Problem #1: Emulate an Iteration of FDTD

Enter the program below and save it as HW2_prob1.m. This program emulates the data that will be calculated during a single iteration of FDTD. You will use this to test your draw1d() function that you write later in Problem #2.

```matlab
% HW2_prob1.m
%
% This MATLAB program generates data to emulate the data calculated
% during a single iteration of FDTD. The function draw1d() is called
% to visualize the data.
%
% EE 5303 -- EM Analysis Using FDTD
% University of Texas at El Paso
% Fall 2018
%
% INITIALIZE MATLAB
close all;
clear all;

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

% CALCULATE A 1D GRID
dz = 0.01;
Nz = 250;
za = [0:Nz-1]*dz;

% BUILD RANDOM DEVICE ON GRID
ER = ones(1,Nz);
nz = rand(1,2);
nz = round(0.7*nz/sum(nz)*Nz);
nz = round(0.12*Nz) + [1 nz(1) nz(1)+nz(2)];
ER(nz(1):nz(2)-1) = 2;
ER(nz(2):nz(3)-1) = 4;

% CALCULATE WAVY FUNCTIONS FOR E AND H
z = linspace(0,1,Nz);
E = cos(7*2*pi*z);
H = 0.5*sin(7*2*pi*z);

% VISUALIZE THE DATA
plot(za,E,'-b');
hold on;
plot(za,H,'-r');
hold off;
```

If your program works correctly, the output of your program should look something like the figure above. Provide this plot in your homework, but do not worry about fancy formatting for this problem.
Problem #2: draw1d()

Write a MATLAB function to visualize an arbitrary set of FDTD data by superimposing the $E$ and $H$ fields onto the materials. Visualize the materials as a grayscale background where the shade of gray indicates the value of the relative permittivity $\varepsilon_r$. Higher values of $\varepsilon_r$ should correspond to darker shades of gray. Visualize the electric field $E$ in blue and visualize the magnetic field $H$ in red. Superimpose all of this into a single plot. The header of your `draw1d()` should be:

```matlab
function draw1d(ER,E,H,dz)
% DRAW1D    Draw 1D Superposition of ER, E, and H
% draw1d(ER,E,H,dz);
% This function draws the dielectric materials and the fields on the same
% plot. ER is an array containing the dielectric constant at each point
% on the grid. E is the electric field at each point on the grid. H is
% the magnetic field at each point on the grid. dz is the grid resolution.
```

To test your function, replace the last section of code in `HW2_prob1.m` that generates the plot with the following. Save this new program as `HW2_prob2.m`.

```matlab
% CALL DRAW1D
draw1d(ER,E,H,dz);
axis tight;
xlabel('$z$', 'Interpreter', 'LaTex');
title('FDTD Iteration');
```

Test your `draw1d()` function using `HW2_prob2.m`. The output of your program should look something like this...
Problem #3: Build a Lollipop

Suppose it is desired to perform a two-dimensional (2D) simulation of electromagnetic scattering from the lollipop illustrated in the figure below. The dimensions are $H = 0.12''$, $R_1 = 0.5''$, $R_2 = 0.527''$, $L = 1.88''$, and $W = 0.08''$. A lollipop is a three-dimensional (3D) structure so it must be flattened before it can be simulated in two dimensions. When this is done using effective medium theory, the dielectric constant of air is 1.0, the dielectric constant of the handle is 1.5, the dielectric constant of the lollipop is 6.0, and the dielectric constant of the region of the lollipop with the handle is 3.9.

Write a MATLAB script file that build a 2D model of the lollipop into a 2D array of size $1382 \times 1920$. The physical size of the array should be $2.16'' \times 3.0''$. The lollipop must have correct dimensions and be perfectly centered in the grid as shown. Use the concept of `meshgrid()` to simplify your code. **Hint: only four lines of code were used in the solution to build the lollipop after the meshgrid was calculated.**

Create a professional diagram of your 2D model of the lollipop like that shown above. Follow the best practices discussed in class when you are writing the MATLAB code. Use the header on the following page for your code.
% HW2_Prob3.m

% INITIALIZE MATLAB
close all;
clc;
clear all;

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

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

% LOLLIPPOP DIMENSIONS
R1 = 0.500;
R2 = 0.527;
H  = 0.120;
L  = 1.880;
W  = 0.080;

% LOLLIPPOP PROPERTIES
er1 = 1.0;
er2 = 6.0;
er3 = 1.5;
er4 = 3.9;

% GRID
Sx = 2.16;
Sy = 3.00;
Nx = 1382;
Ny = 1920;