HERIOT-WATT UNIVERSITY
DEPARTMENT OF COMPUTING AND ELECTRICAL ENGINEERING

22.3MB1 Electromagnetics

Matlab Tutorial 1

Introduction:

Matlab is a very powerful scientific programming package with outstanding visualisation capabilities. As we progress through the tutorial and the course, you should become more comfortable with Matlab and use it to understand and visualise the physical processes. You will find a small library of functions that you can download and use freely. You are encouraged to do so as early as possible. Some functions of the “library” are useful to understand vector calculus and differential forms of the Maxwell equations as well as the Nabla operator that you will study during the next 3 weeks. Matlab can be used in Lab 2.52 on PC Caledonia where 50 licenses are available. Log in onto your PC Caledonia account and click on the Matlab icone in your desktop. If for some reason, the icone is not there, use the Start Program menu to start Matlab. Then in Matlab, use the cd command to move to the directory where the program lies and type the name of the file to start the program. The two examples developed here are available on-line for download at:
http://www.cee.hw.ac.uk/~ceeyrp/teaching/223MB1/

Objective of the tutorial:

We want to calculate the electric field generate by various sources of charge (point and line) and visualise it using Matlab. The following programs are good examples of what can be done and we will analyse them step by step.

Program1: Static charges (Electrostatics Case)

```
% 22.3MB1 Fall 01
% Yvan Petillot
% Fields due to discrete charges distributions
% File Name: EmfieldS.m

clf; %Clears all figures
% define charges. Can be changed to generate new fields
charges = ...
   [1 1 1;
   -1 -1 -1;
   1 -1 1;
   -1 1 -1];
epsilon0 = 8.8e-9;
% create Mesh
[x,y] = meshgrid(-2:0.05:2,-2:0.05:2);
% Calculates potential using Coulomb Law
V = x.*0;
for i = 1 : size(charges,1)
   dist = sqrt((x-charges(i,1)).^2+(y-charges(i,2)).^2);
   V = V+1*charges(i,3)./((4*pi*epsilon0)*dist);
end
figure(1);
contour3(x,y,V,100); % Displays the 3D contour of V
xlabel('x');
ylabel('y');
title('Potential(Volts) generated by n coplanar charges');
hold on;
```



```
% Shows where the charges are (+ for positive charges, * for negative
ones)
% We can see the notion of sources and sinks very clearly here
for i = 1 : size(charges,1)
   if (charges(i,3) > 0)
      plot3(charges(i,1),charges(i,2),25,'+g');
   else
      plot3(charges(i,1),charges(i,2),-25,'*m');
   end
end
% Now 2 D representation
figure(2);
contour(x,y,V,100); % Displays the 2D contour of V
hold on;
```

Program2: Variable Field (EM case)

```
% 22.3MB1 Fall 01
% Yvan Petillot
% Demo of Matlab Capabilities to visualise EM Fields and Potentials
% File Name : EmfieldsM.m

% Creates mesh for calculus
[x,y] = meshgrid(-2:0.2:2,-1:0.2:1);
% As we have variable fields, we need to create a movie to visualise the
changes
nframes = 25;  % Number of frames in Movie
VF = moviein(nframes); % Create Movie structure for potential
EF = moviein(nframes); % Idem for Field
delt_t = 0.1;  % Time variation unit

% For each frame we repeat the actions
for k = 1 : nframes
   % Find t
   t = (k-1)*delt_t;
   % Calculate the potential
   V = x.*y.^2.*exp(-t.*x.^2-t.*y.^2);
   figure(1);
   clf(1);
   % Visualise the potential in 3D
   contour3(x,y,V,100);
   xlabel('x');
   ylabel('y');
   title('Potential(Volts) generated by n coplanar charges');
   % Put the current figure in a movie frame
   VF(:,k) = getframe;
   figure(2);
   clf(2);
   % Get the fields as E = grad(-V)
   [ex,ey] = gradient(-V,0.2,0.2);
   % Show the field using the quiver function
   quiver(x,y,ex,ey,2);
   xlabel('x');
   ylabel('y');
   title('Potential(Volts) and Electric Field(Volt/m) for n charges in
2D');
   drawnow;
   % Put the field in a Movie Frame
   EF(:,k) = getframe;
end
% Show movies
figure(1);
movie(VF,1);
figure(2);
movie(EF,1);
```