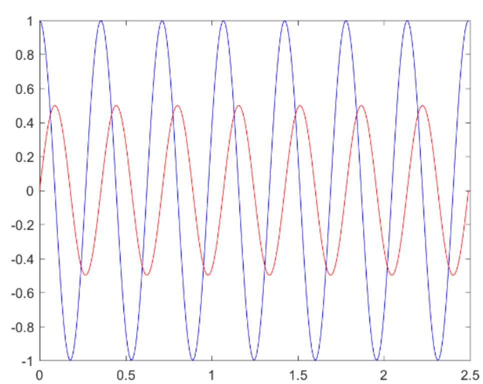
Problem #1: Emulate an Iteration of FDTD

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.

```
% 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 2016

% INITIALIZE MATLAB
close all;
clc;
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.

Problem #2: draw1d()

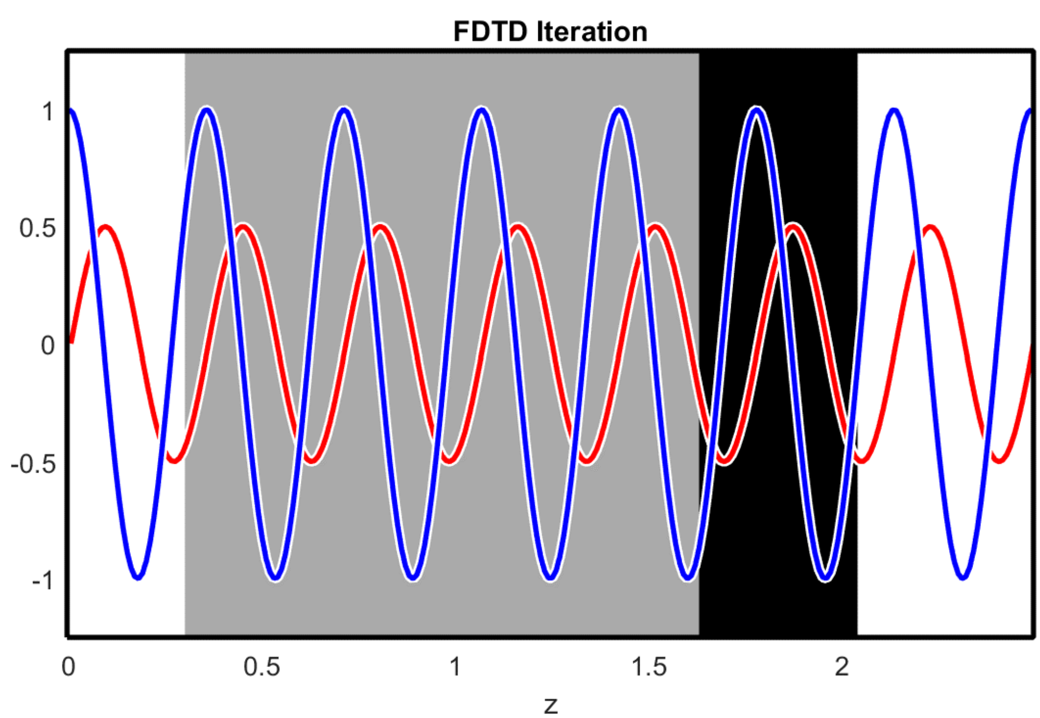
Write a MATLAB function to visualize an arbitrary set of FDTD data by superimposing the *E* and *H* fields onto the materials. Visualize the materials as a grayscale background where the shade of gray indicates the value of permittivity ε_r. Higher values of ε_r should correspond to darker shades of 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:

```
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`.

```
% CALL DRAW1D
draw1d(ER,E,H,dz);
axis tight;
xlabel('z');
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 Triangle

Write a MATLAB script file that creates a 20×20 array where the x-axis spans $0.7<x<2.0$ and the y-axis spans $2.6<y<3.9$. Construct a triangle on this grid where the triangle is defined by the following three points.

$$\vec{p}_1 = (1.9, 2.7) \qquad \vec{p}_2 = (0.8, 3.2) \qquad \vec{p}_3 = (1.1, 3.8)$$

Fill the entire array with values of 2.3 at points that lie outside this triangle and values of 4.1 at points inside the triangle. Create a diagram showing the array containing the triangle and give it a professional and polished look. Use a similar header as `HW_prob1.m` above for this problem. Your output should look something like this…