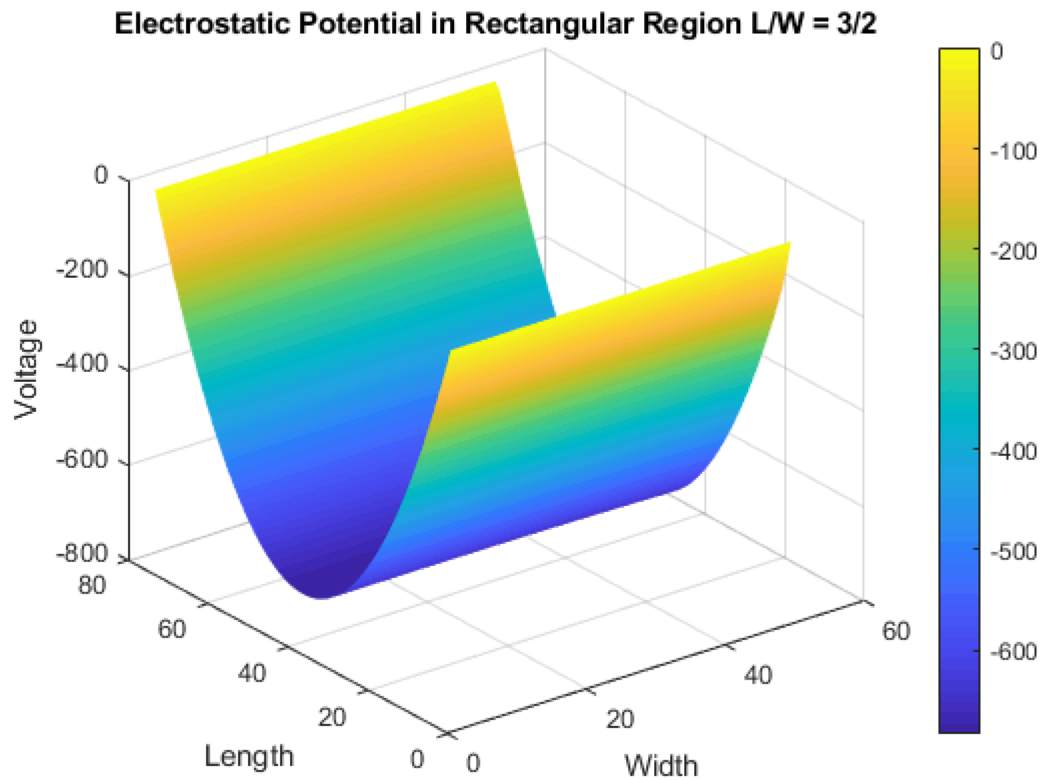
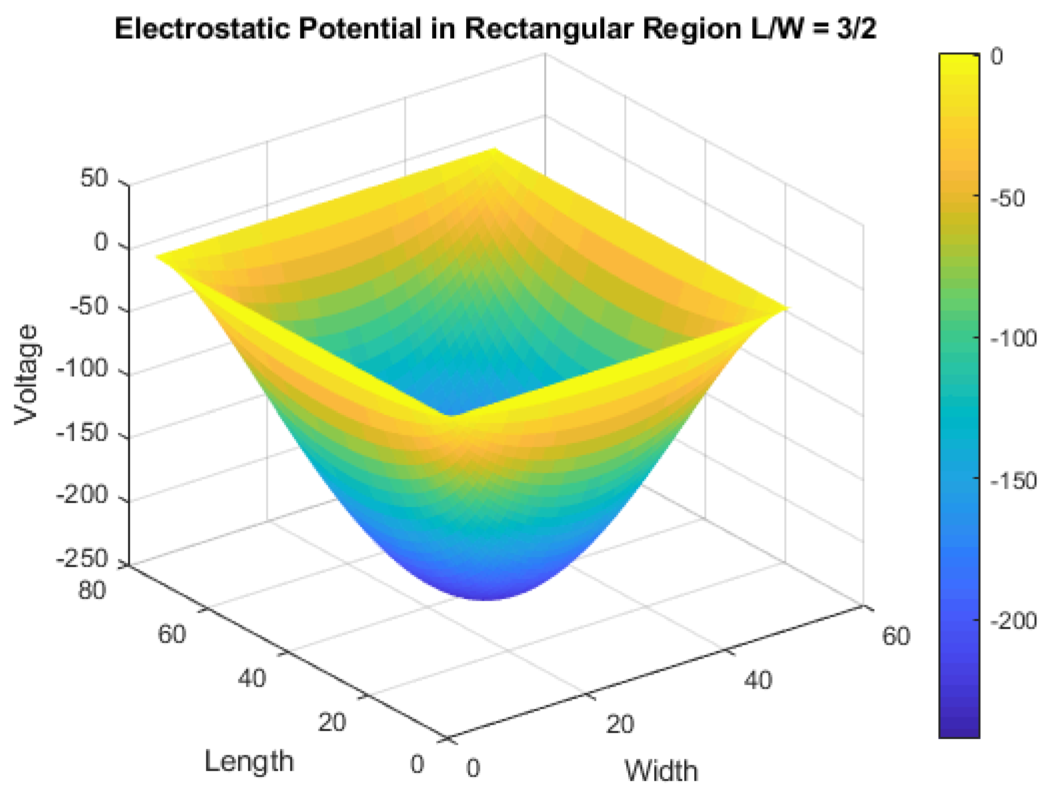
```
%%%%%%%%%%%% Harmonic Wave Equation in 2D FD and Modes %%%%%%%%%%%
% By David, Patrobas, Andrew and Xiaochen
% Febuary 24th, 2019
% Assignment 2
% Patrobas Adewumi
global C;
C.q_0 = 1.60217653e-19;             % electron charge
C.hb = 1.054571596e-34;             % Dirac constant
C.h = C.hb * 2 * pi;                    % Planck constant
C.m_0 = 9.10938215e-31;             % electron mass
C.kb = 1.3806504e-23;               % Boltzmann constant
C.eps_0 = 8.854187817e-12;          % vacuum permittivity
C.mu_0 = 1.2566370614e-6;           % vacuum permeability
C.c = 299792458; % speed of light

nx = 75;
L = nx;% length
ny = 50;
W = ny; % width

dx = 1;
dy = 1;
G = sparse(nx*ny, ny*nx);
V = ones(nx*ny,1);
alpha = (C.hb^2) / (2 * C.m_0);

map = @(i,j) j + (i - 1)*ny;

%%%%%%%%%%%%%%%%%%%%%%% Part a %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Set boundary conditions

for i=1:nx
    for j=1:ny
        n = map(i,j);
        nxm = map(i-1,j);
        nxp = map(i+1,j);
        nym = map(i,j-1);
        nyp = map(i,j+1);

        % when Length = 0 (V = Vo)
        if i == 1
            G(n,:) = 0;
            G(n,n) = 1;
            V(n) = 1;
        % When lenght is some given length, L (V = 0)
        elseif i == nx
            G(n,:) = 0;
            G(n,n) = 1;
            V(n) = 0;
        elseif (j == 1 || j == ny)
            G(n,:) = 0;
            G(n,n) = -3;
```

```
            G(n,nxm) = 1;
            G(n,nxp) = 1;
            G(n,nyp) = 1;
        else
            G(n,:) = 0;
            G(n,n) = -4;
            G(n,nxm) = 1;
            G(n,nxp) = 1;
            G(n,nym) = 1;
            G(n,nyp) = 1;

        end
    end
end


% GV = F Solve for F
F = G\V;
surfs_up = zeros(nx,ny);
for i = 1:nx
    for j = 1:ny
        n = map(i,j);
        surfs_up(i,j) = F(n);
    end
end

figure(1)
surf(surfs_up)
% I am a simple man and so is the colormap
colormap default
shading interp
colorbar

title('Electrostatic Potential in Rectangular Region L/W = 3/2')
xlabel('Width')
ylabel('Length')
zlabel('Voltage')

%%%%%%%%%%%%%%%%%%%%%%% Part b %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Set boundary conditions

for i=1:nx

    for j=1:ny
        n = map(i,j);
        nxm = map(i-1,j);
        nxp = map(i+1,j);
        nym = map(i,j-1);
        nyp = map(i,j+1);


        if i == 1
            G(n,:) = 0;
            G(n,n) = 1;
```

```matlab
            V(n) = 1;

        elseif i == nx
            G(n,:) = 0;
            G(n,n) = 1;
            V(n) = 1;
        elseif j == 1
            G(n,:) = 0;
            G(n,n) = 1;
            V(n) = 0;
        elseif j == ny
            G(n,:) = 0;
            G(n,n) = 1;
            V(n) = 0;
        else
            G(n,:) = 0;
            G(n,n) = -4;
            G(n,nxm) = 1;
            G(n,nxp) = 1;
            G(n,nym) = 1;
            G(n,nyp) = 1;
        end
    end
end

% GV = F Solve for F
F = G\V;
% Set up a surf plot
surfs_up = ones(nx,ny);
for i = 1:nx
    for j = 1:ny
        n = map(i,j);
        surfs_up(i,j) = F(n);
    end
end

figure(2)
surf(surfs_up)
% I am a simple man and so is the colormap
colormap default
shading flat
colorbar

title('Electrostatic Potential in Rectangular Region L/W = 3/2')
xlabel('Width')
ylabel('Length')
zlabel('Voltage')
```


Electrostatic Potential in Rectangular Region L/W = 3/2
Voltage
0
-200
-400
-600
-800
Length
80
60
40
20
0
Width
0
20
40
60
0
-100
-200
-300
-400
-500
-600


Electrostatic Potential in Rectangular Region L/W = 3/2
Voltage
50
0
-50
-100
-150
-200
-250
Length
80
60
40
20
0
Width
0
20
40
60
0
-50
-100
-150
-200

Publish this report

Meshing becomes an accurate tool when the amount of points used becomes near infinite Analytical solutions can be obtained exactly with pencil and paper; Numerical solutions cannot be obtained exactly in finite time and typically cannot be solved using pencil and paper.

```
% These distinctions, however, can vary. There are increasingly many
 theorems
% and equations that can only be solved using a computer; however, the
 computer
% doesn't do any approximations, it simply can do more steps than any
 human can ever hope to do without error.

% In numerical computing, we specify a problem, and then crunch
 numbers in a very well-defined, carefully-constructed order.
% If we are very careful about the way in which the numbers are
 crunched,
% we can guarantee that the result is only slightly inaccurate, and
 usually close enough for its intended purpose.
% Numerical solutions very rarely can contribute to proofs of new
 ideas.
% Analytic solutions are generally considered to be "stronger".
% The thinking goes that if we can get an analytic solution, it is
 exact,
% and then if we need a number at the end of the day, we can just plug
 numbers into the analytic solution.
% However, even if analytic solutions can be found, they might not be
 able to be computed quickly.
% As a result, numerical approximation will never go away, and both
 approaches contribute holistically to the fields of mathematics and
 quantitative sciences.
```

Published with MATLAB® R2018a