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4th Project. MAE 185. Microstrip line solution by finite difference method

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Problem description

See last page for problem description.

Instruction to running the program

The program for this project was written in MATLAB 6.5
To run, please follow these instructions:

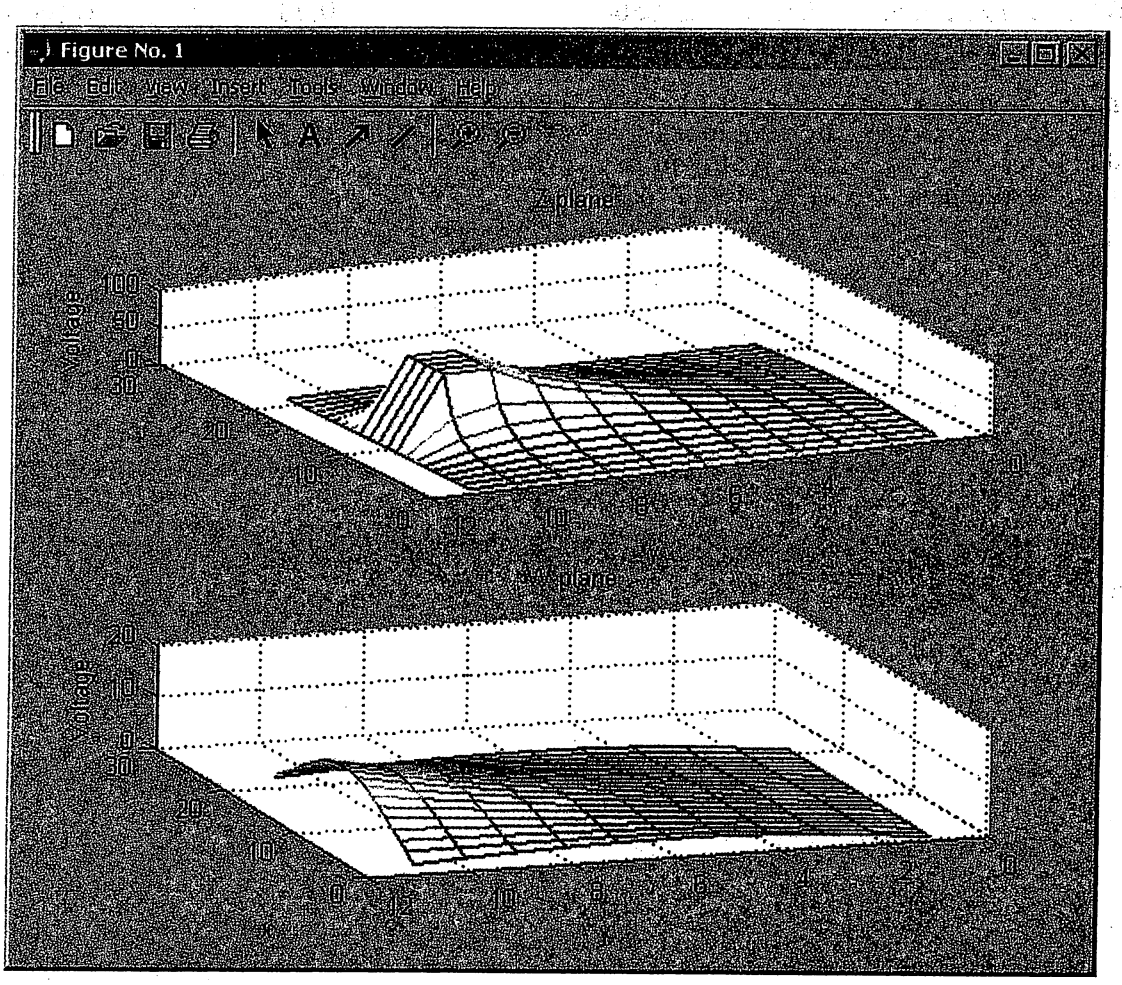
1. Copy the content of the floppy disk attached to some location on your hard disk. Assume you copied the content of the floopy disk to a folder called C:\TEMP.
2. Add the folder C:\TEMP to MATLAB path by following these instructions:
   Open MATLAB, then select FILE→ SET PATH→ Add Foler→
   Now navigate to select the folder C:\TEMP.
   Now click SAVE.
3. Now ready to start the program. From MATLAB console, type the following command:

   nma_MAE_proj_4

4. Now the program will run and will produce the output shown below.

Example run and output of program

>> nma_MAE185_proj_4



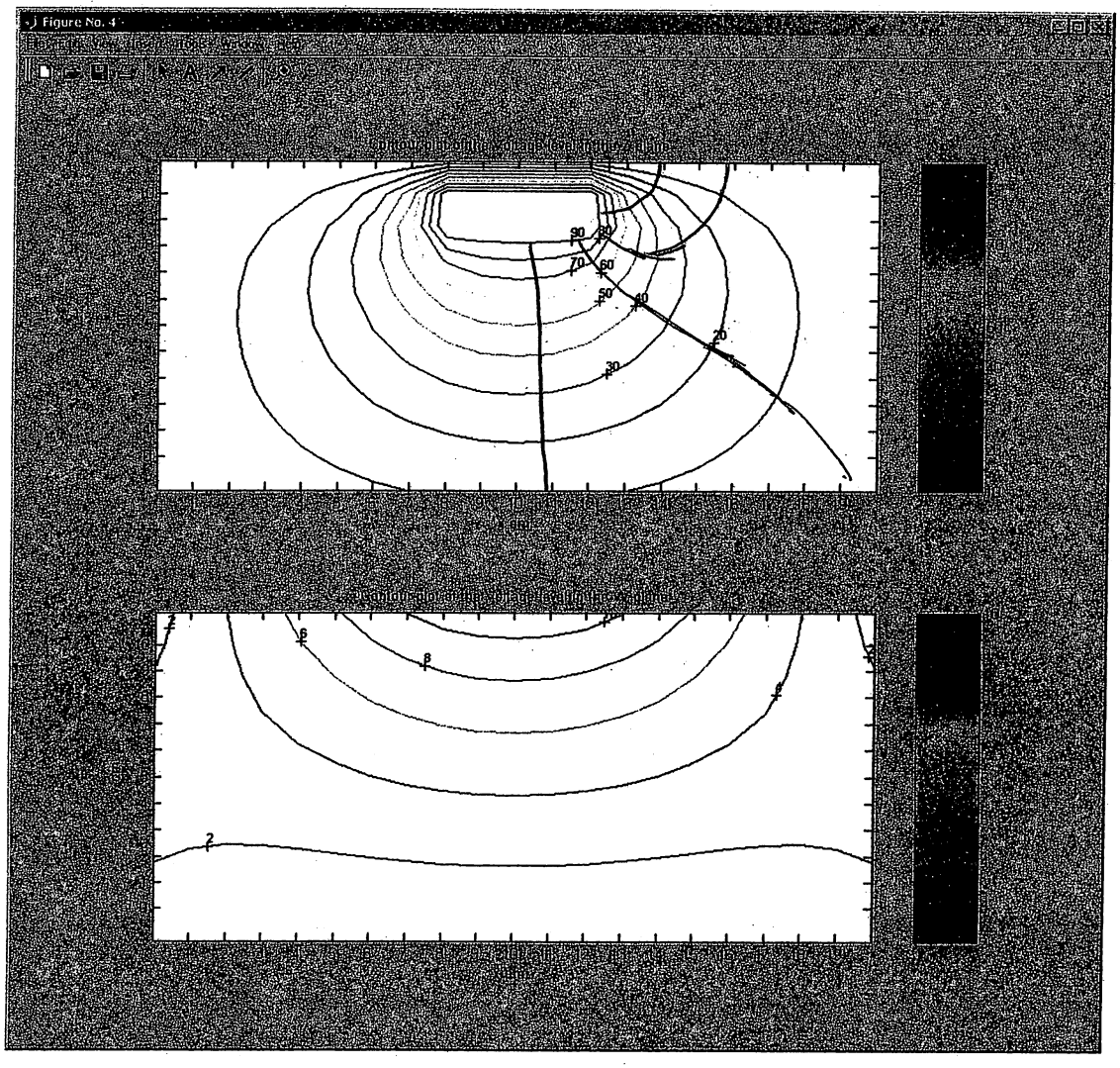


Figure No. 4
90
80
70
60
50
40
30
20
10
8
6
4
2

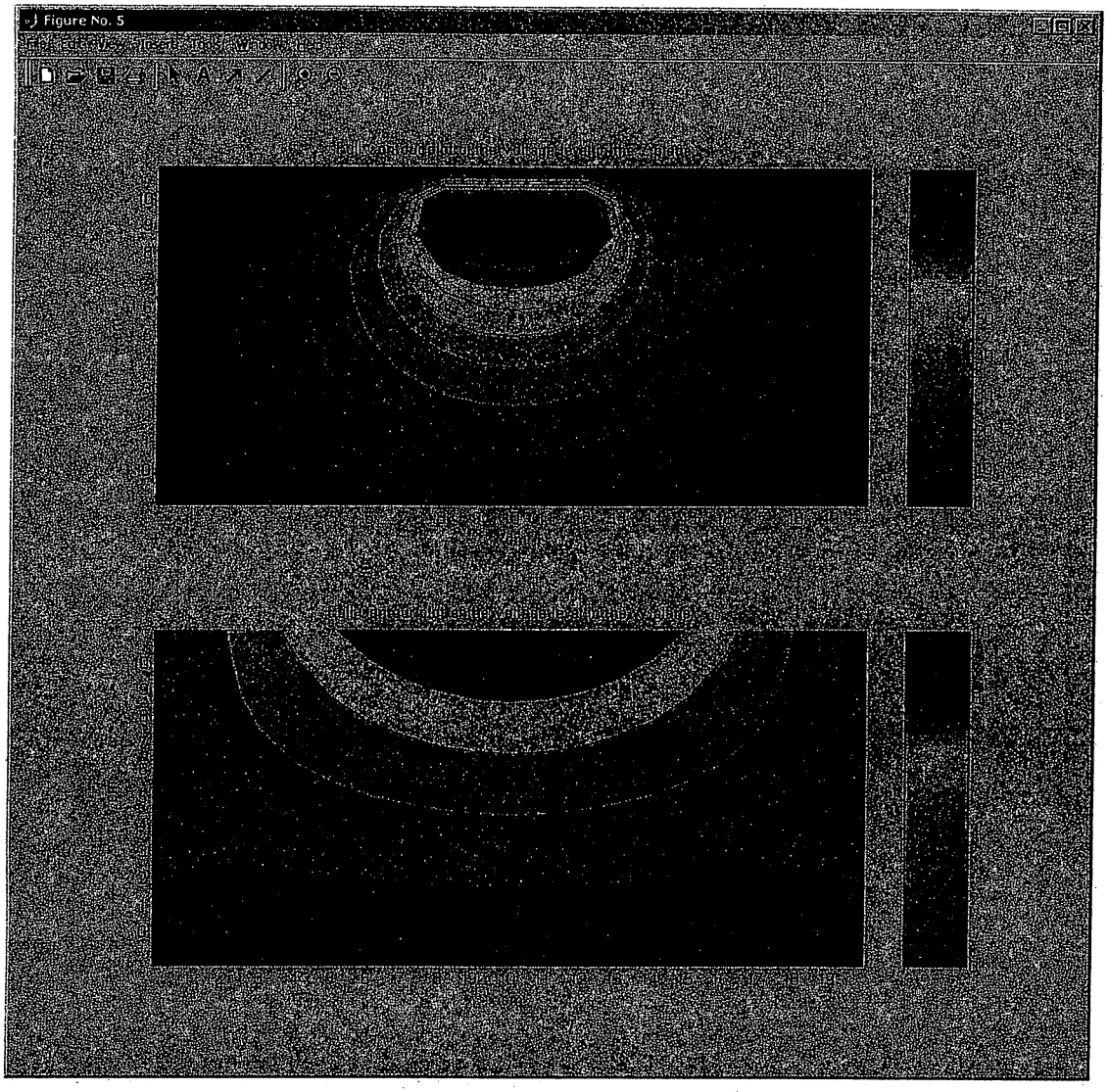


Figure No. 5

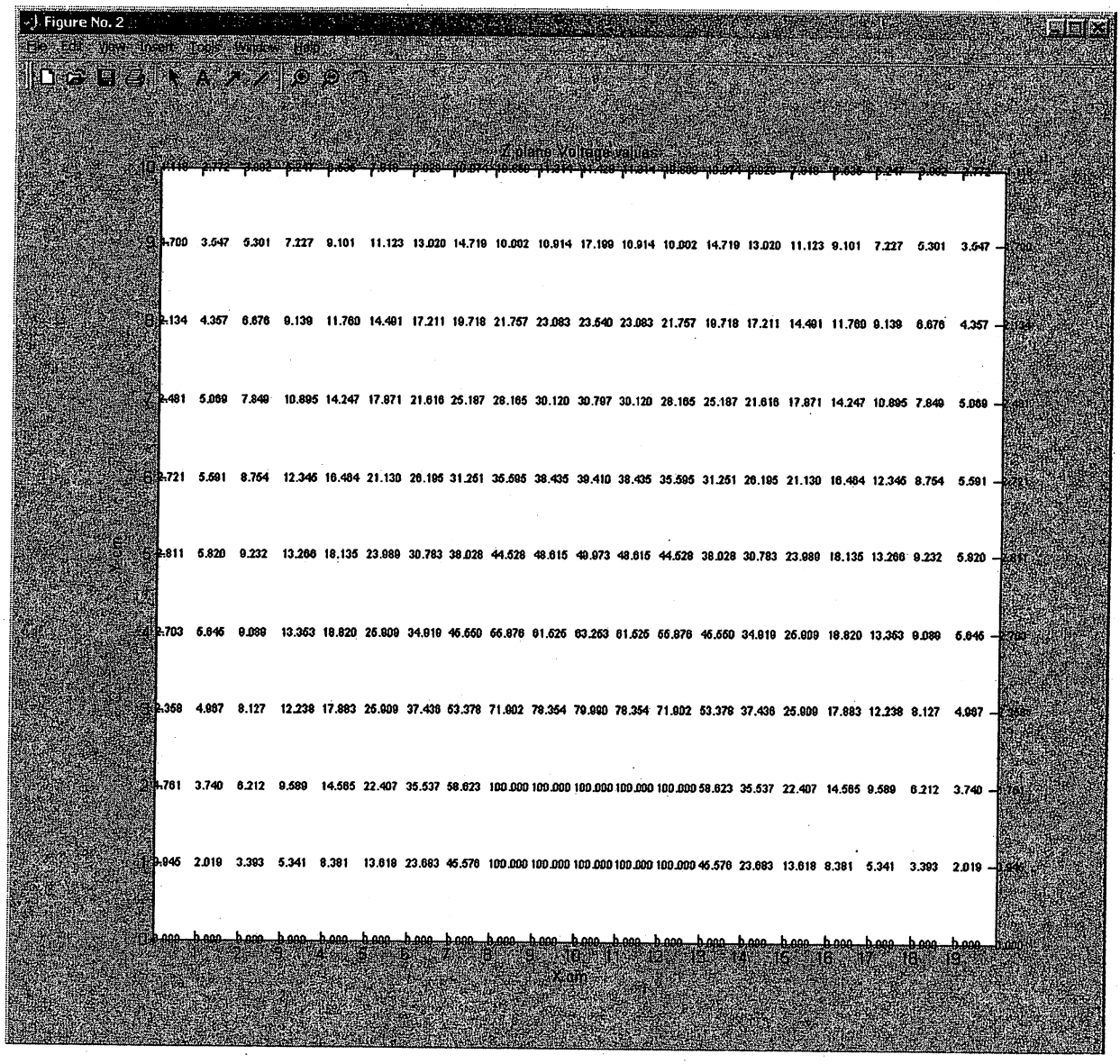


Figure No. 2
File Edit View Insert Tools Window Help
Z plane Voltage values
Y dm
X dm
9 4.700 3.547 5.301 7.227 9.101 11.123 13.020 14.719 16.002 16.914 17.199 16.914 16.002 14.719 13.020 11.123 9.101 7.227 5.301 3.547
8 4.134 4.357 6.676 9.139 11.760 14.491 17.211 19.718 21.757 23.083 23.540 23.083 21.757 19.718 17.211 14.491 11.760 9.139 6.676 4.357
7 4.481 5.069 7.849 10.895 14.247 17.971 21.616 25.187 28.165 30.120 30.797 30.120 28.165 25.187 21.616 17.971 14.247 10.895 7.849 5.069
6 4.721 5.591 8.754 12.346 16.484 21.130 26.195 31.251 35.595 38.435 39.410 38.435 35.595 31.251 26.195 21.130 16.484 12.346 8.754 5.591
5 4.811 5.820 9.232 13.266 18.135 23.989 30.783 38.028 44.528 48.615 49.973 48.615 44.528 38.028 30.783 23.989 18.135 13.266 9.232 5.820
4 4.703 5.646 9.089 13.363 18.820 25.909 34.910 46.550 55.876 61.625 63.263 61.625 55.876 46.550 34.910 25.909 18.820 13.363 9.089 5.646
3 4.358 4.997 8.127 12.238 17.883 25.909 37.436 53.378 71.902 78.354 79.990 78.354 71.902 53.378 37.436 25.909 17.883 12.238 8.127 4.997
2 3.761 3.740 6.212 9.589 14.565 22.407 35.537 58.623 100.000 100.000 100.000 100.000 100.000 58.623 35.537 22.407 14.565 9.589 6.212 3.740
1 2.945 2.019 3.393 5.341 8.381 13.618 23.683 45.576 100.000 100.000 100.000 100.000 100.000 45.576 23.683 13.618 8.381 5.341 3.393 2.019
0 0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

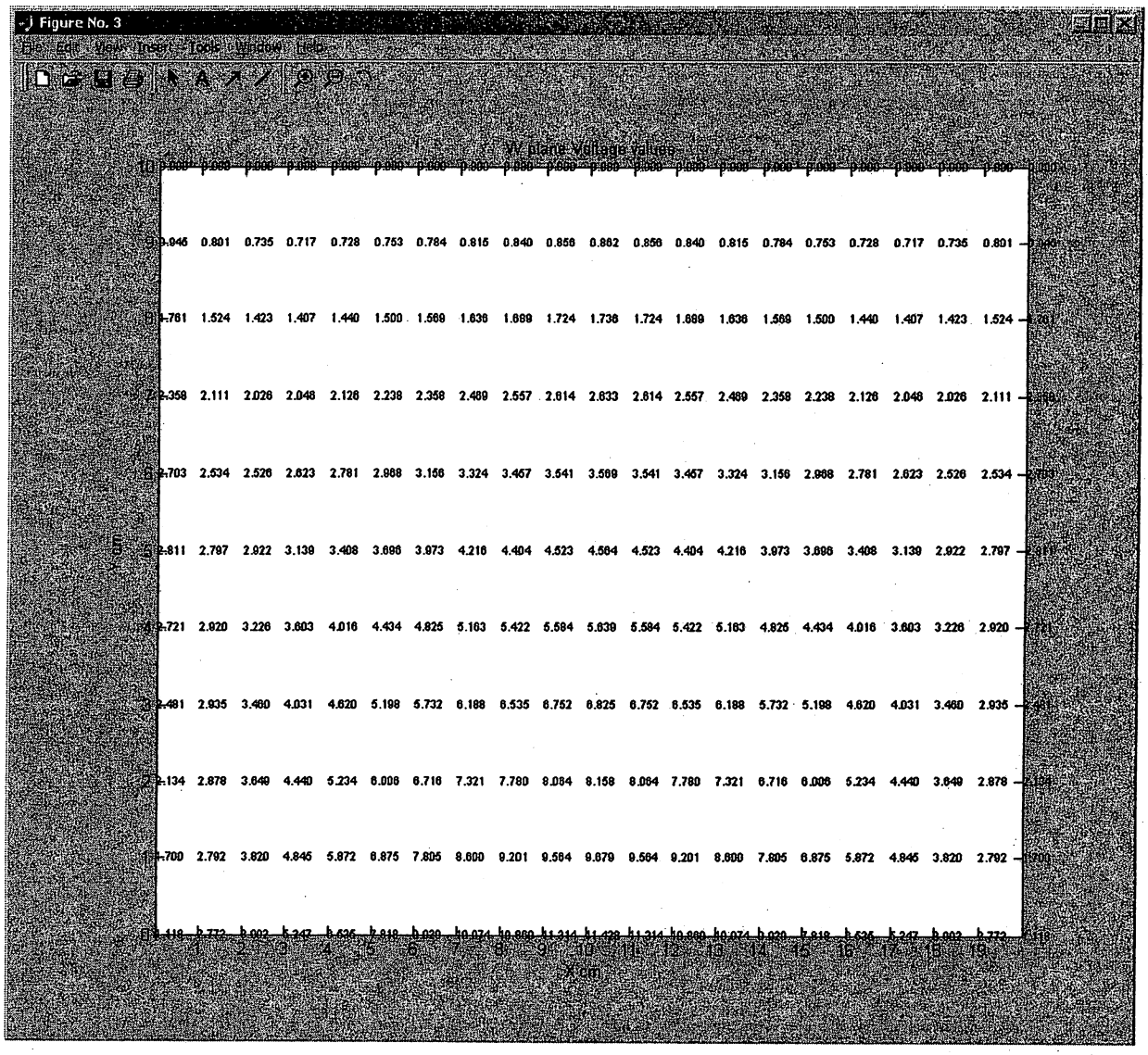


Figure No. 3
File Edit View Insert Tools Window Help
W plane Voltage values
0.046 0.801 0.735 0.717 0.728 0.753 0.784 0.815 0.840 0.856 0.862 0.856 0.840 0.815 0.784 0.753 0.728 0.717 0.735 0.801
1.761 1.524 1.423 1.407 1.440 1.500 1.569 1.636 1.689 1.724 1.736 1.724 1.689 1.636 1.569 1.500 1.440 1.407 1.423 1.524
2.358 2.111 2.026 2.048 2.126 2.238 2.358 2.469 2.557 2.614 2.633 2.614 2.557 2.469 2.358 2.238 2.126 2.048 2.026 2.111
2.703 2.534 2.526 2.623 2.781 2.988 3.156 3.324 3.457 3.541 3.569 3.541 3.457 3.324 3.156 2.988 2.781 2.623 2.526 2.534
2.811 2.797 2.922 3.139 3.408 3.696 3.973 4.216 4.404 4.523 4.564 4.523 4.404 4.216 3.973 3.696 3.408 3.139 2.922 2.797
2.721 2.920 3.226 3.603 4.016 4.434 4.825 5.163 5.422 5.584 5.639 5.584 5.422 5.163 4.825 4.434 4.016 3.603 3.226 2.920
2.481 2.935 3.460 4.031 4.620 5.198 5.732 6.188 6.535 6.752 6.825 6.752 6.535 6.188 5.732 5.198 4.620 4.031 3.460 2.935
2.134 2.878 3.649 4.440 5.234 6.006 6.716 7.321 7.780 8.054 8.158 8.054 7.780 7.321 6.716 6.006 5.234 4.440 3.649 2.878
1.700 2.792 3.820 4.845 5.872 6.875 7.805 8.600 9.201 9.564 9.679 9.564 9.201 8.600 7.805 6.875 5.872 4.845 3.820 2.792
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
X cm
Y cm

Appendix

Source code

```
function nma_MAE185_proj_4()
%
% SOlves project #4 for course MAE 185
% UCI, spring 2003.
%
% See report for full description of problem and
% output.
%
% AUthor: Nasser Abbasi
FALSE = 0;
TRUE  = 1;

TOLERANCE=0.0001;

nRow = 11;
nCol = 11;

Z = zeros(nRow,nCol);
W = zeros(nRow,nCol);

%Now add the voltage

Z(nRow-1,1:3) = 100;
Z(nRow-2,1:3) = 100;

while(1)
    Z_old=Z;

    for(i=1:nRow-1)
        for(j=1:nCol)
            if( (i == 10 | i==9)  & (j==1 | j==2 | j==3))
                ;
            else
                if(i==1)
                    top = W(end-1,j);
                    if(j~=nCol)
                        right=Z(i+1,j);
                    else
                        right = W(end-i+1,end-1);
                    end
                    btm=Z(i+1,j);
                    if(j~=1)
                        left=Z(i,j-1);
                    else
                        left=Z(i,j+1);
                    end
                else
                    if(j==1)
                        left = Z(i,j+1);
                        right=Z(i,j+1);
                        top=Z(i-1,j);
                        btm=Z(i+1,j);
                    else
                        if(j==nCol)
                            right = W(end-i+1,end-1);
                            top=Z(i-1,j);
                            left=Z(i,j-1);
                            btm=Z(i+1,j);
                        else
                            top=Z(i-1,j);
                            left=Z(i,j-1);
                            right=Z(i,j+1);
                            btm=Z(i+1,j);
                        end
                    end
                end

                Z(i,j)=top+btm+left+right;
                Z(i,j)=Z(i,j)/4;
            end
        end
    end
```

```
        C=Z;
        C(nRow-1,1:3) = 0;
        C(nRow-2,1:3) = 0;
        [maxRow,maxRowIndex]=max(C);
        [maxEle,maxColIndex]=max(maxRow);
        pos=[maxRowIndex(1),maxColIndex(1)];
        x=pos(1);
        y=pos(2);
        eps=abs(   (Z(x,y) - Z_old(x,y)) / Z(x,y) ) * 100;
        if( eps < TOLERANCE )
            break;
        end
    end

    W(end,:) = Z(1,:);

    for(i=1:nRow)
        W(end-(i-1),end)=Z(i,end);
    end

    while(1)
        W_old=W;

        for(i=2:nRow-1)
            for(j=1:nCol-1)
                if(j==1)
                    left = W(i,j+1);
                    right=W(i,j+1);
                    top=W(i-1,j);
                    btm=W(i+1,j);
                else
                    top=W(i-1,j);
                    left=W(i,j-1);
                    right=W(i,j+1);
                    btm=W(i+1,j);
                end
                if(i==9 & j==9)
                    i;
                end

                W(i,j)=top+btm+left+right;
                W(i,j)=W(i,j)/4;
            end
        end

        [maxRow,maxRowIndex]=max(W(1:end-1,1:end-1));
        [maxEle,maxColIndex]=max(maxRow);
        pos=[maxRowIndex(1),maxColIndex(1)];
        x=pos(1);
        y=pos(2);
        eps=abs(   (W(x,y) - W_old(x,y)) / W(x,y) ) * 100;
        if( eps < TOLERANCE)
            break;
        end
    end

    %Now add the other halfs from symmetry
    Zfull = zeros( nRow,(nCol+nCol-1) );
    Wfull = zeros( nRow,(nCol+nCol-1) );

    for(i=1:nRow)
        k=0;
        for(j=nCol:-1:1)
            k=k+1;
            Zfull(i,j)=Z(i,k);
            Wfull(i,j)=W(i,k);
        end
    end
    Zfull(:,nCol:end)=Z(:,:);
    Wfull(:,nCol:end)=W(:,:);

    figure;
    subplot(2,1,1);
    mesh(Zfull)
    view(-116,64)
    title('Z plane');
    xlabel('x');
    ylabel('y');
    zlabel('Voltage');
    %setAxisLimits;
```

```
subplot(2,1,2);
mesh(Wfull)
view(-109,52)
title('W plane');
xlabel('x');
ylabel('y');
zlabel('Voltage');
%setAxisLimits;


plotit(Zfull,'Z');
plotit(Wfull,'W');

figure;
subplot(2,1,1);
clabel(contour(Zfull),'FontSize',8);
title('Contour plot of the Voltage level in the Z plane');
setAxisLimits;
xlabel('x cm');
ylabel('y cm');
colorbar;

subplot(2,1,2);
clabel(contour(Wfull),'FontSize',8);
title('Contour plot of the Voltage level in the W plane');
setAxisLimits;
xlabel('x cm');
ylabel('y cm');
colorbar;


figure;
subplot(2,1,1);
contourf(Zfull);
title('Full Contour plot of the Voltage level in the Z plane');
setAxisLimits;
xlabel('x cm');
ylabel('y cm');
colorbar;

subplot(2,1,2);
contourf(Wfull);
title('Full Contour plot of the Voltage level in the W plane');
setAxisLimits;
xlabel('x cm');
ylabel('y cm');
colorbar;


%%%%%%%%%%%%%%%
%
%
%%%%%%%%%%%%%%%
function plotit(M,name)

figure;
[nRowsFull,nColsFull]=size(M);
plot(nRowsFull,nColsFull,'*');
hold on;
plot(1,1,'*');
XLim([1,nColsFull]);
YLim([1,nRowsFull]);

for(i=1:nRowsFull)
    yCoord=nRowsFull-i+1;
    for(j=1:nColsFull)
        xCoord= nColsFull-j+1;
        val=sprintf('%.3f',M(i,j));
        text(xCoord,yCoord,val,'FontSize',7);
    end
end

title(sprintf('%s plane Voltage values',name));
xlabel('X cm');
ylabel('Y cm');

setAxisLimits;
```

```
%%%%%%%%%%%%%%%%%%
%
%
%%%%%%%%%%%%%%%%%%%%5
function setAxisLimits()

newXlabel=[1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19];
l=get(gca,'xtick');
l=linspace(l(1),l(end),length(newXlabel));
set(gca,'xtick',l);
set(gca,'xticklabel',newXlabel);

newYlabel=[0 1 2 3 4 5 6 7 8 9 10];
l=get(gca,'ytick');
l=linspace(l(1),l(end),length(newYlabel));
set(gca,'ytick',l);
set(gca,'yticklabel',newYlabel);
```