Assignment

01

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3	0	1	5	7
8	6	3	1	

A01 **Assignment 01** due Wed Sept 24th 2025 @ 11:59 pm A01

Instructions:

Papers to be submitted electronically via Canvas.

Formatting: use 8.5" X 11" Page size with clean edges; write neatly so that all symbols are easy to read; use the cover sheet provided.

File specifications: to submit handwritten work use a document scanner (SFU provides them at various locations) or professional document camera **(cell phone camera not permitted!)**; naming: Axx-316-1207-yyyy; with xx: assignment number; yyyy: student id last digits; size < 200 kB per page.

Submissions not adhering to format/file specifications graded with a 50% reduced score (refundable)

1) Watch this video online and answer each question with **no more than two sentences**.

a) What historical event triggered the 16th century voyages of discovery?

b) What was William Gilbert's profession?

c) Summarize the content of Gilbert's book, "De Magnete".

d) What did Otto Von Guericke observe from his sulphur balls?

e) How much would a university student earn when working at the weather station on Ben Nevis?

f) How did Charles Wilson produce clouds in streaks?

g) What did Appleton observe and measure in 1924?

MATLAB Exercises:

2) Exercise 1.1 (page 2)

3) Exercise 1.3 (page 3)

4) Exercise 1.4 (page 4)

5) Exercise 1.7 (page 11)

6) Exercise 1.10 (page 12)

7) Exercise 1.11 (page 12)

Textbook Exercises:

8) Problem 1.11 (page 54) Nonuniform surface charge on a disc:

A surface charge is distributed in free space to make the shape of a circular disc or radius, A. The charge density is $\rho(\vec{\mathbf{r}}) = \rho_{s0}\left(\frac{\gamma}{A}\right)^2 \quad 0 < \gamma < A$ where γ is the distance to the centre & ρ_{s0} is some constant. Calculate the total charge of the disc.

9) Problem 1.13 (page 54) Field maximum on the axis of a ring:

(a) For the charged ring in Fig. 1.11, assume Q > 0, and find z for which the Electric Field Intensity along the z-axis is maximum.

(b) Plot the function $E_z(z) \doteq E_z(\vec{\mathbf{r}})\big|_{\vec{\mathbf{r}}=z\hat{\mathbf{z}}} \doteq \vec{\mathbf{E}}(\vec{\mathbf{r}})\bullet\hat{\mathbf{z}}\big|_{\vec{\mathbf{r}}=z\hat{\mathbf{z}}} \quad \forall z \in \mathbb{R}$

10) Problem 1.21 (page 55) Charged square contour:

A line charge of uniform charge density, ρ_ℓ, is distributed along a square contour, length = L, on each side. The medium is a vacuum. Find the Electric Field Intensity Vector at a point that is a distance, L, from each of the square vertices. (The point is at the top of a pyramid)

MATLAB EXERCISE 1.1 **Vector magnitude.** Using MATLAB, write a function `vectorMag()` that calculates the magnitude of a given vector. The input to the function is either a one-dimensional (1-D) vector, $\mathbf{a} = a_x\,\hat{\mathbf{x}}$, or a 2-D one, $\mathbf{a} = a_x\,\hat{\mathbf{x}} + a_y\,\hat{\mathbf{y}}$, or a 3-D vector,

$$\mathbf{a} = a_x\,\hat{\mathbf{x}} + a_y\,\hat{\mathbf{y}} + a_z\,\hat{\mathbf{z}} \quad \text{(Cartesian vector components)} \tag{1.4}$$

– in a Cartesian coordinate system (Fig.1.2), and it is specified as either a row or column array, named `vector`, with the elements of the array representing respective Cartesian components of the vector **a**. *(vectorMag.m on IR)*[3]

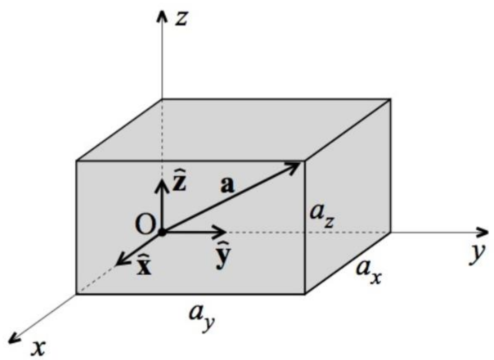


Figure 1.2 Decomposition of a vector (**a**) onto components (a_x, a_y, and a_z) in a Cartesian coordinate system, Eq.(1.4); for MATLAB Exercise 1.1.

Submit a listing of the code for the function, vectorMag().
Your function should check the input argument to ensure that it is either a row or column vector.
If it is not then display a message and return a magnitude ZERO.

MATLAB EXERCISE 1.3 **3-D vector plot.** Use MATLAB to write a function `vecPlot3D()` that – for an input 3-D vector given by coordinates of its starting and ending points – plots the vector in a 3-D Cartesian coordinate system. Other input parameters are: information whether or not scaling is to be performed, the color of the vector, and, since the function will later be used to plot the electric force on a charge, whether there should be a dot representing the charge "target" at the tail of the force vector. *(vecPlot3D.m on IR)*

Submit a listing of the code for the function, vecPLot3D().
Submit an image of a figure window and command line that verifies that your code works correctly.
Your function should have inputs, vecPlot3D(Vstart, Vend, Scaling, Colour, Origin).

Vstart &
Vend – row or column vectors that are the cartesian coordinates of the vector endpoints.
Scaling – passed to **`quiver3`** – read the help file for syntax. You may want to watch this video.

[Part 6:](#) Display of Quiver3 and Cone Plots. (5:23)

Colour – specifies the colour of the arrow using typical MATLAB property coding.
Origin – Zero => no circle, not ZERO => draw a circle.
(**`plot3`** - use style 'o') at the start point of the arrow.

A01 **Assignment 01** due Wed Sept 24th 2025 @ 11:59 pm A01

MATLAB EXERCISE 1.4 **Electric force due to multiple charges.** Write a program in MATLAB that uses functions from the previous three MATLAB exercises and calculates and plots the electric force on a point charge due to N other point charges in free space. The input to the program consists of N, coordinates of charge points, and charges Q_1, Q_2, ..., Q_N, as well as coordinates and charge of the point charge on which the force is evaluated. *(ME1_4.m on IR)*

Write a MATLAB script: Name the file "**AME-01-04.m**".
Submit a listing of your script code.
Get user information using **`input()`**.

- N -- number of **source** charges.
- X, then Y, then Z – the **source** charge location in units of cm.
- Q –the value of the **source** charge in nC.
- Repeat for each vector,
- X, then Y, then Z – the **test** charge location in units of cm.
- Q –the value of the **test** charge in nC.

Write the components of the Force and its magnitude on the console.
Draw 'o' at each source point and a dotted line from each source to the field point in BLUE.
Using vecPlot3D,
draw the vector contribution from each source at the field point in BLUE. (NO circle)
draw the Total Force Vector at the field point in RED. (including the circle , 'o')
Scale all vectors by dividing by (100 * magnitude of the resultant force).

Submit an image of your figure window for
Q1 = -1nC @ (1,0,0), Q2 = -1nC @ (0,1,0), Q3 = +1nC @ (1,1,0), Qtest = +1nC @ (3,3,3).

MATLAB EXERCISE 1.7 **Electric field due to multiple charges.** In MATLAB, calculate and plot the electric field intensity vector due to N point charges placed at arbitrary locations in a Cartesian coordinate system, in free space, based on Eq.(1.9) and the program developed in MATLAB Exercise 1.4. *(ME1_7.m on IR)*

Write a MATLAB script: Name the file "**AME-01-07.m**".
DO NOT Submit a listing of your script code.
Get user information using **`input()`**.

- same as for 1.4 except now there is no test charge.

Write the components of the Electric Field and its magnitude on the console.
Draw – same as for 1.4

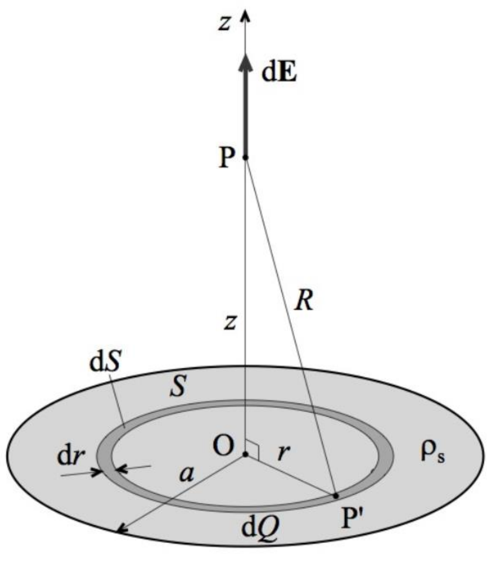
Submit an image of your figure window for
Q1 = +1nC @ (1,0,0), Q2 = -2nC @ (0,1,0), Q3 = -2nC @ (1,1,0), Field point @ (2,2,2).

MATLAB EXERCISE 1.10 **Symbolic integration.** MATLAB supports operations with symbolic variables, that is, all kinds of calculations using symbols in place of real-valued (numerical) variables. Symbolic integration is implemented in MATLAB through function `int()`. Write your own function named `integral()` that invokes `int` and has the following input data [`integral(f,t,r,a,b)`] in order to compute the integral $\int_a^b ft\,dr$: `f` and `t` (their product represents the function to be integrated), `r` (independent variable of integration), and `a` and `b` (integration limits). *(integral.m on IR)*

MATLAB EXERCISE 1.11 **Charged disk – symbolic and analytical solutions.** Consider a very thin charged disk (i.e., a circular sheet of charge), of radius a and a uniform surface charge density ρ_s, in free space, and the electric field it generates at a point P along the z-axis in Fig.1.8(a). By subdividing the disk into elemental rings of width $\mathrm{d}r$, as shown in Fig.1.8(a), applying Eq.(1.15) for the field at the point P due to a ring of radius r ($0 \le r \le a$) and charge $\mathrm{d}Q = \rho_s\,\mathrm{d}S$, with $\mathrm{d}S = 2\pi r\,\mathrm{d}r$ being the surface area of the ring (calculated as the area of a thin strip of length equal to the ring circumference, $2\pi r$, and width $\mathrm{d}r$), and superposition, the total electric field vector is given by

$$\mathbf{E} = \int_S \mathrm{d}\mathbf{E} = \int_S \frac{\mathrm{d}Q\,z}{4\pi\varepsilon_0 R^3}\,\hat{\mathbf{z}} = \frac{\rho_s z}{2\varepsilon_0}\,\hat{\mathbf{z}} \int_{r=0}^{a} \frac{r\,\mathrm{d}r}{R^3}\,, \quad R = \sqrt{r^2+z^2}\,. \tag{1.17}$$

Using this expression and function `integral` (written in the previous MATLAB exercise), compute $\mathbf{E}$ by symbolic integration. Also, solve the integral analytically and plot both solutions for $\rho_s = 2\ \mathrm{mC/m^2}$, $a = 10$ cm, and $-2a \le z \le 2a$. *(ME1_11.m on IR)*



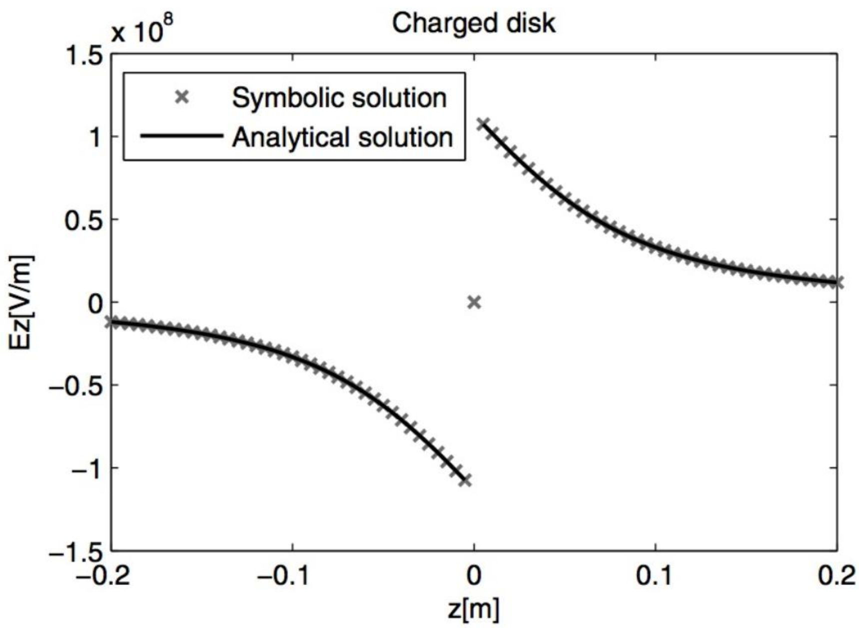


Figure 1.8 (a) Evaluation of the electric field due to a charged disk and (b) field intensity along the axis (z-axis) of the disk obtained by symbolic integration in Eq.(1.17) using function `integral` (from the previous MATLAB exercise) and by analytical integration in Eq.(1.18), respectively; for MATLAB Exercise 1.11. *(color figure on CW)*

For Exercise 1.10 -- Submit a listing of the code for your function **`integral()`**.
This is a very trivial function - don't complicate things. Read the help for the MATLAB function **`int()`**
The function body should only contain one line.

For Exercise 1.11 -- Write a MATLAB script: Name the file "**AME-01-11.m**".
Submit a listing of the code for the SCRIPT.
Submit an image of YOUR figure window that reproduces figure 1.8 (b)

1) Watch this video online and answer each question with **no more than two sentences.**

a) What historical event triggered the 16th century voyages of discovery?

b) What was William Gilbert's profession?

c) Summarize the content of Gilbert's book, "De Magnete".

d) What did Otto Von Guericke observe from his sulphur balls?

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f) How did Charles Wilson produce clouds in streaks?

g) What did Appleton observe and measure in 1924?

1a) The need to obtain material from far East without the Turks
b) Society Doctor, soon physician of the Queen.
c) Earth is a magnet, talked about space and all his magnet discovery
d) The ball attracts things, made cracking noise and glowed in the dark. This was all from spinning it.
e) They were unpaid workers
f) A sealed glass container leads from a piston, leading from a tube with a valve into a vacuum. Whenever air goes in, it causes air pressure to drop in the cylinder and forms clouds

g) Found radio waves shot to the sky would bounce back to the ground. Helped measure how far enemy aircrafts were, a radar.

Text book Question:

8) Problem 1.11 (page 54) Nonuniform surface charge on a disc:

A surface charge is distributed in free space to make the shape of a circular disc or radius, A. The charge density is $\rho(\vec{r}) = \rho_{s0}\left(\frac{\gamma}{A}\right)^2 \quad 0 < \gamma < A$ where γ is the distance to the centre & ρ_{s0} is some constant.

Calculate the total charge of the disc.

$$Q = \int_0^{2\pi}\int_0^A \rho_{s0}\left(\frac{\gamma}{A}\right)^2 \gamma \, d\gamma \, d\theta$$

$$Q = \frac{1}{A^2}\int_0^{2\pi} \frac{\gamma^4 \rho_{s0}}{4}\Big|_0^A$$

$$Q = \frac{A^2 \rho_{s0}}{4}(2\pi)$$

$$Q = \frac{A^2 \pi \rho_{s0}}{2}$$

9) Problem 1.13 (page 54) Field maximum on the axis of a ring:

(a) For the charged ring in Fig. 1.11, assume Q > 0, and find z for which the Electric Field Intensity along the z-axis is maximum.

(b) Plot the function $E_z(z) \doteq E_z(\vec{r})\big|_{\vec{r}=z\hat{z}} \doteq \vec{E}(\vec{r})\cdot\hat{z}\big|_{\vec{r}=z\hat{z}} \qquad \forall z \in \mathbb{R}$

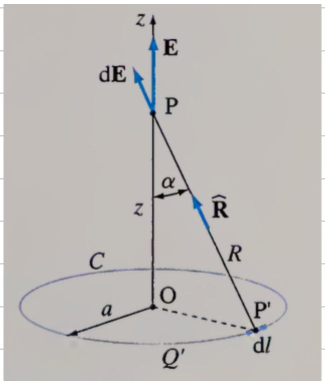


Figure 1.11 Evaluation of the electric field along the axis of a charged ring normal to its plane; for Example 1.6.

$$E = \frac{Qz}{4\pi\epsilon_0(z^2+a^2)^{3/2}}$$

$$E = \frac{Q}{4\pi\epsilon_0}\left(\frac{z}{(z^2+a^2)^{3/2}}\right)$$

$$\frac{dE}{dz} = \frac{Q}{4\pi\epsilon_0}\left(\frac{(z^2+a^2)^{\frac{3}{2}} - z\left(3z\sqrt{a^2+z^2}\right)}{(z^2+a^2)^3}\right.$$

$$= \frac{Q}{4\pi\epsilon_0}\left(\frac{(z^2+a^2)^2 - 3z^2(z^2+a^2)}{(z^2+a^2)^{\frac{7}{2}}}\right)$$

$$= \frac{Q}{4\pi\epsilon_0}\left(\frac{(z^2+a^2)(z^2+a^2-3z^2)}{(z^2+a^2)^{\frac{7}{2}}}\right)$$

$$= \frac{Q}{4\pi\epsilon_0}\left(\frac{(-2z^2+a^2)}{(z^2+a^2)^{\frac{5}{2}}}\right.$$

$$0 = \frac{Q}{4\pi\epsilon_0}\left(\frac{-2z^2+a^2}{(z^2+a^2)^{\frac{5}{2}}}\right)$$

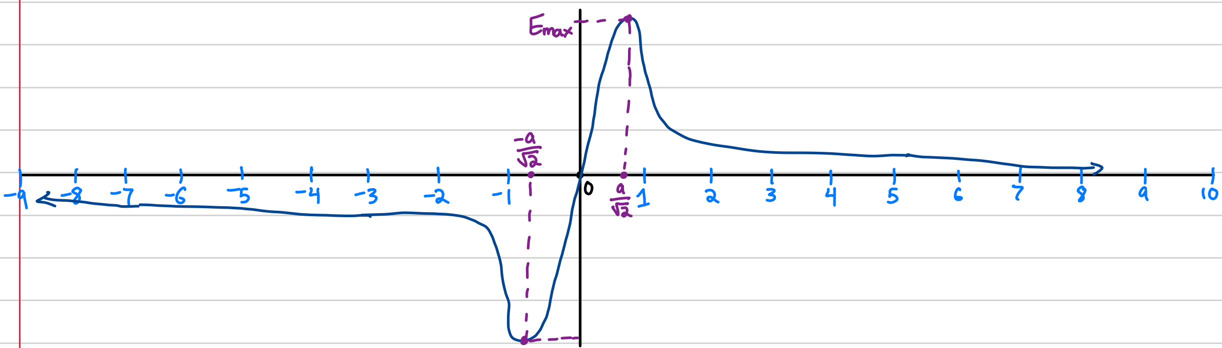
$$0 = -2z^2 + a^2$$
$$2z^2 = a^2$$
$$z = \frac{a}{\sqrt{2}}$$

b) $$E\left(\frac{a}{\sqrt{2}}\right) = \frac{Q\left(\frac{a}{\sqrt{2}}\right)}{4\pi\epsilon_0\left(\frac{a^2}{2}+a^2\right)^{3/2}}$$

$$= \frac{Qa}{4\sqrt{2}\pi\epsilon_0\left(\frac{3a^2}{2}\right)^{3/2}}$$

$$= \frac{Qa\sqrt{2}}{8\pi\epsilon_0\frac{\sqrt{27}a^3}{\sqrt{8}}}$$

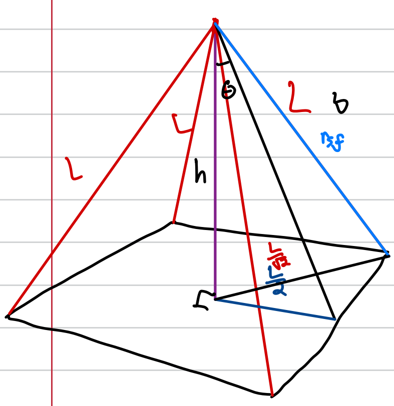
$$= \frac{4Q}{8\pi\epsilon_0\sqrt{27}a^2} = \frac{Q}{6\pi\epsilon_0\sqrt{3}a^2}$$

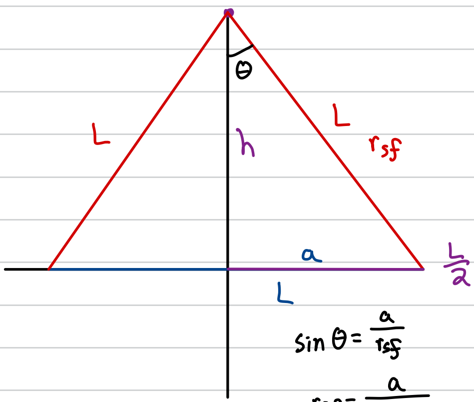


10)

10) Problem 1.21 (page 55) <u>Charged square contour:</u>

A line charge of uniform charge density, ρ_ℓ, is distributed along a square contour, length = L, on each side. The medium is a vacuum. Find the Electric Field Intensity Vector at a point that is a distance, L, from each of the square vertices. (The point is at the top of a pyramid)





$$\sin\theta = \frac{a}{r_{sf}}$$
$$r_{sf} = \frac{a}{\sin\theta}$$

$$\sqrt{a^2+h^2} = r_{sf}$$

$$L = \sqrt{h^2+\left(\frac{L}{\sqrt{2}}\right)^2}$$
$$L^2 - \frac{L^2}{2} = h^2$$
$$\frac{L^2}{2} = h^2$$
$$\frac{L}{\sqrt{2}} = h$$

$$dE_z = \frac{k\rho_\ell}{r_{sf}^2}dx\cos\theta$$

$$\cos\theta = \frac{h}{r_{sf}}$$
$$r_{sf} = \sqrt{h^2+x^2+\left(\frac{L}{2}\right)^2}$$

$$dE_z = \frac{k\rho_\ell}{r_{sf}^2}\cdot\frac{h}{r_{sf}}dx$$

$$r_{sf} = \sqrt{a^2+x^2}$$

$$E_z = \int_{-\frac{L}{2}}^{\frac{L}{2}} \frac{k\rho_\ell h}{(a^2+x^2)^{3/2}}dx$$

$$\frac{E_z}{4} = k\rho_e h \left[\frac{1}{a^2\sqrt{x^2+a^2}} \right]_{-\frac{L}{2}}^{\frac{L}{2}}$$

$$\frac{E_z}{4} = \frac{2Lhk\rho_e}{a^2\sqrt{4a^2+L^2}}$$

$$a = h^2 + \frac{L^2}{4} = \frac{L^2}{2} + \frac{L^2}{4} = \frac{3L^2}{4}$$

$$\frac{E_z}{4} = \frac{2L\left(\frac{L}{\sqrt{2}}\right)k\rho_e}{\frac{3L^2}{4}\sqrt{3L^2+L^2}}$$

$$\frac{E_z}{4} = \frac{4L^2k\rho_e}{3\sqrt{2}L^3}$$

$$E_z = 4\left(\frac{4k\rho_e\sqrt{2}}{2L\cdot 3}\right) = \frac{8k\rho_e\sqrt{2}}{3L} = \frac{8\rho_e\sqrt{2}}{3L}\cdot\frac{1}{4\pi\epsilon_0} = \frac{2\sqrt{2}\rho_e}{3\pi\epsilon_0 L}$$

MatLab Exercise 1.1

C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\vectorMag.m

```
function f = vectorMag(vector)
    if ~(isrow(vector) || iscolumn(vector))
        f = 0;
        fprintf('The magnitude of the given vector is: %4.2\n', f)
        return;
    end
    a = 0;
    if isrow(vector) %if row
        sz = length(vector);
        for i = 1:sz;
            a = a + vector(i).^2;
        end
        f = sqrt(a);
        fprintf('The magnitude of the given vector is: %4.2\n', f)
        return;
    elseif iscolumn(vector)
        sz = length(vector);
        for i = 1:sz;
            a = a + vector(i).^2;
        end
        f = sqrt(a);
        fprintf('The magnitude of the given vector is: %4.2\n', f)
        return;
    else
        f = 0;
        fprintf('The magnitude of the given vector is: %4.2\n', f)
        return;
    end
end
```

Matlab 1.3

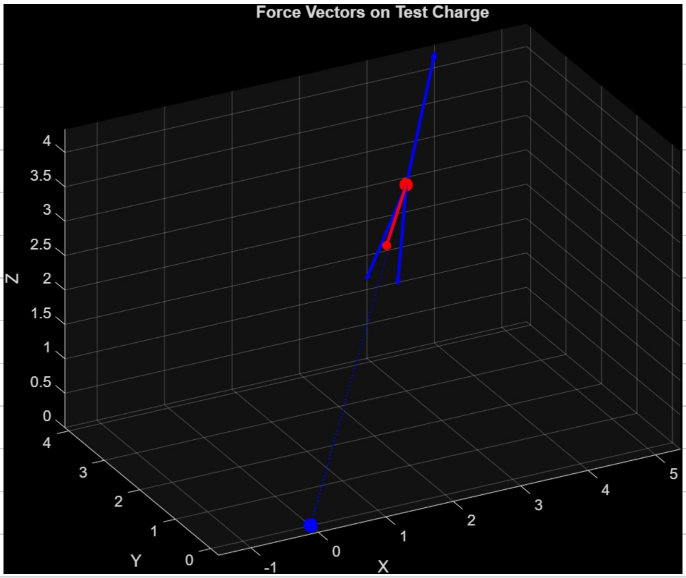
C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\vecPlot3D.m

```
function f = vecPlot3D(Vstart, Vend, Scaling, Colour, Origin)

    if (Origin)
        scatter3(Vstart(1), Vstart(2), Vstart(3), 'filled', 'o');
    else
        scatter3(Vstart(1), Vstart(2), Vstart(3));
    end

    hold on;

    if length(Vstart) ~= 3 || length(Vend) ~= 3
        f = 0;
        fprintf('Vectors must be 3-dimensional\n');
        return;
    end
    % scatter3(Vend(1), Vend(2), Vend(3));
    Vdiff = Vend - Vstart;
    hold on;
    quiver3(Vstart(1), Vstart(2), Vstart(3), Vdiff(1), Vdiff(2), Vdiff(3), Scaling, 'Color', Colour, 'LineWidth', 2);
    view(3);
    grid on;
    xlabel('X');
    ylabel('Y');
    zlabel('Z');
    return;




end
```

Matlab 1.4

C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\AME_01_04.m

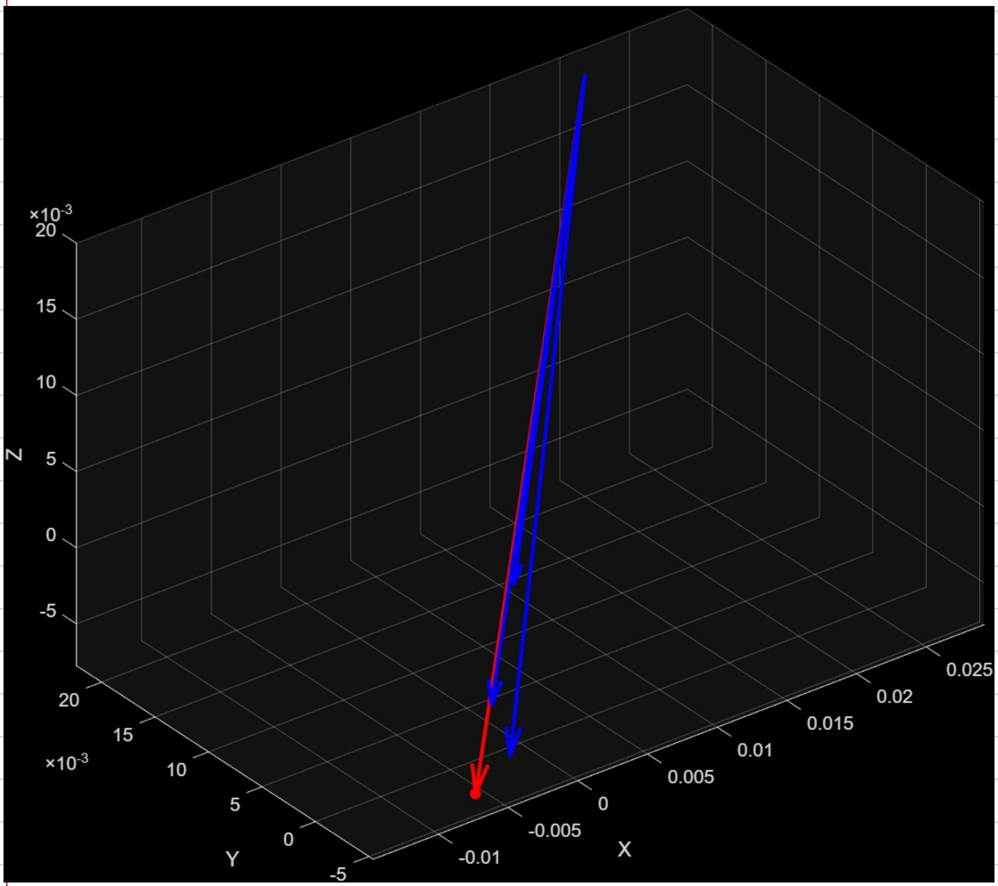
```
vector_Q = [];
coords_Q = [];
k = 1 ./ (4 * pi * 8.854E-12)

N = input('Number of source charges: ');

for i = 1:N
    X = input(sprintf('X Coordinate of Q%1.0f in units of cm: ', i));
    Y = input(sprintf('Y Coordinate of Q%1.0f in units of cm: ', i));
    Z = input(sprintf('Z Coordinate of Q%1.0f in units of cm: ', i));

    if ~(isnumeric([X Y Z]))
        fprintf('The inputed coordinate address is invalid!')
        break;
    end
    coords_Q = [[X Y Z]; coords_Q];
    vector_Q(i) = input(sprintf('Value of Q%1.0f in nC: ', i));



end

%Test charge input

Xtest = input('X Coordinate of Qtest in units of cm: ');
Ytest = input('Y Coordinate of Qtest in units of cm: ');
Ztest = input('Z Coordinate of Qtest in units of cm: ');


coords_test = [Xtest Ytest Ztest];
Qtest = input('Value of Qtest in nC: ')

% Plot the points
for i = 1:N

    rvec = coords_test - coords_Q(i, :)
    rmag = vectorMag(rvec)
    F_vec = (k * Qtest * vector_Q(i) * 10E-18 * rvec) ./ (rmag).^3;
    Magnitude = vectorMag([F_vec]);
    fprintf(['For source charge Q%1.0f, the force component is \n' ...
        'Fx = %.3e\n' ...
        'Fy = %.3e\n' ...
        'Fz = %.3e\n' ...
        'Magnitude = %.3e\n'], N, Fx, Fy, Fz, Magnitude)

    hold on;
    % Plot the dot

    scatter3(coords_Q(i,1), coords_Q(i,2), coords_Q(i,3), 80, 'blue', 'o') %source
    hold on;
    plot3([coords_Q(i,1) Xtest], [coords_Q(i,2) Ytest], [coords_Q(i,3) Ztest], 'LineStyle', '-.', 'Color', 'b') %Plots the line


    Vend = coords_test + coords_Q(i, :);
    vecPlot3D(coords_test, Vend, 1, 'b', 0);
    hold on;


    Vstart = coords_test;
    Vend = coords_test + F_vec;
    vecPlot3D(Vstart, Vend, 0, 'r', 1);

end
scatter3(Xtest, Ytest, Ztest, 80, 'blue', 'o')
axis equal
grid on
view(3)   % force 3D view
```



Matlab 1.7

C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\AME_01_07.m

```matlab
vector_Q = [];
coords_Q = [];
k = 1 ./ (4 * pi * 8.854E-12)

N = input('Number of source charges: ');

for i = 1:N
    X = input(sprintf('X Coordinate of Q%1.0f in units of cm: ', i));
    Y = input(sprintf('Y Coordinate of Q%1.0f in units of cm: ', i));
    Z = input(sprintf('Z Coordinate of Q%1.0f in units of cm: ', i));

    if ~(isnumeric([X Y Z]))
        fprintf('The inputed coordinate address is invalid!')
        break;
    end
    coords_Q = [[X Y Z]; coords_Q];
    vector_Q(i) = input(sprintf('Value of Q%1.0f in nC: ', i));



end

%Field Point

Xtest = input('X Coordinate of Field Point in units of cm: ');
Ytest = input('Y Coordinate of Field Point in units of cm: ');
Ztest = input('Z Coordinate of Field Point in units of cm: ');


coords_test = [Xtest Ytest Ztest];
% Plot the points
for i = 1:N

    rvec = coords_test - coords_Q(i, :)
    rmag = vectorMag(rvec)
    F_vec = (k * Qtest * vector_Q(i) * 10E-18 * rvec) ./ (rmag).^3;
    Magnitude = vectorMag([F_vec]);
    fprintf(['For source charge Q%1.0f, the force component is \n' ...
        'Fx = %.3e\n' ...
        'Fy = %.3e\n' ...
        'Fz = %.3e\n' ...
        'Magnitude = %.3e\n'], N, coords_Q(i,1), coords_Q(i,2), coords_Q(i,3) , Magnitude)

    hold on;
    % Plot the dot

    scatter3(coords_Q(i,1), coords_Q(i,2), coords_Q(i,3), 80, 'blue', 'o')  %source
    hold on;
    plot3([coords_Q(i,1) Xtest], [coords_Q(i,2) Ytest], [coords_Q(i,3) Ztest], 'LineStyle', '-.', 'Color', 'b') %Plots the line


    Vend = coords_test + coords_Q(i, :);
    vecPlot3D(coords_test, Vend, 1, 'b', 0);
    hold on;


    Vstart = coords_test;
    Vend = coords_test + F_vec;
    vecPlot3D(Vstart, Vend, 0, 'r', 1);

end
scatter3(Xtest, Ytest, Ztest, 80, 'blue', 'o')
axis equal
grid on
view(3)   % force 3D view
```



×10-3
20
15
10
Z
5
0
-5
20
15
×10-3
10
5
Y
0
-5
-0.01
-0.005
0
0.005
X
0.01
0.015
0.02
0.025

Matlab 1.10

C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\integral.m

```matlab
function F = integral(f, t, r, a, b)

    F = int(f*t, r, a, b);


end
```

Matlab 1.11

C:\Users\Lex Leung\OneDrive\Desktop\SFU Work\316HW\HW1\AME_01_11.m

```matlab
syms r z sigma a eps0 real;


%p = 0.002;
%a = 0.1;
%eps0 = 8.8542E-12;

f = sigma / (2*eps0);
t = z*r / (r^2 + z^2)^(3/2);

% Calculation

Esymbol = integral(f, t, r, 0, a);

pretty(Esymbol);


% Analytical

Eanalytical = sigma / (2*eps0) * (sign(z) - z/sqrt(a^2+z^2));

pretty(Eanalytical);


% Plug in

value_sigma = 2E-3;
Val_A = 0.1;
value_eps0 = 8.8542E-12;

zvec = [linspace(-2*Val_A, -1e-6, 500), 0, linspace(1e-6, 2*Val_A, 500)];

Esymbol_value = zeros(size(zvec));

Eanalytical_value = zeros(size(zvec));

for i = 1:length(zvec)
    zvec_part = zvec(i);
    if zvec_part == 0
        Eanalytical_value(i) = value_sigma/(2*value_eps0);
        Esymbol_value(i) = value_sigma/(2*value_eps0);
    else
        Eanalytical_value(i) = double(subs(Eanalytical, {sigma, a, eps0, z}, {...
            value_sigma, Val_A, value_eps0, zvec_part}));
        Esymbol_value(i) = double(subs(Esymbol, {sigma, a, eps0, z}, {...
            value_sigma, Val_A, value_eps0, zvec_part}));
    end
end


plot(zvec, Esymbol_value, 'x');
hold on;
plot(zvec, Eanalytical_value);

xlabel('z[m]');
ylabel('Ez[V/m]');
legend('Symbolic Solution', 'Analytical solution');
```