080 \lambda_d$$
$$L = 0.6755 \lambda_d$$
$$d = 0.2405 \lambda_d$$
$$t = 0.0510 \lambda_d$$
$$\mu_r = 1.0$$
$$\varepsilon_r = 10.0$$

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 outline presented in the lecture notes exactly.

Problem #1: `fdfd2d()`

Convert your previous FDFD code into a generic MATLAB function that simulates periodic devices using the finite-difference frequency-domain (FDFD) method. Your function `fdfd2d()` must not generate any graphics, it must not display anything in the command window, and it must not overwrite the input arguments.

DO NOT OVERWRITE ANY INPUT ARGUMENTS*!*

Use the following header for your program:

```
function DAT = fdfd2d(DEV,SRC)
% FDFD2D    Two-Dimensional Finite-Difference Frequency-Domain
%
% DAT = fdfd2d(DEV,SRC)
%
% INPUT ARGUMENTS
% =================
% DEV   Device Parameters
%   .UR2    Relative permeability on 2X grid
%   .ER2    Relative permittivity on 2X grid
%   .NPML   Size of PML on 1X grid [xlo xhi ylo yhi]
%   .RES    [dx2 dy2] grid resolution of 2X grid
%
% SRC
%   .lam0   free space wavelength
%   .theta  Angle of incidence
%   .MODE   Mode: 'E' or 'H'
%
% OUTPUT ARGUMENTS
% =================
% DAT       Output Data
%   .RDE    Array of diffraction efficiencies of reflected harmonics
%   .REF    Overall Reflectance
%   .TDE    Array of diffraction efficiencies of transmitted harmonics
%   .TRN    Overall Transmittance
%   .CON    Conservation of Energy
%   .F      Field
%
% Homework #8, Problem 1
% EE 5320 - COMPUTATIONAL ELECTROMAGNETICS
```

Problem #2: Frequency Sweep

Write a MATLAB program that simulates the device using the `fdfd2d()` function. Plot the reflectance, transmittance, and conservation of power as a function of frequency from 4.0 to 12.0 GHz. Do this for both the *E* and *H* modes at normal incidence. Be sure to use enough points in your sweep that your lines are smooth and continuous (i.e. no triangles). Justify that your answer is converged. Explain and justify any anomalies. You will be graded on your accuracy!

Problem #3: Angle Sweep

Write a MATLAB program to generate a second parameter sweep for this same device. Plot the reflectance, transmittance and conservation of power as a function of angle of incidence from -50° to +50°. Do this for both the *E* and *H* modes at 7.85 GHz. Be sure to use enough points in your sweep that your lines are smooth and continuous (i.e. no triangles). Justify that your answer is converged. Explain and justify any anomalies. You will be graded heavily on your accuracy!