MATLAB EXERCISE 1.6 **Three unequal point charges in Cartesian coordinate system.** Point charges $Q_1 = 1\ \mu$C, $Q_2 = -2\ \mu$C, and $Q_3 = 2\ \mu$C are situated in free space at points defined by Cartesian coordinates $(1\,\text{m}, 0, 0)$, $(0, 1\,\text{m}, 0)$, and $(0, 0, 1\,\text{m})$, respectively (see Fig.S1.3). In MATLAB, compute the resultant electric force on charge Q_1, and graphically represent partial and total force vectors $\mathbf{F}_{e21}$, $\mathbf{F}_{e31}$, and $\mathbf{F}_{e1} = \mathbf{F}_{e21} + \mathbf{F}_{e31}$. *(ME1_6.m on IR)*

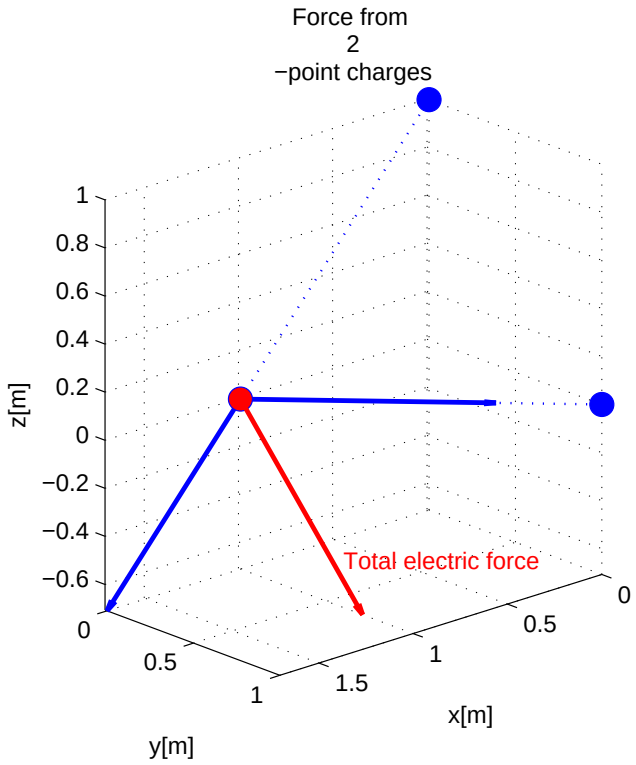

Figure S1.3 3-D MATLAB plot of the solution – obtained with the program from MATLAB Exercise 1.4 – for the vector summation of Coulomb forces in the Cartesian coordinate system; for MATLAB Exercise 1.6.

SOLUTION:

We use the program developed in MATLAB Exercise 1.4, with the corresponding input data. The scaling factor in function `vecPlot3D` should be changed from `1/Fmag/100` (see MATLAB Exercise 1.4) to `1/Fmag` to be able to properly plot and see forces within the current coordinate mesh.

The resulting graph is shown in Fig.S1.3.

The magnitude of the resultant force is 8.987539 mN. The unit vector of the resultant force is given by $(0, 0.7071, -0.7071)$.

```
%
%   Book: MATLAB-Based Electromagnetics (Pearson Prentice Hall)
%   Author: Branislav M. Notaros
%   Instructor Resources
%   (c) 2011
%
%   This MATLAB code or any part of it may be used only for
%   educational purposes associated with the book
%
%
%


%  Three point charges in Cartesian coordinate system


clear all;
close all;
EPS0 = 8.8542*10^(-12);

 N = 2;
 x = [0 0]*100;
 y = [1 0]*100;
 z = [0 1]*100;
 xp = 100;
 yp = 0;
 zp = 0;

 Q = [-2 2];
 Qp = 1;


x = x * 10^(-2);
y = y * 10^(-2);
z = z * 10^(-2);
Q = Q * 10^(-6);

xp = xp * 10^(-2);
yp = yp * 10^(-2);
zp = zp * 10^(-2);
Qp = Qp * 10^(-6);

% Compute distance and direction between observation point and each charge

r = sqrt((xp - x).^2 + (yp - y).^2 + (zp - z).^2);
ux = (xp - x)./r;
uy = (yp - y)./r;
uz = (zp - z)./r;
uVec = [ux; uy; uz];

% Electric force computation
```

```
F = (ones(3,1)*(Qp*Q./(4*pi*EPS0*r.^2))).*uVec;  %each component
Ftot = sum(F,2);
Fmag = vectorMag(Ftot);
Fuv = (Ftot/Fmag)';

% Output

fprintf('Magnitude of resultant force at point P is %f mN.\n',Fmag*1000 );
disp('Unit vector of resultant force :');
disp(Fuv);

figure(1);
plot3(0,0,0,'k');
hold on;
for i=1:N
plot3(x(i),y(i),z(i),'o','MarkerSize',10,'MarkerFaceColor','b');
line ([xp , x(i)],[yp,y(i)], [zp,z(i)],'LineStyle',':');
hold on;
vecPlot3D([xp yp zp],[xp yp zp] + F(:,i)',1/Fmag,'b',0);
hold on;
end;
vecPlot3D([xp yp zp],[xp yp zp] + Ftot',1/Fmag,'r',1);
text(1.4*xp,1.4*yp,1.4*zp,'Total electric force','Color','r');

hold off;
axis equal;
xlabel('x[m]');
ylabel('y[m]');
zlabel('z[m]');
title({'Force from ',int2str(N),'-point charges'});
```