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Lab 2

Aim: Plotting data in graphs and few properties

```
clc
clear all
close all
```

Question 1

```
A = randAdjMatrix(5);
ran2D = rand(length(A),2);
ran3D = rand(length(A),3);

plot2DGraph(A,ran2D);
title('2D Random Graph');

val = [1,-1,0,1,-1];
plot3Dv2(A,ran3D,val);
title('3D Random Graph with [1,-1,0,1,-1] at vertices');

[V, D] = eig(A);
eigenvalue= diag(D);
plot3Dv2(A,ran3D,eigenvalue);
title('3D Random Graph with eigenvalues at vertices');

for n=1:length(V)
```
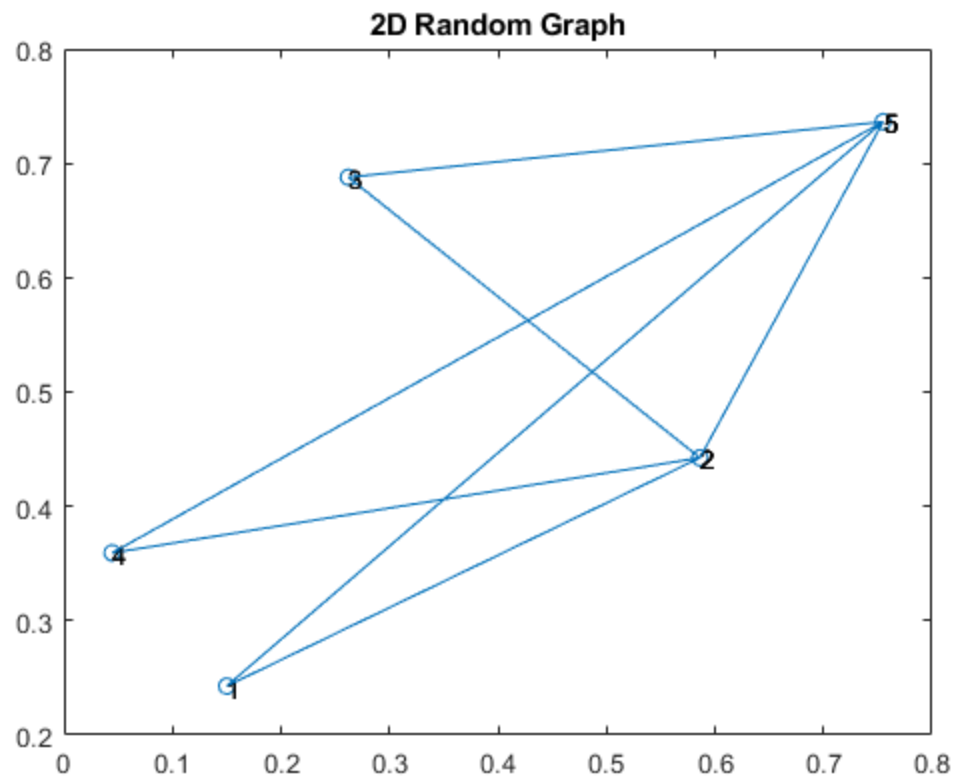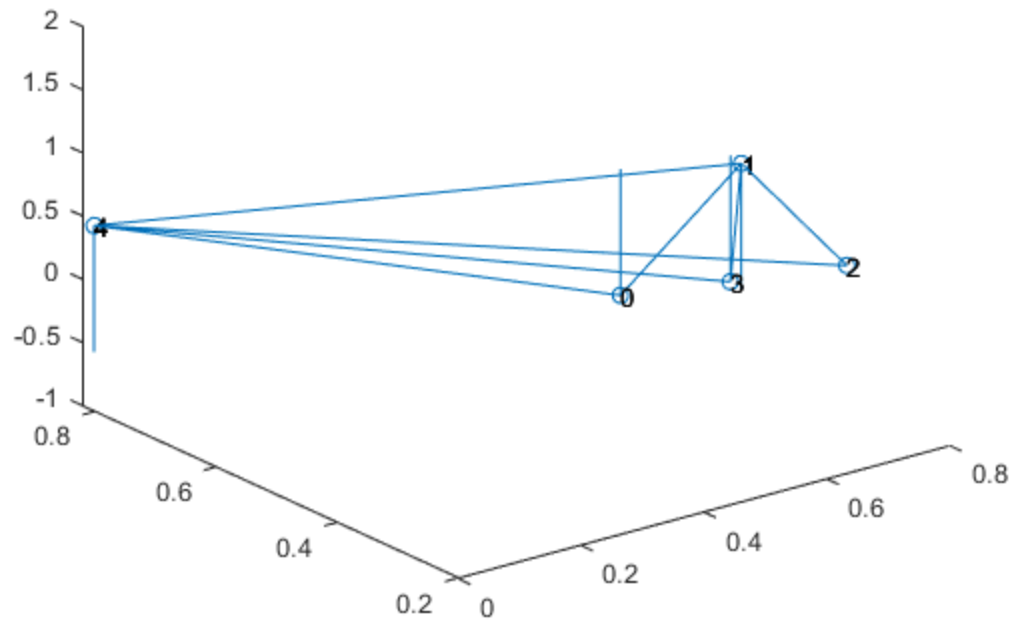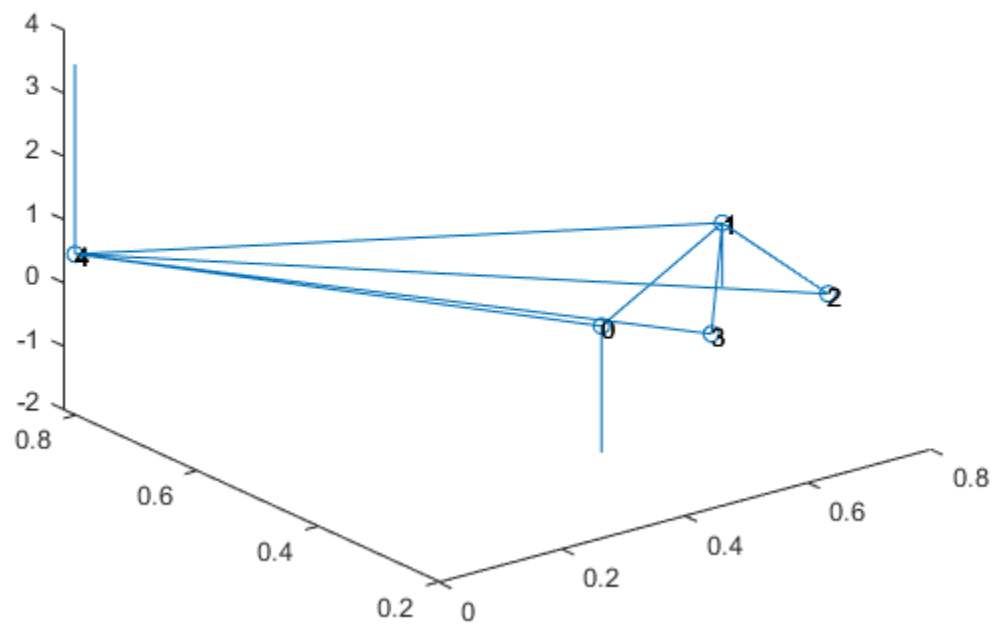
```
plot3Dv2(A,ran3D,V(:,n));
title('3D Random Graph with Vk(n) at vertices');
end
```
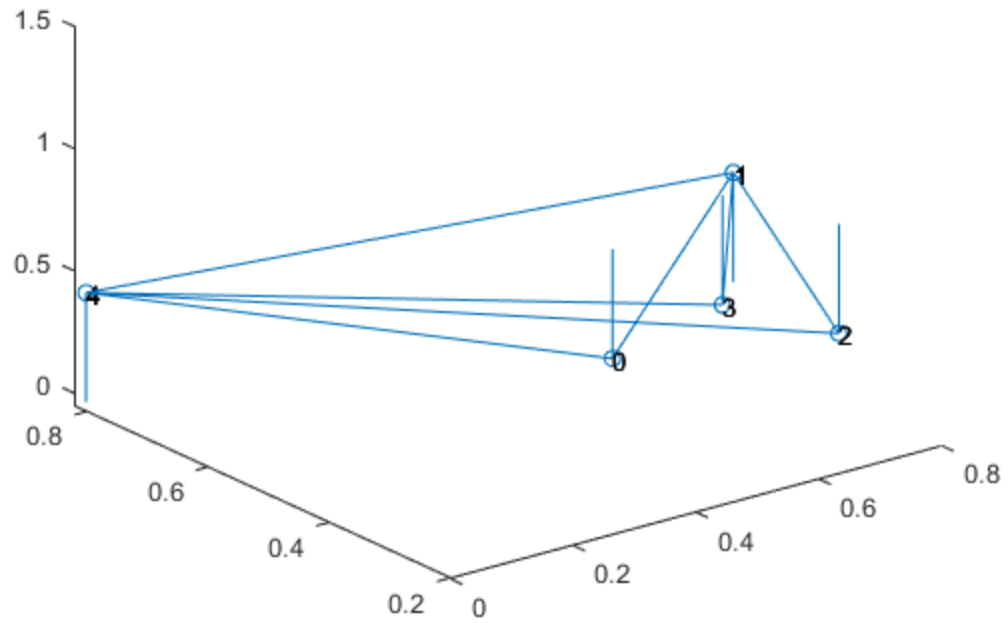
2D Random Graph

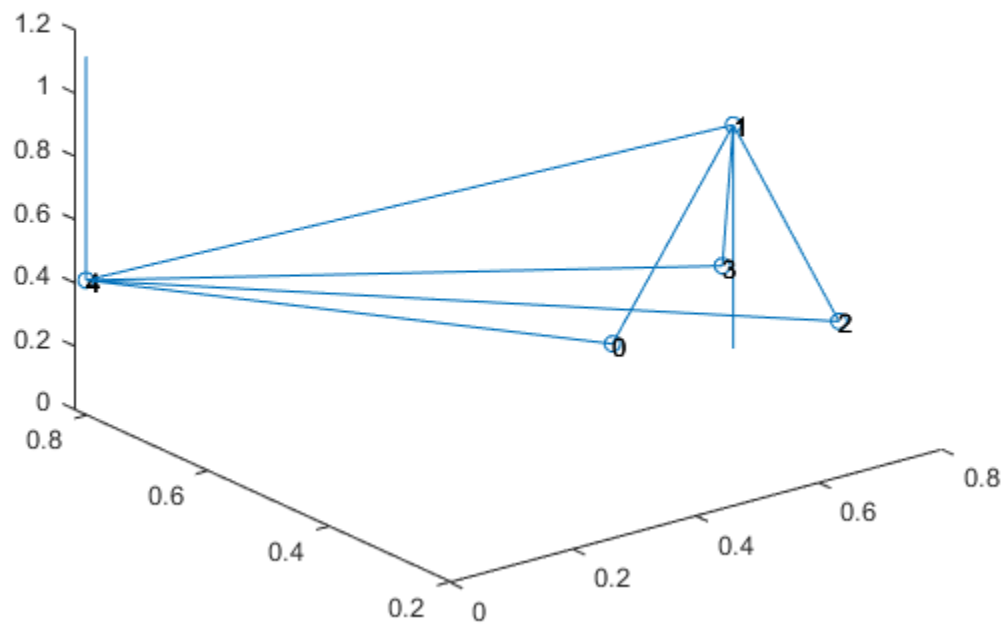**3D Random Graph with [1,-1,0,1,-1] at vertices**

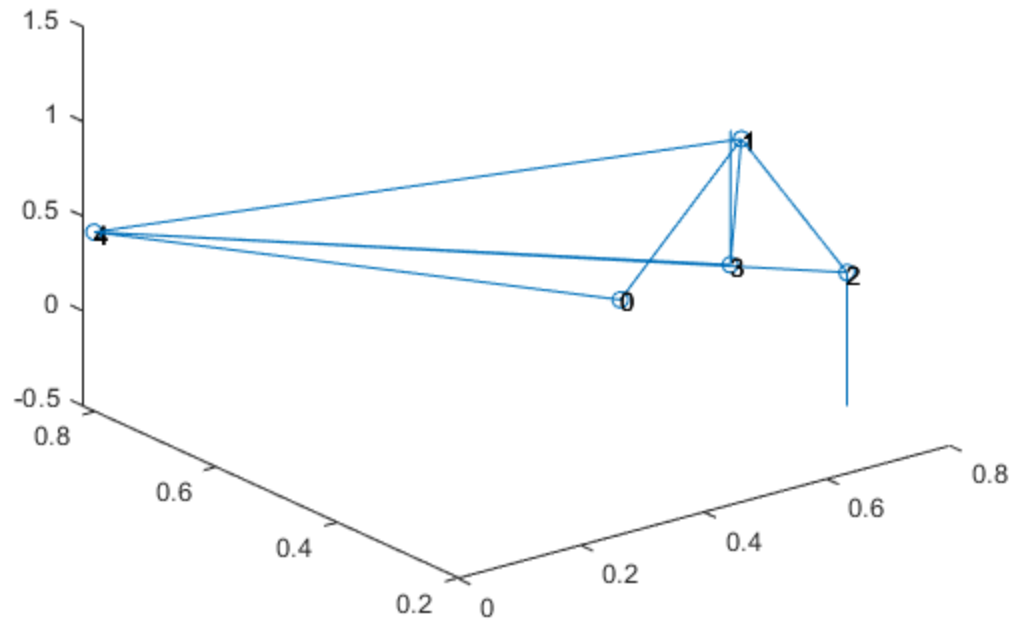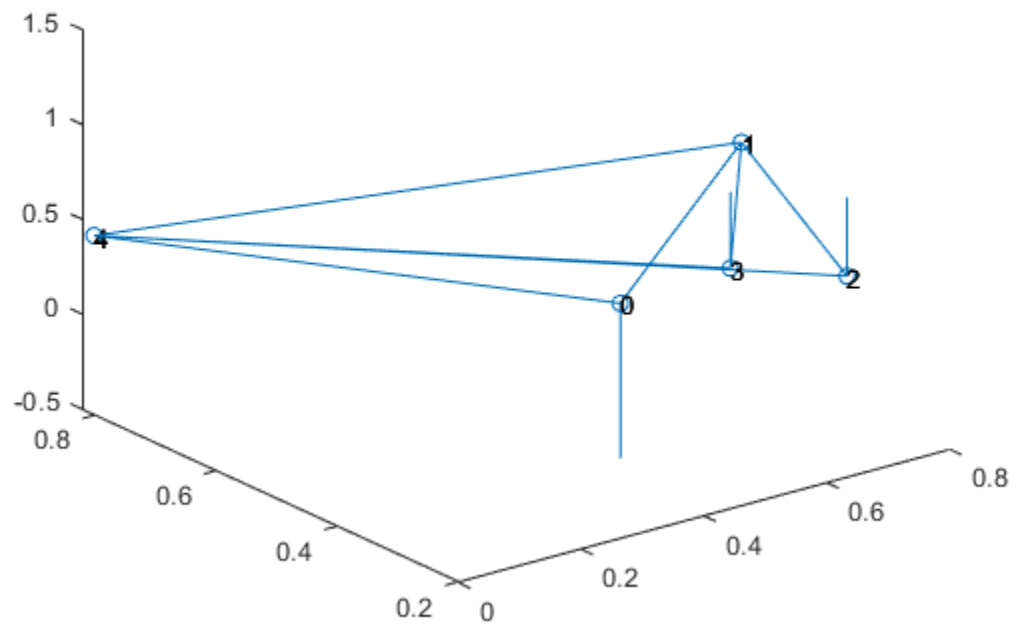**3D Random Graph with eigenvalues at vertices**

3D Random Graph with Vk(n) at vertices
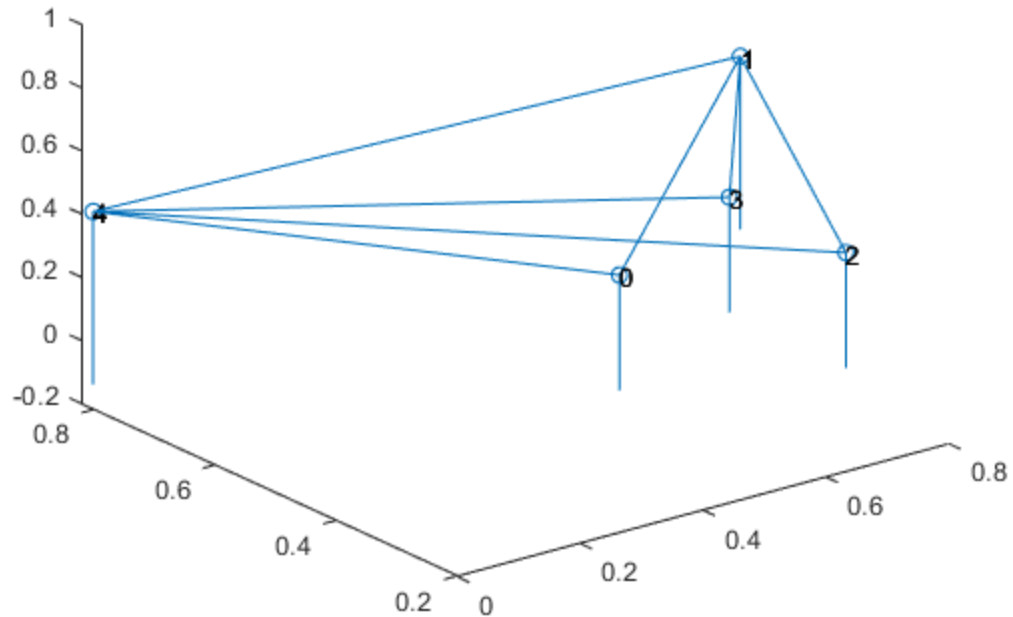

3D Random Graph with Vk(n) at vertices

3D Random Graph with Vk(n) at vertices

3D Random Graph with Vk(n) at vertices

3D Random Graph with Vk(n) at vertices

Question 2

```matlab
complete = [[0 1 1 1];[1 0 1 1];[1 1 0 1];[1 1 1 0]];
ran1_3D = rand(length(complete),3);

[V, D] = eig(complete);
eigenvalue = diag(D);
plot3Dv2(complete,ran1_3D,eigenvalue);
title('3D complete Graph with eigenvalues at vertices');

for n=1:length(V)
    plot3Dv2(complete,ran1_3D,V(:,n));
    title('3D complete Graph with Vk(n) eigenvectors at vertices');
end

bipartite = [[0 0 0 1 1 1 1];[0 0 0 1 1 1 1];[0 0 0 1 1 1 1];[1 1 1 0
 0 0 0];[1 1 1 0 0 0 0];[1 1 1 0 0 0 0];[1 1 1 0 0 0 0]];
ran2_3D = rand(length(bipartite),3);

[V, D] = eig(bipartite);
eigenvalue = diag(D);
plot3Dv2(bipartite,ran2_3D,eigenvalue);
title('3D bipartite Graph with eigenvalues at vertices');

for n=1:length(V)
```

```matlab
    plot3Dv2(bipartite,ran2_3D,V(:,n));
    title('3D bipartite Graph with Vk(n) eigenvectors at vertices');
end

regular = [[0 1 1 1];[1 0 1 1];[1 1 0 1];[1 1 1 0]];
ran3_3D = rand(length(regular),3);

[V, D] = eig(regular);
eigenvalue = diag(D);
plot3Dv2(regular,ran3_3D,eigenvalue);
title('3D regular Graph with eigenvalues at vertices');

for n=1:length(V)
    plot3Dv2(regular,ran3_3D,V(:,n));
    title('3D regular Graph with Vk(n) eigenvectors at vertices');
end

star = [[0 1 1 1];[1 0 0 0];[1 0 0 0];[1 0 0 0]];
ran4_3D = rand(length(star),3);

[V, D] = eig(star);
eigenvalue = diag(D);
plot3Dv2(star,ran4_3D,eigenvalue);
title('3D star Graph with eigenvalues at vertices');

for n=1:length(V)
    plot3Dv2(star,ran4_3D,V(:,n));
    title('3D star Graph with Vk(n) eigenvectors at vertices');
end

circular = [[0 1 0 1];[1 0 1 0];[0 1 0 1];[1 0 1 0]];
ran5_3D = rand(length(circular),3);

[V, D] = eig(circular);
eigenvalue = diag(D);
plot3Dv2(circular,ran5_3D,eigenvalue);
title('3D circular Graph with eigenvalues at vertices');

for n=1:length(V)
    plot3Dv2(circular,ran5_3D,V(:,n));
    title('3D circular Graph with Vk(n) eigenvectors at vertices');
end

line = [[0 1 0 0];[1 0 1 0];[0 1 0 1];[0 0 1 0]];
ran6_3D = rand(length(line),3);

[V, D] = eig(line);
eigenvalue = diag(D);
plot3Dv2(line,ran6_3D,eigenvalue);
title('3D line Graph with eigenvalues at vertices');

for n=1:length(V)
    plot3Dv2(line,ran6_3D,V(:,n));
    title('3D line Graph with Vk(n) eigenvectors at vertices');
```

```
end

[A,ran2D] = bucky;

plot2DGraph(A,ran2D);
title('2D Bucky Graph');

[A,ran3D] = bucky;
A = full(A);
plot3DGraph(A,ran3D);
title('3D Bucky Graph');

[V, D] = eig(A);

eigenvalue = diag(D);
k = [1,3,30,31,55,60];
for i = 1:length(k)
    plot3Dv2(A,ran3D,V(:,k(i)));
    title('3D Random Graph with eigenvectors at vertices');
end
```
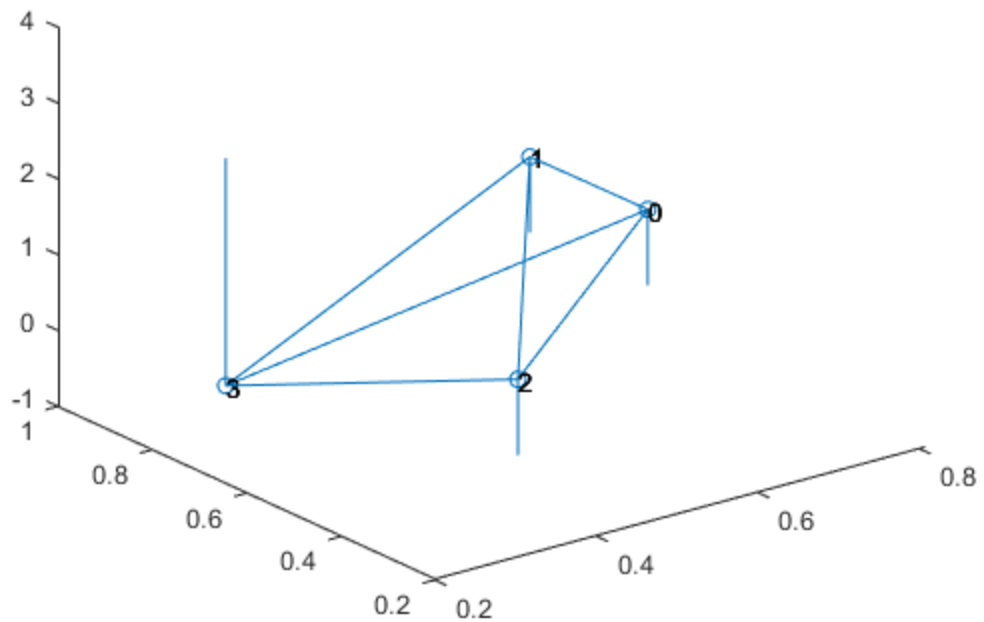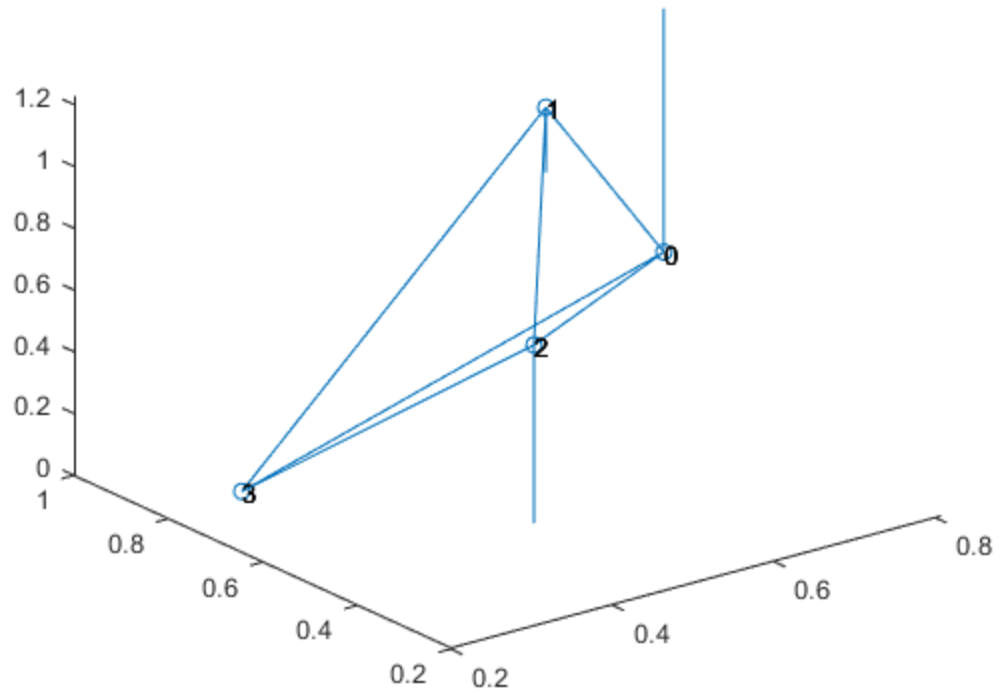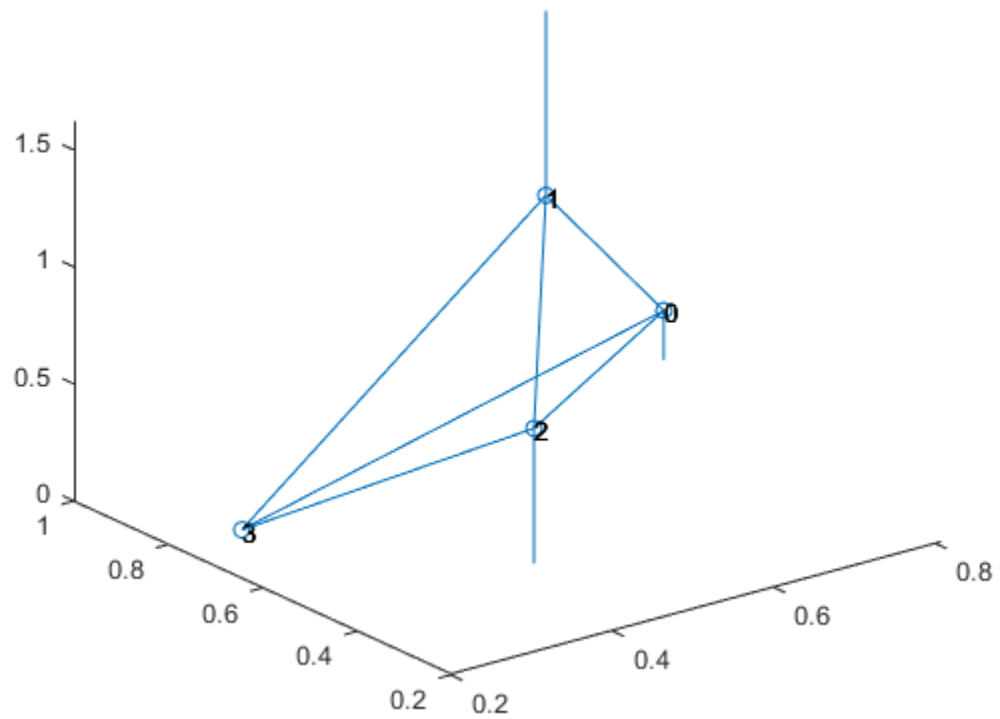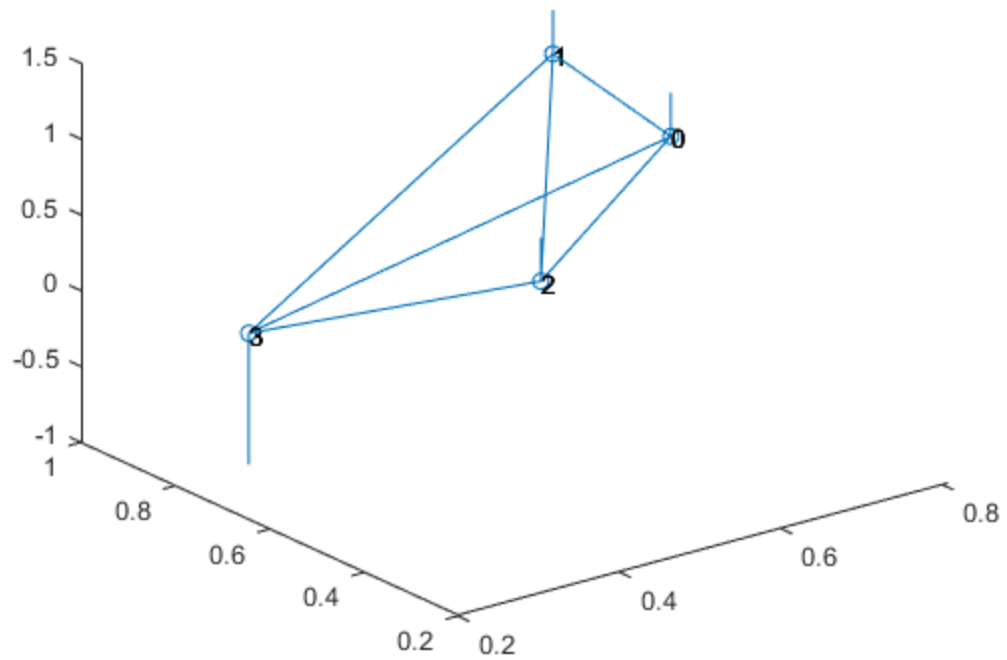

3D complete Graph with eigenvalues at vertices
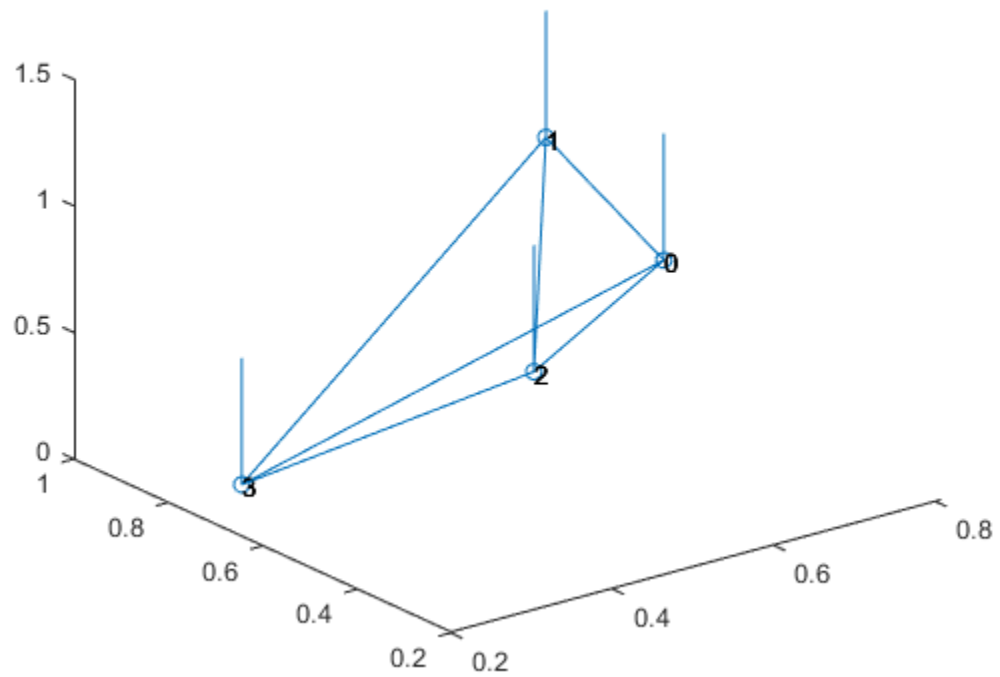
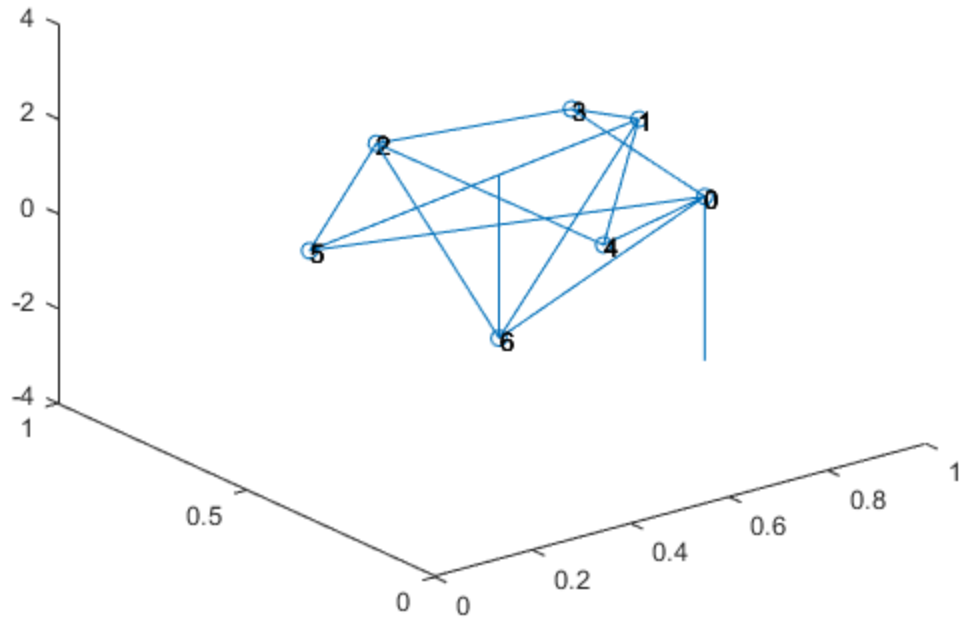**3D complete Graph with Vk(n) eigenvectors at vertices**

3D complete Graph with Vk(n) eigenvectors at vertices

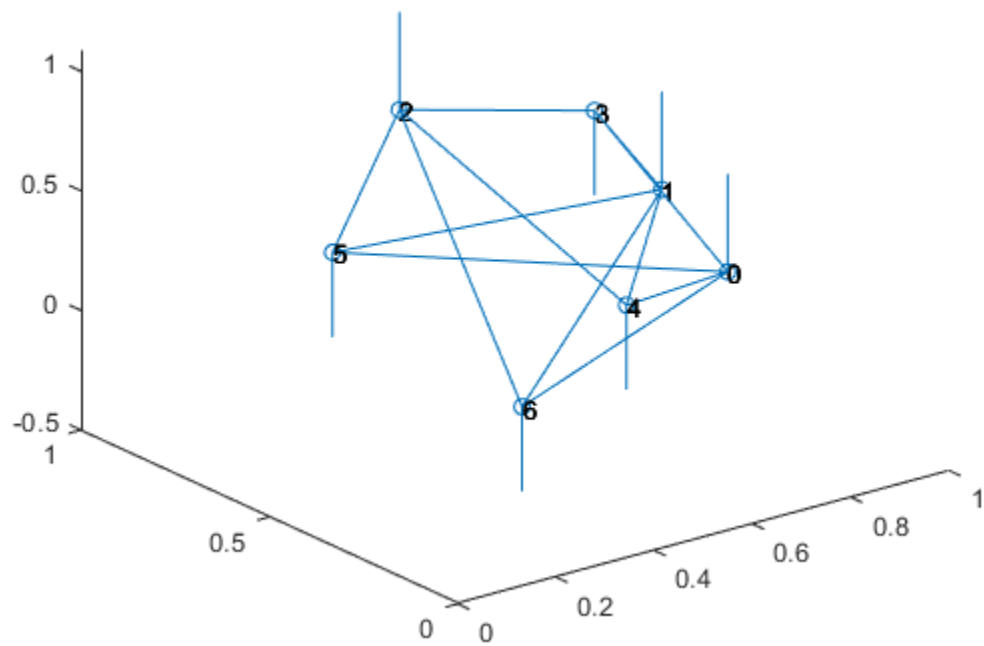**3D complete Graph with Vk(n) eigenvectors at vertices**

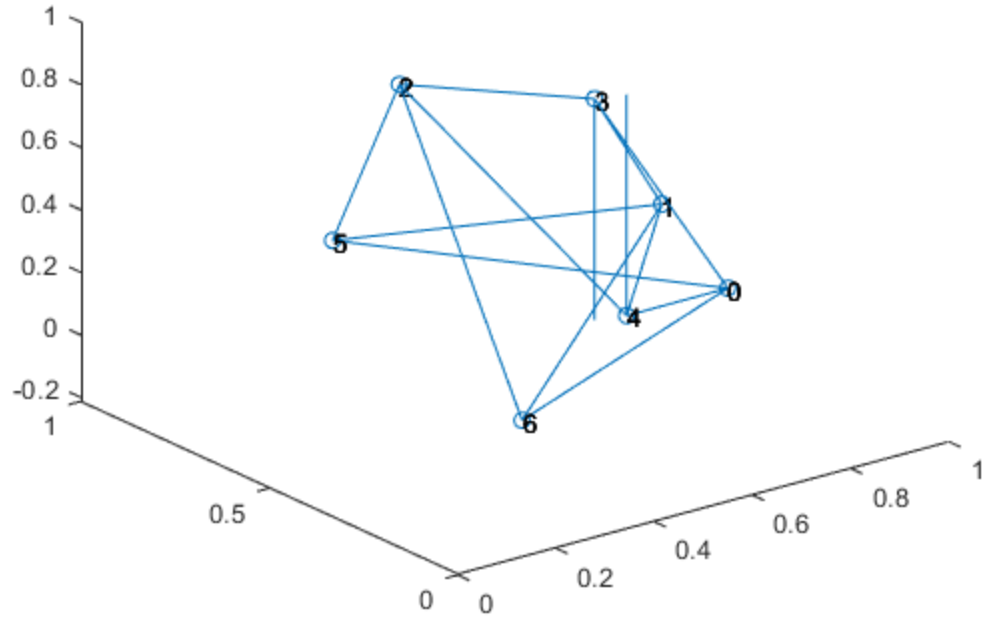**3D complete Graph with Vk(n) eigenvectors at vertices**
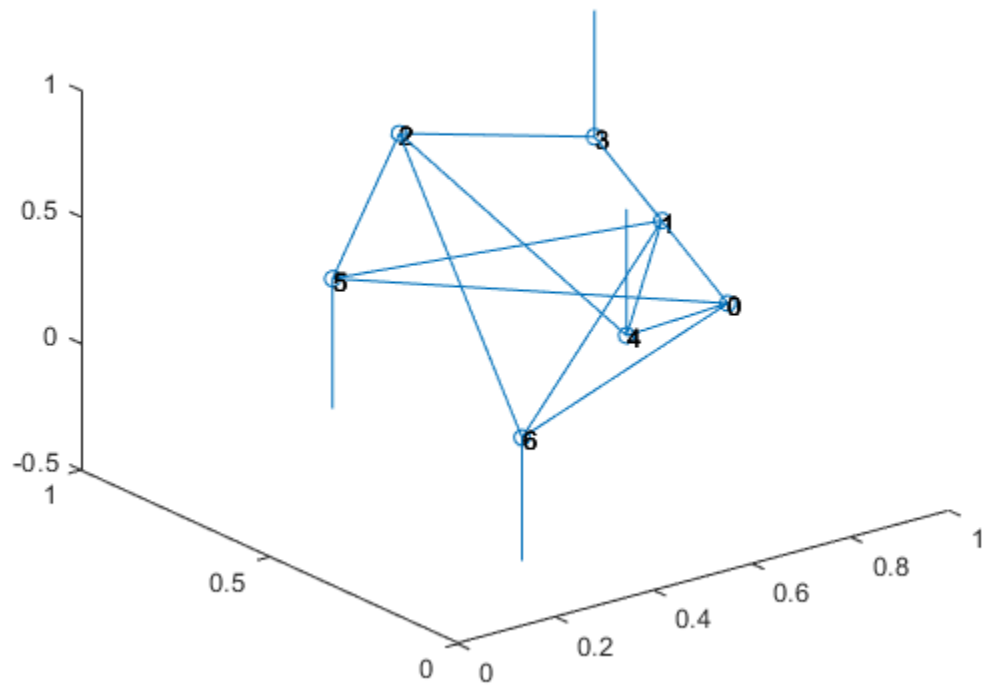
3D bipartite Graph with eigenvalues at vertices
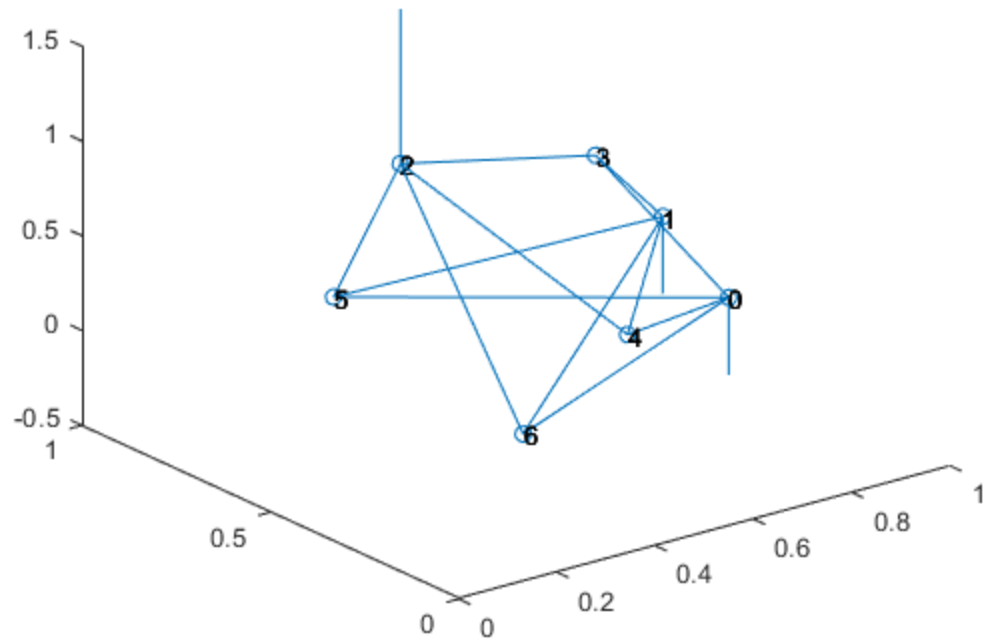

3D bipartite Graph with Vk(n) eigenvectors at vertices
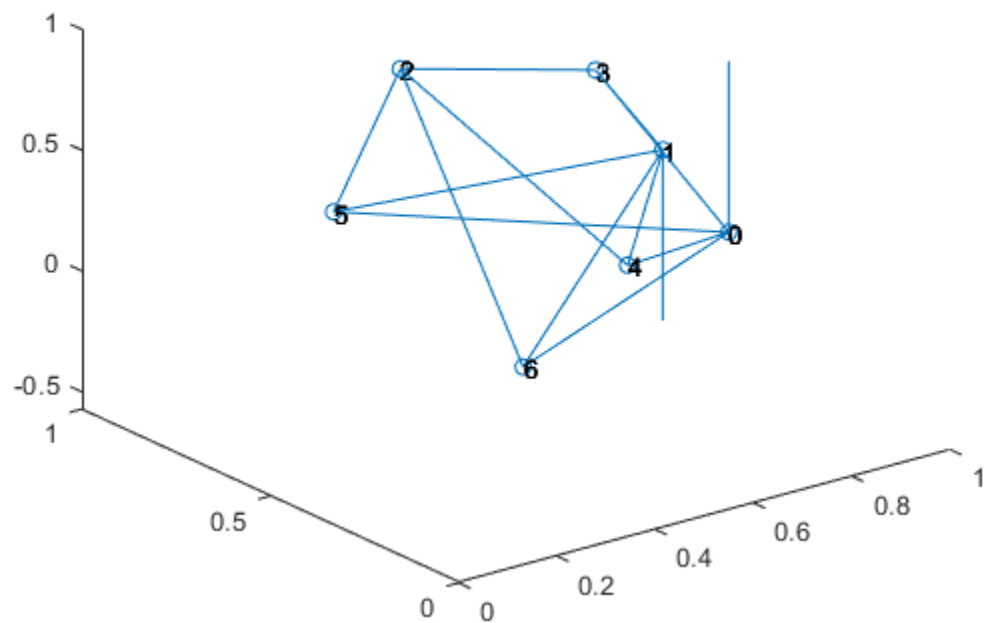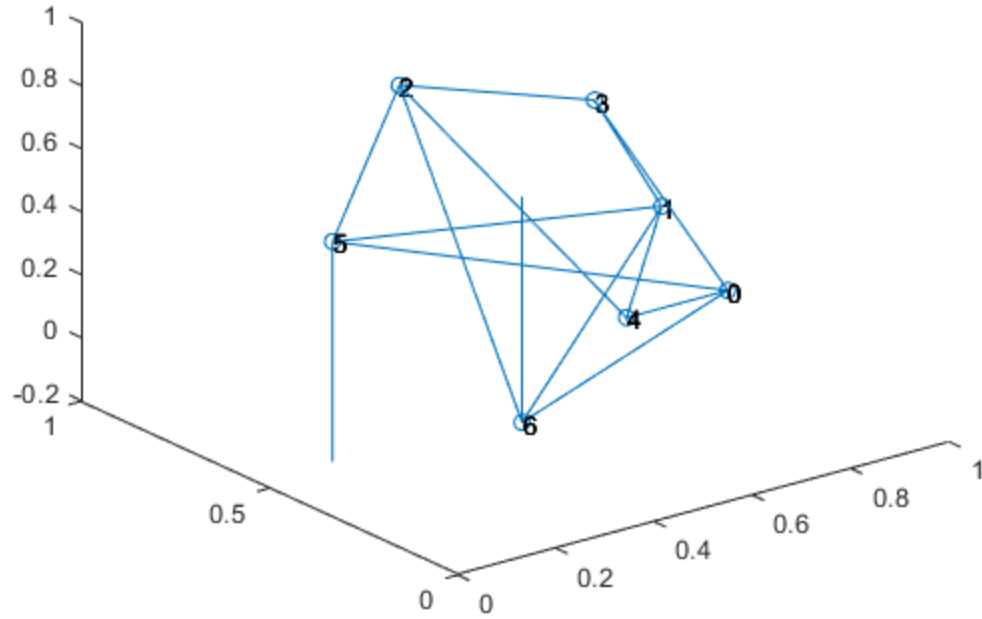
3D bipartite Graph with Vk(n) eigenvectors at vertices

3D bipartite Graph with Vk(n) eigenvectors at vertices

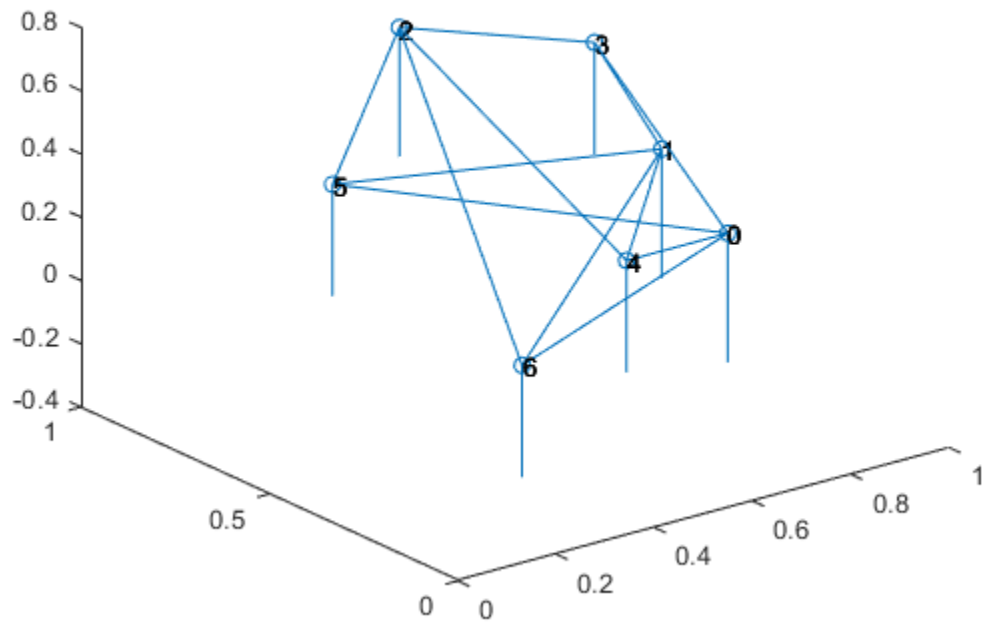**3D bipartite Graph with Vk(n) eigenvectors at vertices**

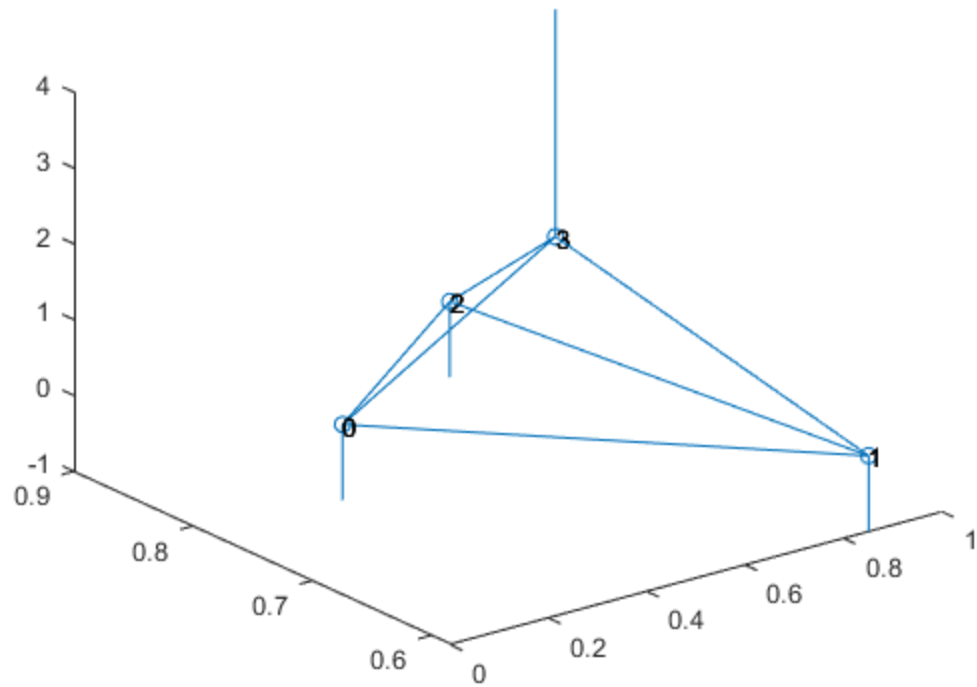**3D bipartite Graph with Vk(n) eigenvectors at vertices**

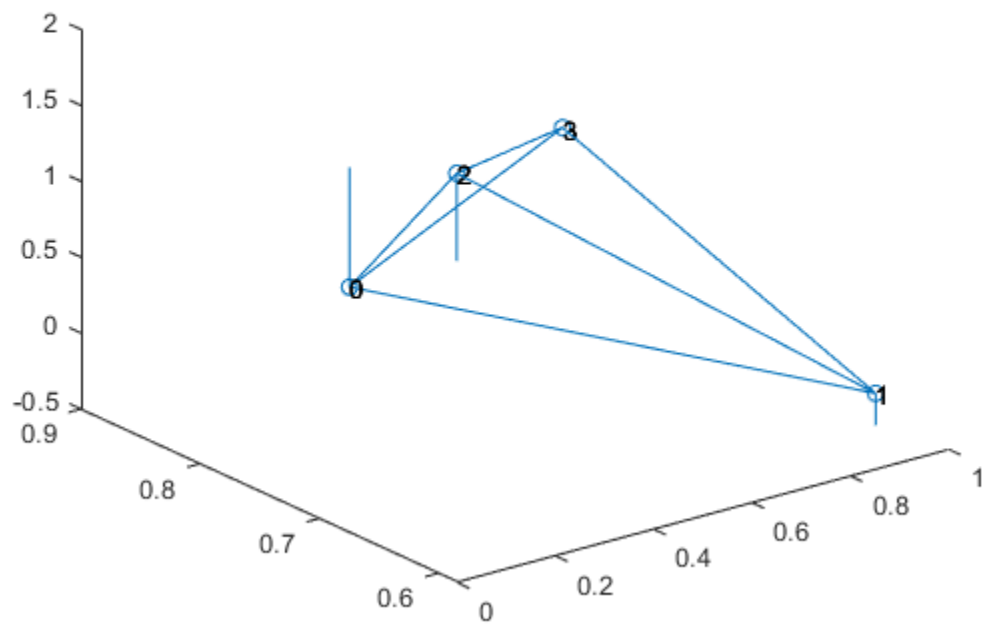**3D bipartite Graph with Vk(n) eigenvectors at vertices**

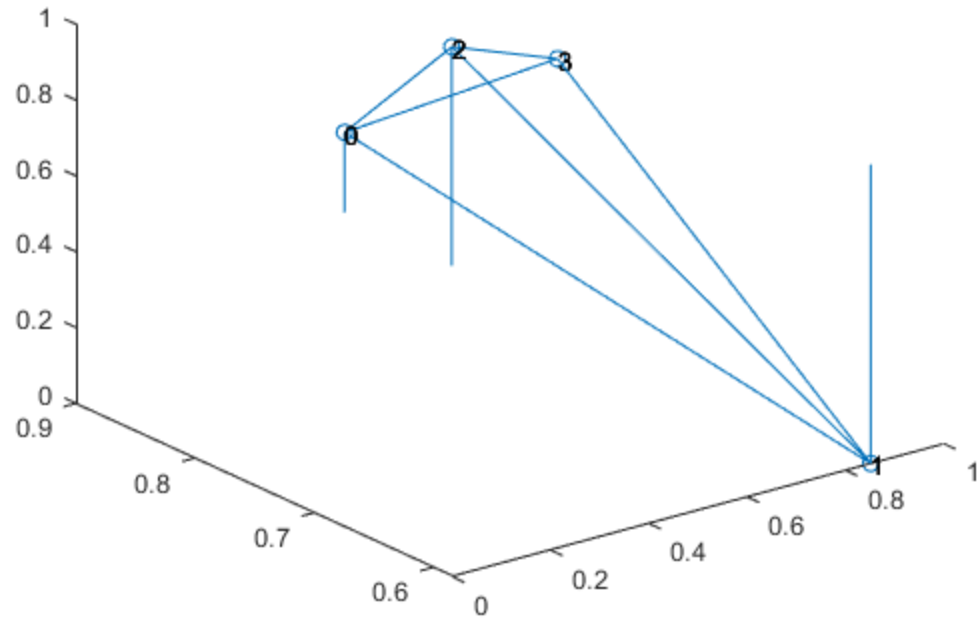**3D bipartite Graph with Vk(n) eigenvectors at vertices**

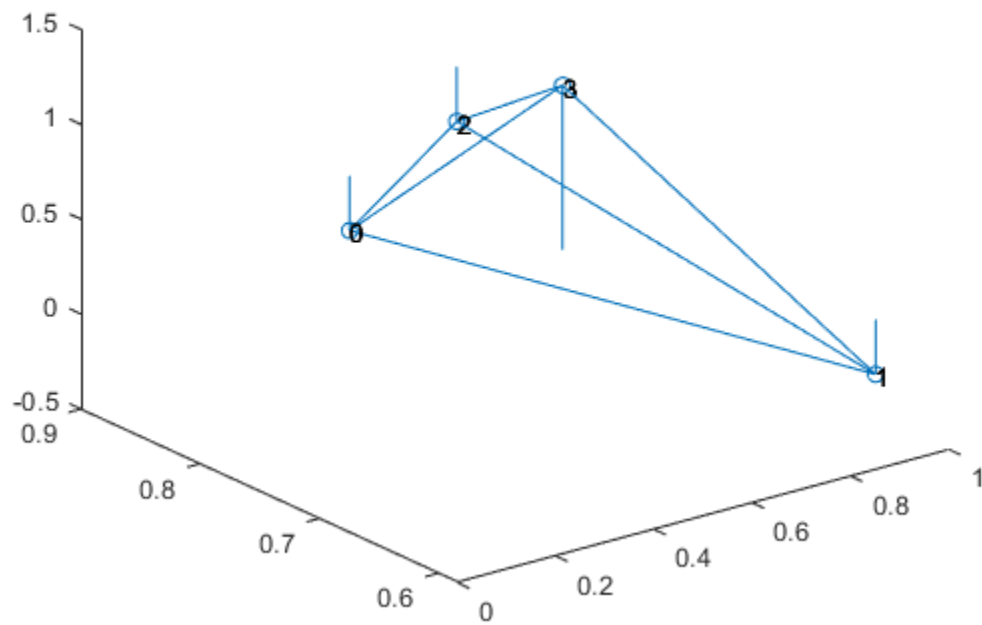**3D regular Graph with eigenvalues at vertices**

3D regular Graph with Vk(n) eigenvectors at vertices
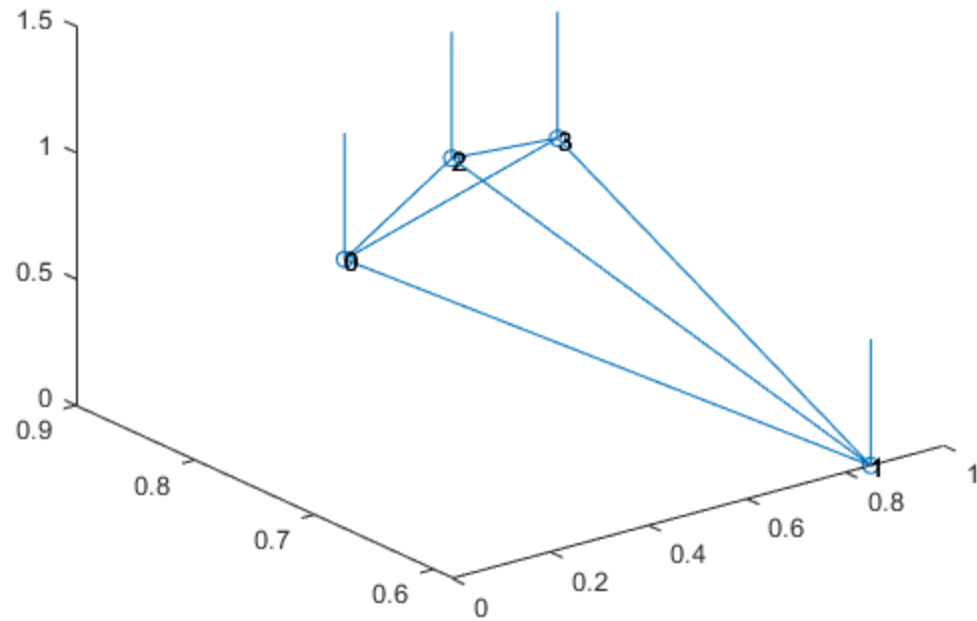
3D regular Graph with Vk(n) eigenvectors at vertices
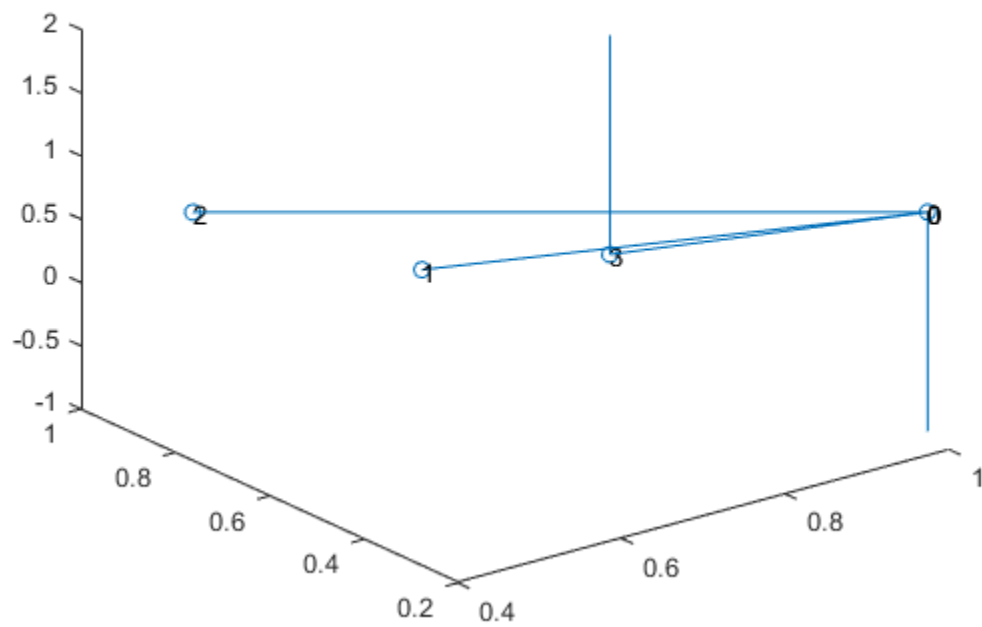

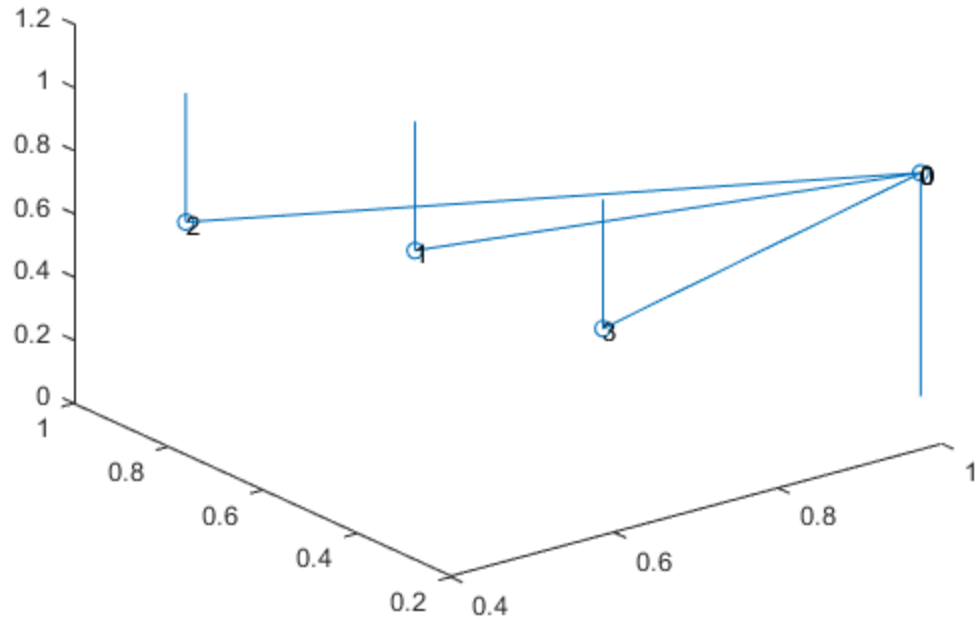**3D regular Graph with Vk(n) eigenvectors at vertices**

3D regular Graph with Vk(n) eigenvectors at vertices
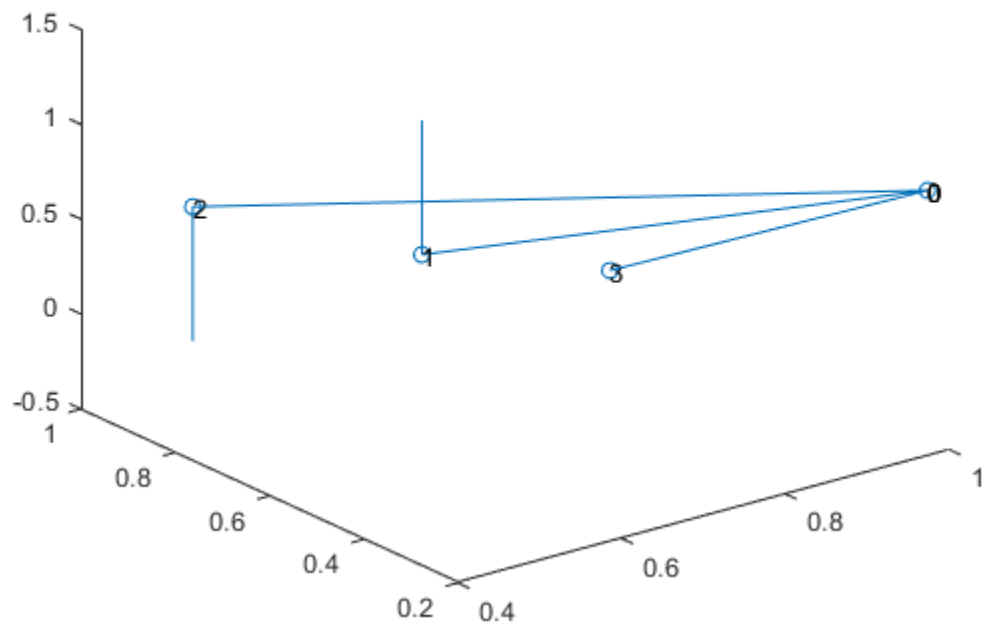

3D star Graph with eigenvalues at vertices

3D star Graph with Vk(n) eigenvectors at vertices

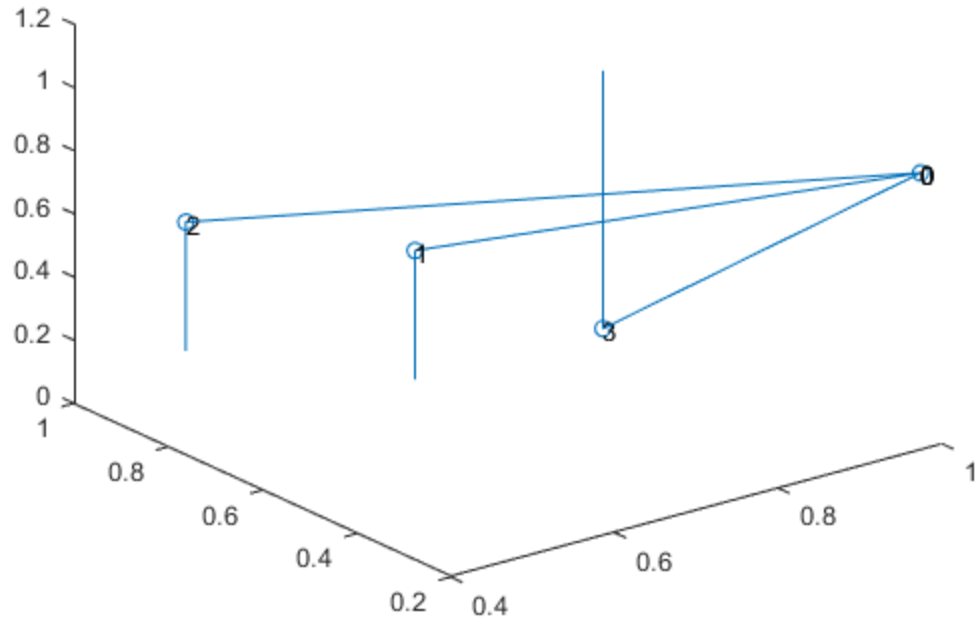**3D star Graph with Vk(n) eigenvectors at vertices**

3D star Graph with Vk(n) eigenvectors at vertices

3D star Graph with Vk(n) eigenvectors at vertices

3D circular Graph with eigenvalues at vertices

3D circular Graph with Vk(n) eigenvectors at vertices

3D circular Graph with Vk(n) eigenvectors at vertices

3D circular Graph with Vk(n) eigenvectors at vertices

3D circular Graph with Vk(n) eigenvectors at vertices

3D line Graph with eigenvalues at vertices

3D line Graph with Vk(n) eigenvectors at vertices
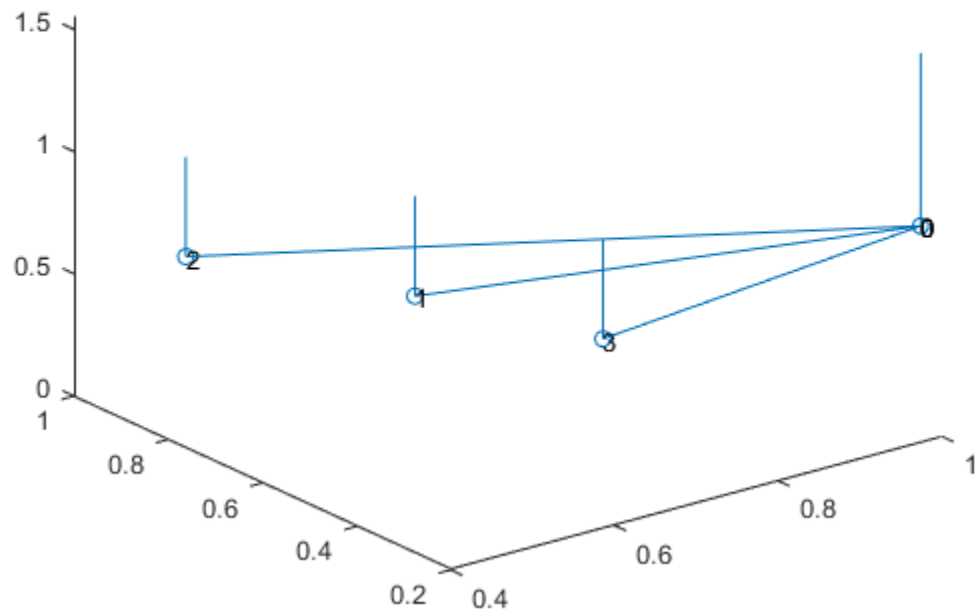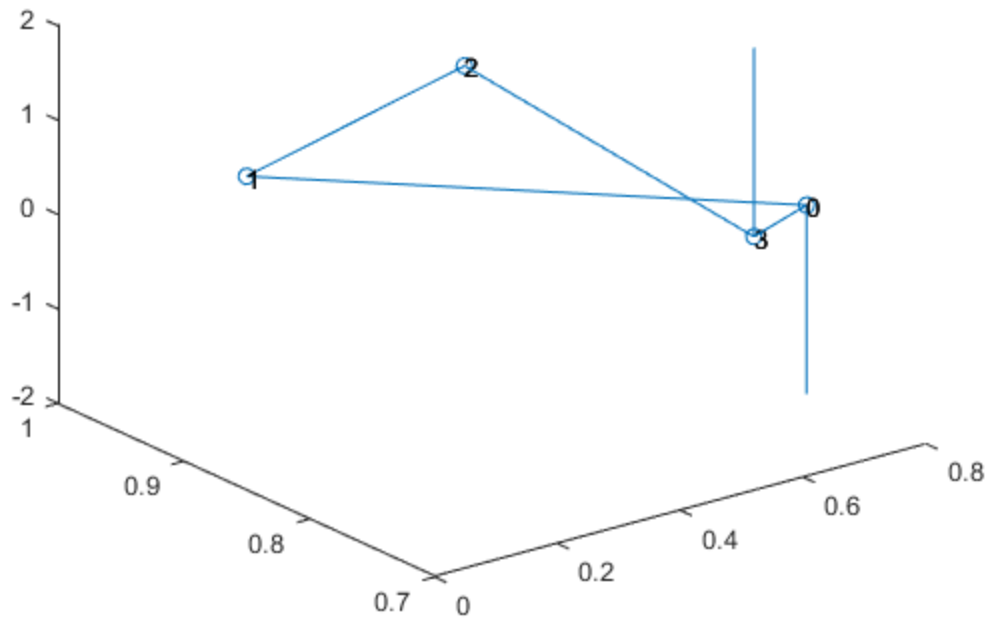

3D line Graph with Vk(n) eigenvectors at vertices
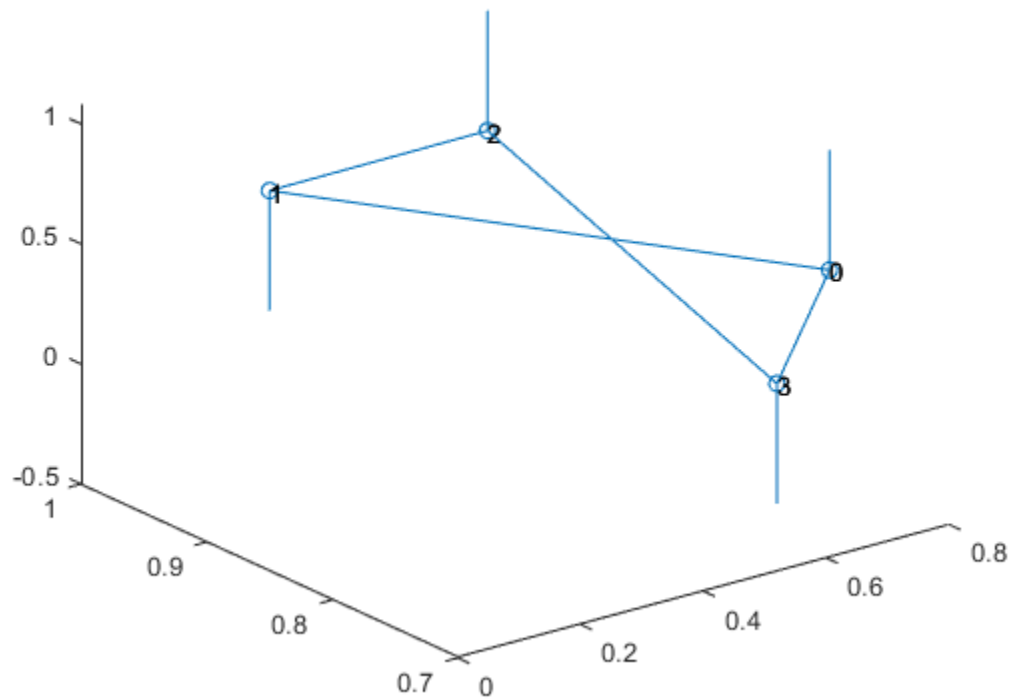
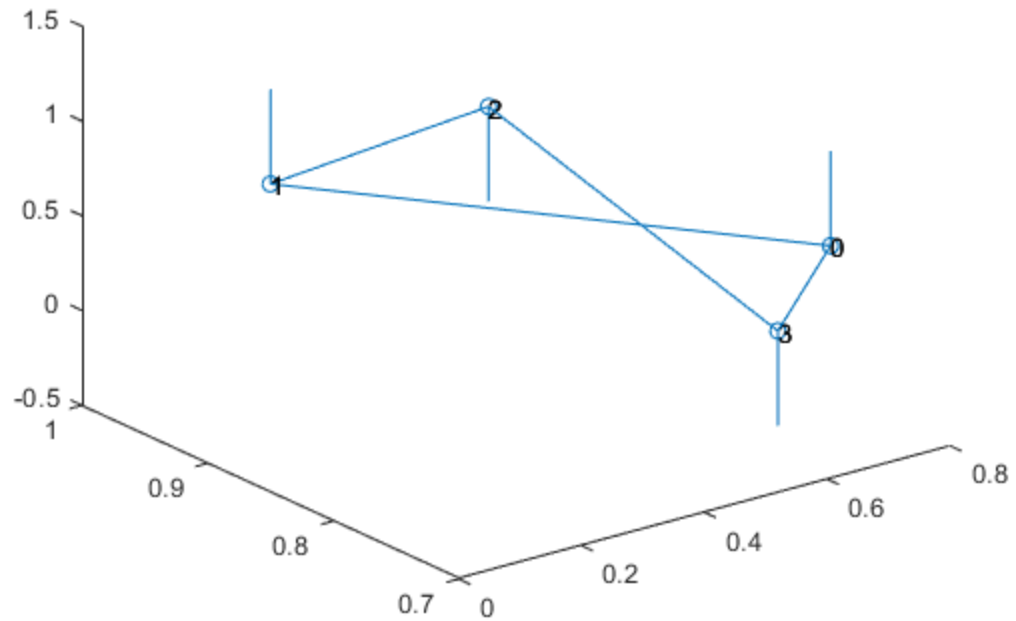**3D line Graph with Vk(n) eigenvectors at vertices**

3D line Graph with Vk(n) eigenvectors at vertices

2D Bucky Graph

3D Bucky Graph

3D Random Graph with eigenvectors at vertices

3D Random Graph with eigenvectors at vertices

3D Random Graph with eigenvectors at vertices

3D Random Graph with eigenvectors at vertices

3D Random Graph with eigenvectors at vertices

3D Random Graph with eigenvectors at vertices

Question 3

```
B = [[0,1,1];[1,0,1];[1,1,0]];

complete = [[0 1 1 1];[1 0 1 1];[1 1 0 1];[1 1 1 0]];
K1 = kronecker(complete,B);
C1 = cartesian(complete,B);
ran1 = rand(length(K1),2);
ran1_3D = rand(length(K1),3);

bipartite = [[0 0 0 1 1 1 1];[0 0 0 1 1 1 1];[0 0 0 1 1 1 1];[1 1 1 0
 0 0 0];[1 1 1 0 0 0 0];[1 1 1 0 0 0 0];[1 1 1 0 0 0 0]];
K2 = kronecker(bipartite,B);
C2 = cartesian(bipartite,B);
ran2 = rand(length(K2),2);
ran2_3D = rand(length(K2),3);

regular = [[0 1 1 1];[1 0 1 1];[1 1 0 1];[1 1 1 0]];
K3 = kronecker(regular,B);
C3 = cartesian(regular,B);
ran3 = rand(length(K3),2);
ran3_3D = rand(length(K3),3);

star = [[0 1 1 1];[1 0 0 0];[1 0 0 0];[1 0 0 0]];
K4 = kronecker(star,B);
C4 = cartesian(star,B);
ran4 = rand(length(K4),2);
ran4_3D = rand(length(K4),3);

circular = [[0 1 0 1];[1 0 1 0];[0 1 0 1];[1 0 1 0]];
K5 = kronecker(circular,B);
C5 = cartesian(circular,B);
ran5 = rand(length(K5),2);
ran5_3D = rand(length(K5),3);

line = [[0 1 0 0];[1 0 1 0];[0 1 0 1];[0 0 1 0]];
K6 = kronecker(line,B);
C6 = cartesian(line,B);
ran6 = rand(length(K6),2);
ran6_3D = rand(length(K6),3);

plot2DGraph(K1,ran1);
title('Kronecker of Complete Graph ');

plot2DGraph(K2,ran2);
title('Kronecker of Bipartite Graph');

plot2DGraph(K3,ran3);
title('Kronecker of Regular Graph');

plot2DGraph(K4,ran4);
title('Kronecker of Star Graph');
```
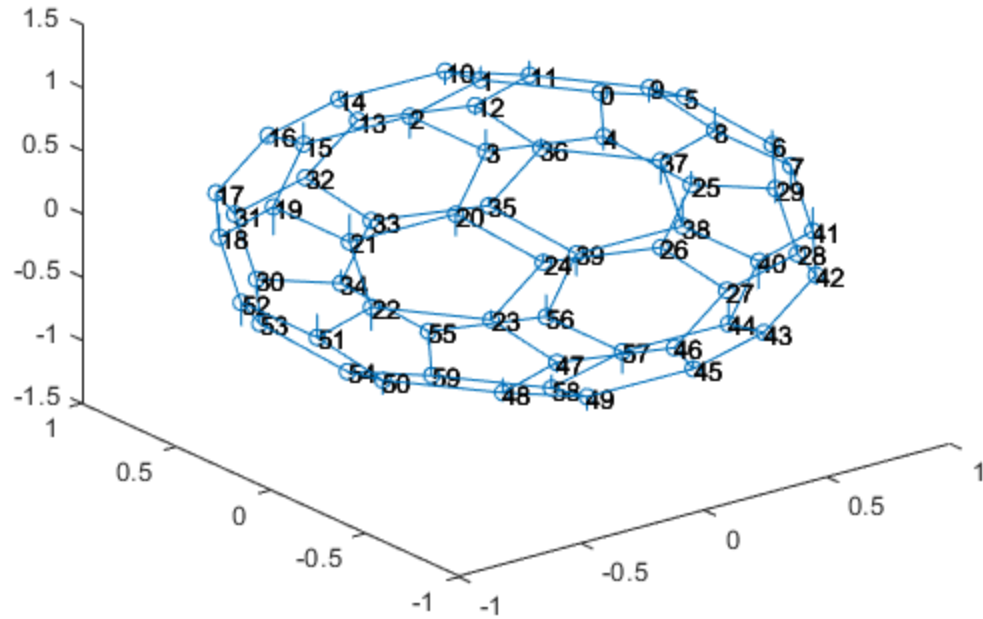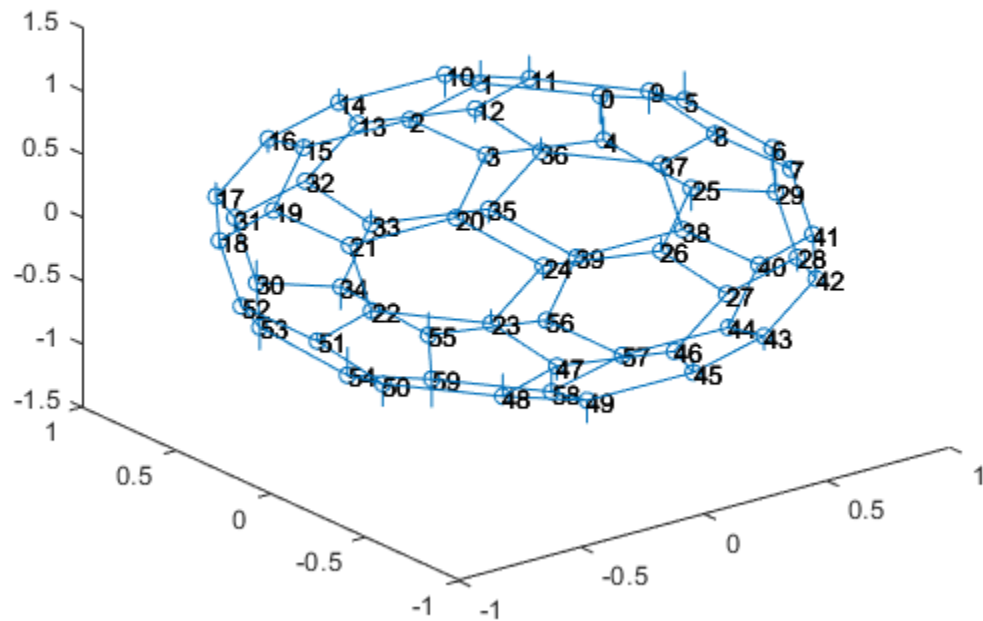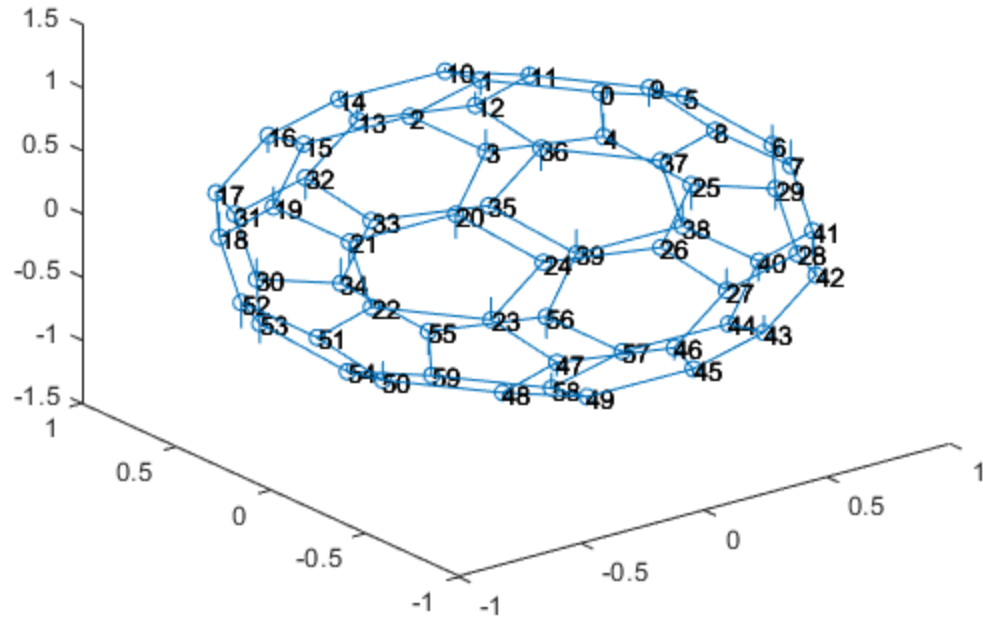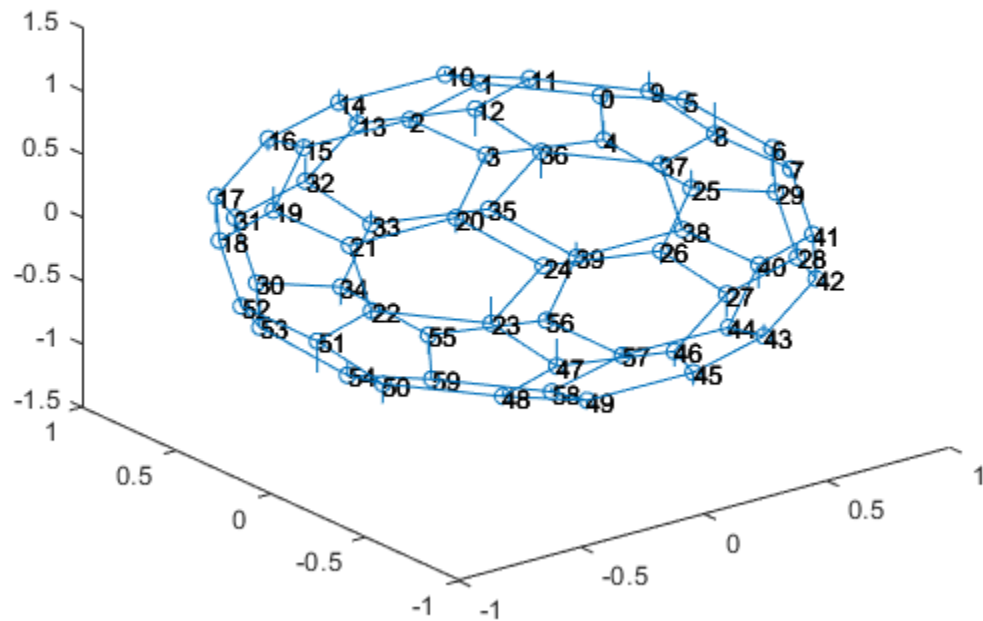
```matlab
plot2DGraph(K5,ran5);
title('Kronecker of Circular Graph');

plot2DGraph(K6,ran6_3D);
title('Kronecker of Line Graph');

plot3DGraph(K1,ran1_3D);
title('Kronecker ofComplete Graph');

plot3DGraph(K2,ran2_3D);
title('Kronecker of Bipartite Graph');

plot3DGraph(K3,ran3_3D);
title('Kronecker of Regular Graph');

plot3DGraph(K4,ran4_3D);
title('Kronecker of Star Graph');

plot3DGraph(K5,ran5_3D);
title('Kronecker of Circular Graph');

plot3DGraph(K6,ran6_3D);
title('Kronecker of Line Graph ');

plot(graph(K1));
title('Using Matlab function plot(graph(A))');

plot(graph(K2));
title('Using Matlab function plot(graph(A))');

plot(graph(K3));
title('Using Matlab function plot(graph(A))');

plot(graph(K4));
title('Using Matlab function plot(graph(A))');

plot(graph(K5));
title('Using Matlab function plot(graph(A))');

plot(graph(K6));
title('Using Matlab function plot(graph(A))');
```
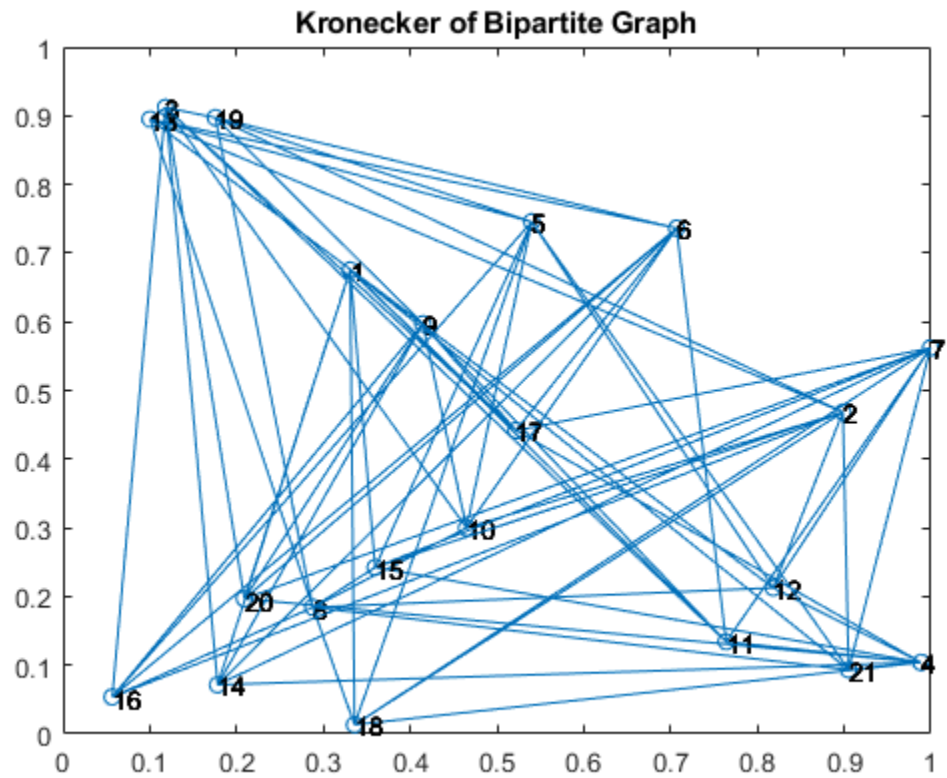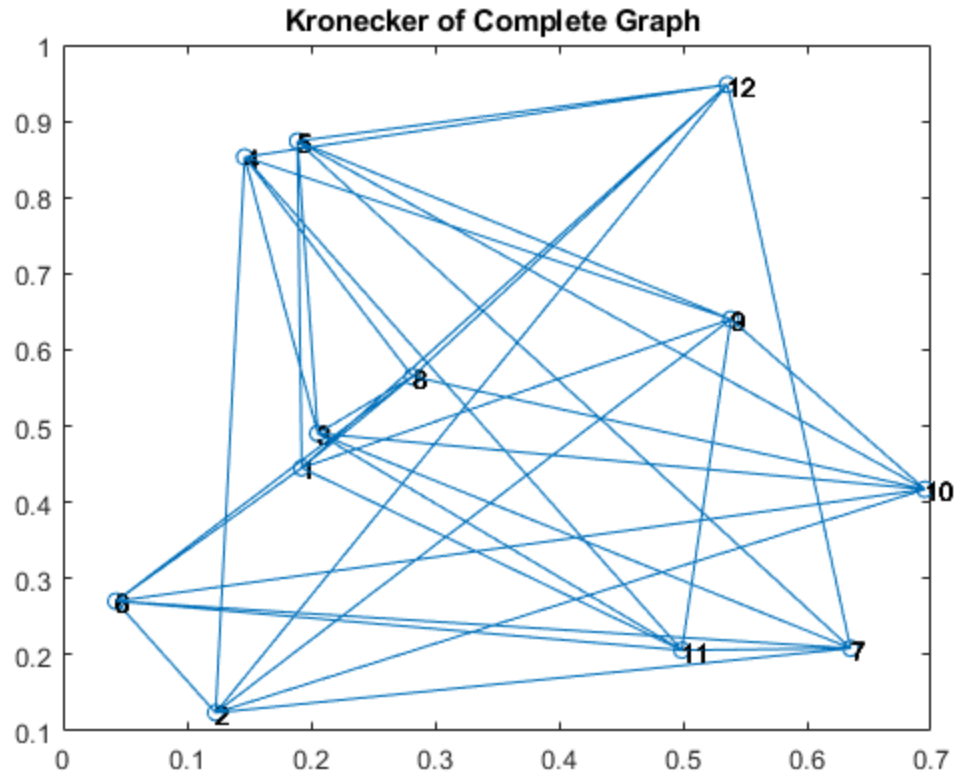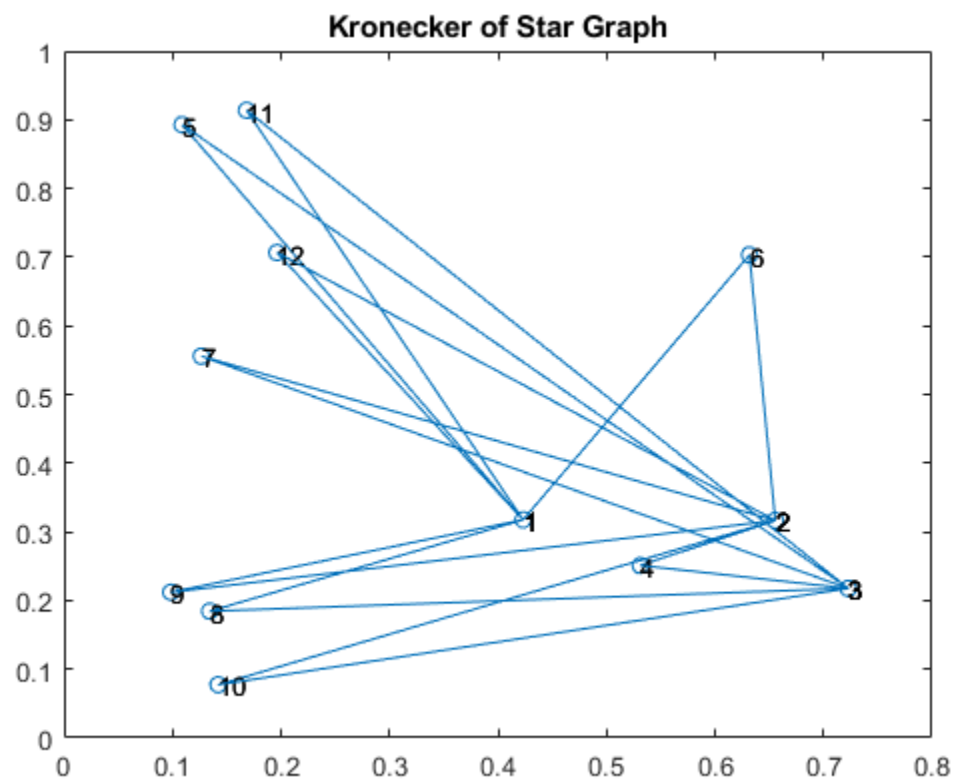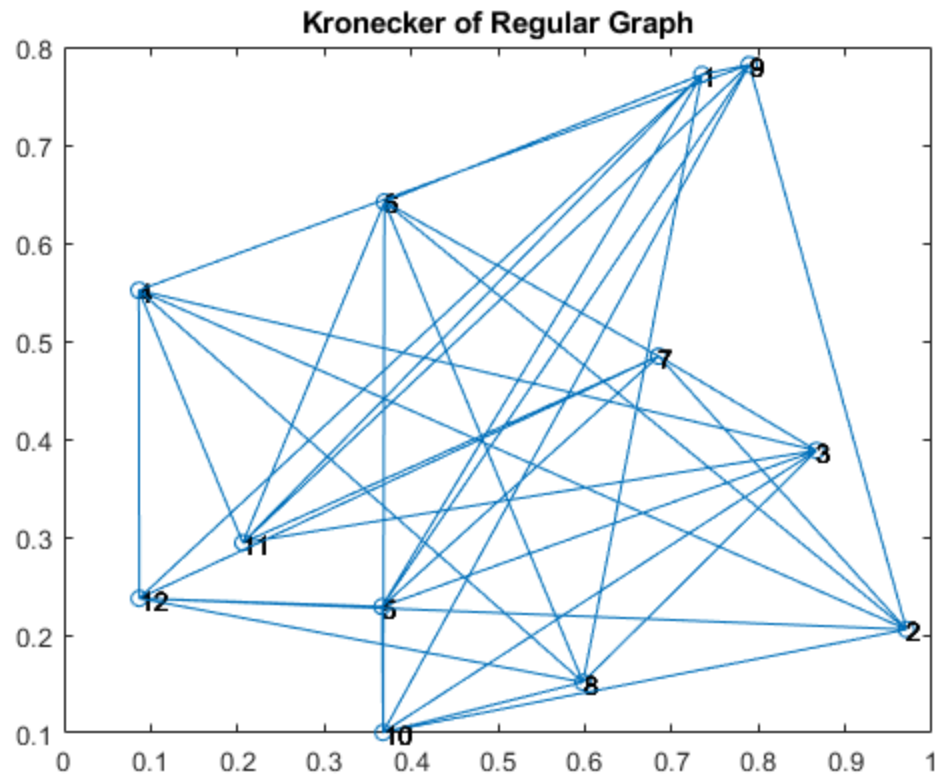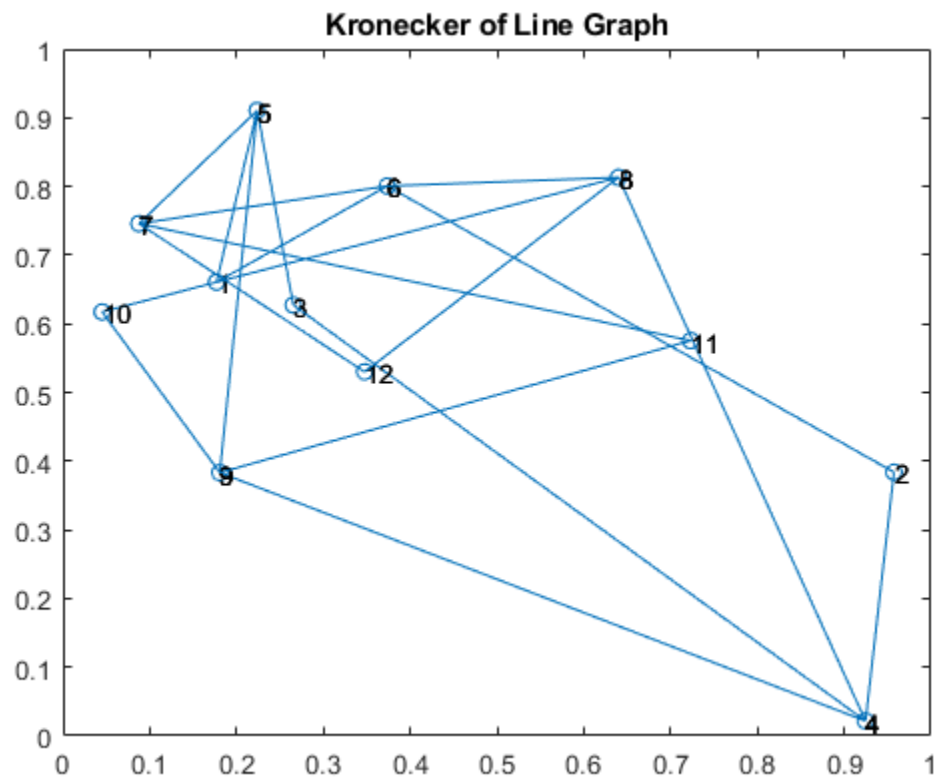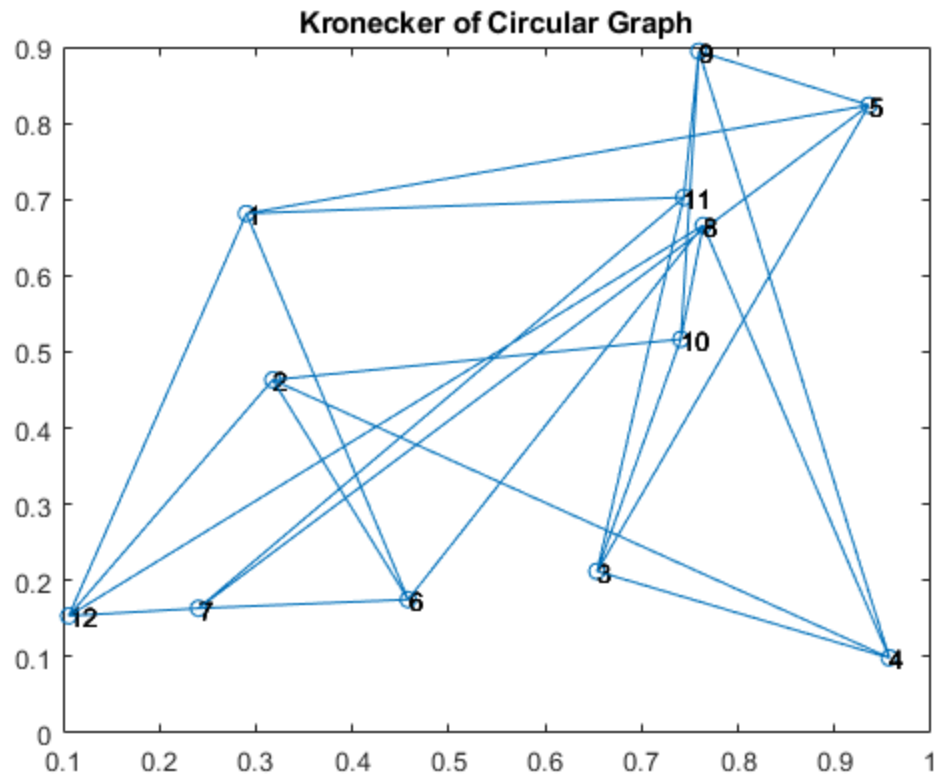
Kronecker of Complete Graph
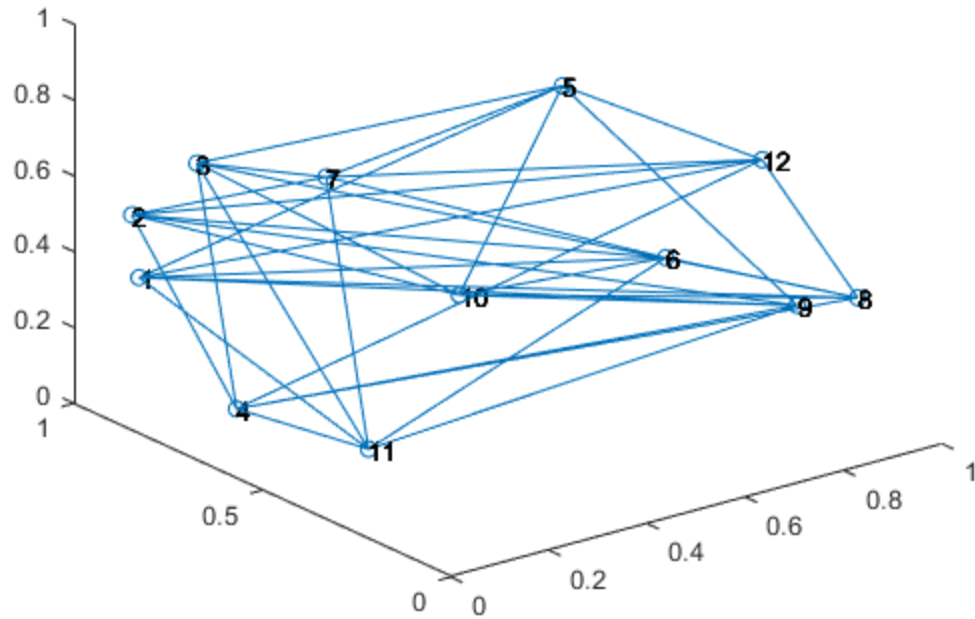
Kronecker of Bipartite Graph

Kronecker of Regular Graph

Kronecker of Star Graph

Kronecker of Circular Graph

Kronecker of Line Graph

Kronecker ofComplete Graph

Kronecker of Bipartite Graph

Kronecker of Regular Graph

Kronecker of Star Graph

Kronecker of Circular Graph

Using Matlab function plot(graph(A))
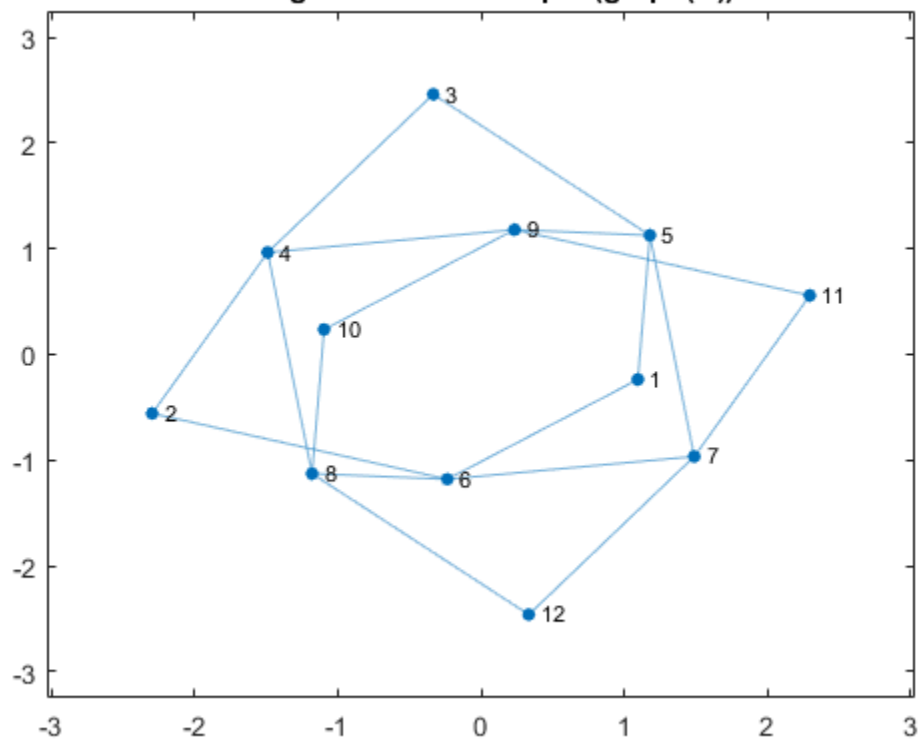
Functions

```
% To create a random NxN adjacency matrix

%function A = randAdjMatrix(N)
%A = []
% Creating upper triangular random matrix
%for i=N:-1:1
%    B = [zeros(1,N-i) round(rand(1,i))]
%    A = [A;B]
%end
%B = A.'  % Taking transpose of upper triangular matrix
%A = A - diag(diag(A)) %Making diagonal 0
%A = A + B %Adding transpose to the original triangular matrix
%A = A - diag(diag(A)) %Making diagonal 0
%end

% To plot 2D graph

%function plot2DGraph(A,ran)
%figure
%plot(ran(:,1),ran(:,2),'O')  %Creating random points in 2D space
%for k = 1: length(A)
%    row = A(k,:); %Extracting kth row
%    for i = 1:length(row)
%        if A(k,i) == 1              % If weight is 1
%            x = [ran(k,1) ran(i,1)];
%            y = [ran(k,2) ran(i,2)]; %x,y-axes stores random points
%            k1 = int2str(k);         % Converting node number to
%                                                string
%            text(ran(k,1),ran(k,2),k1)     % Naming the node
%            line(x,y);                  % Drawing line
%        end
%    end
%end
%end

% To plot 3D graph

%function plot3DGraph(A,ran)
%figure
%plot3(ran(:,1),ran(:,2),ran(:,3),'O') %Creating random points in 3D
 space
%for k = 1: length(A)
%    row = A(k,:); %Extracting kth row
%    for i = 1:length(row)
%        if A(k,i) == 1     % If weight is 1
%            x = [ran(k,1) ran(i,1) ran(k,1)];   %x,y,z-axes stores
 random
%                                              points
%            y = [ran(k,2) ran(i,2) ran(k,2)];
%            z = [ran(k,3) ran(i,3) ran(k,3)];
```
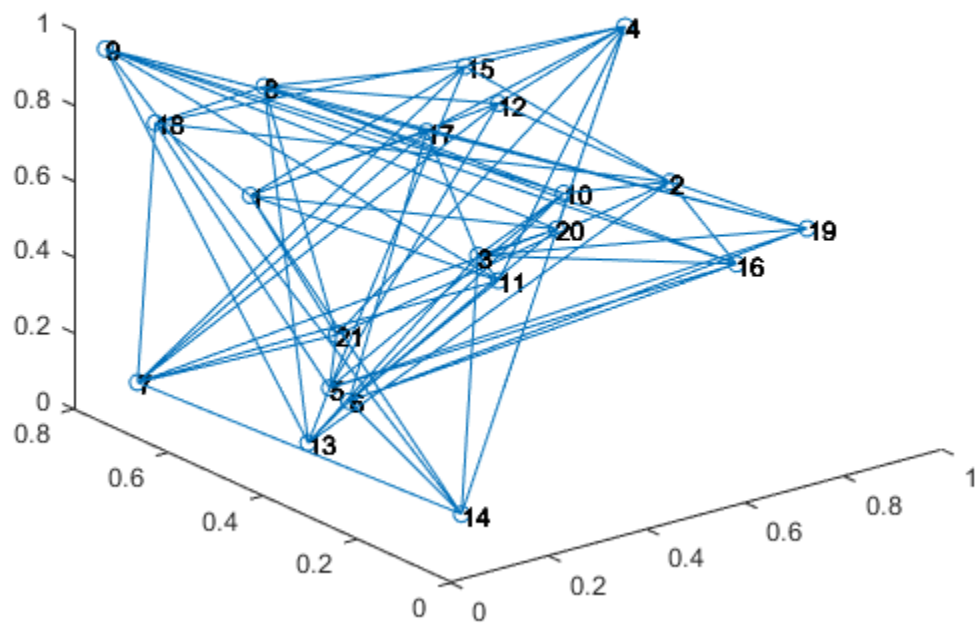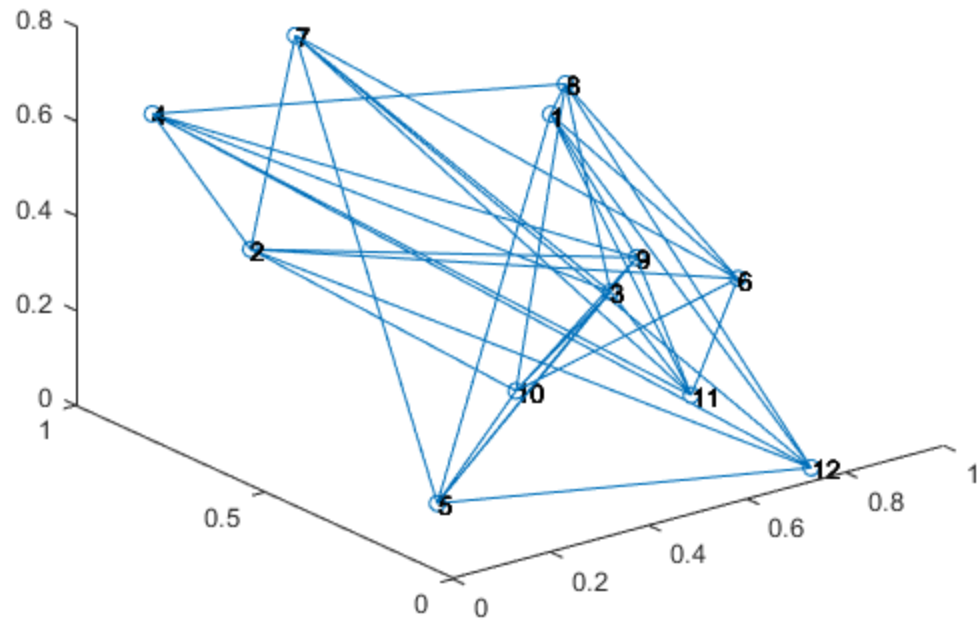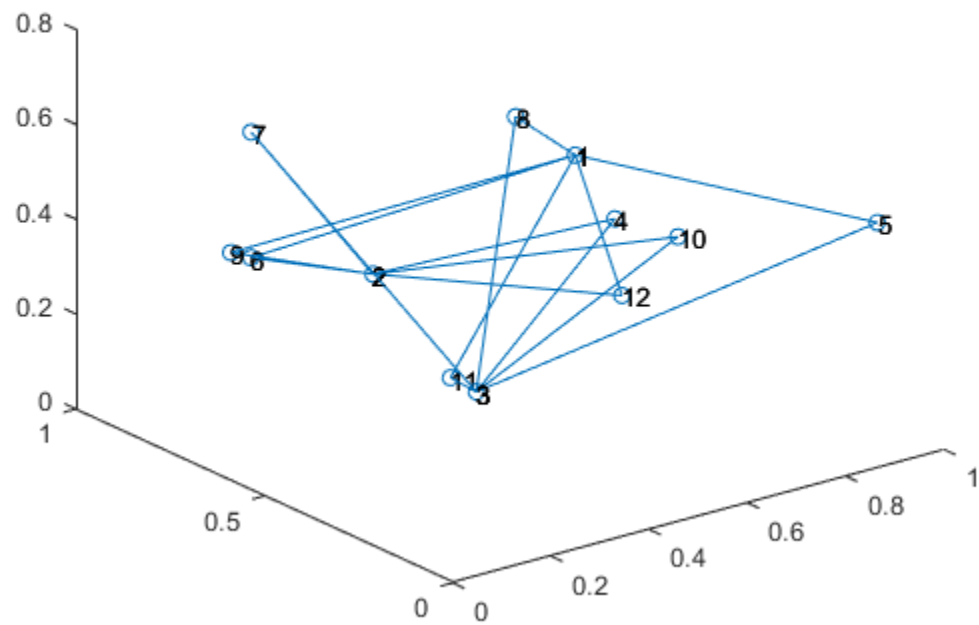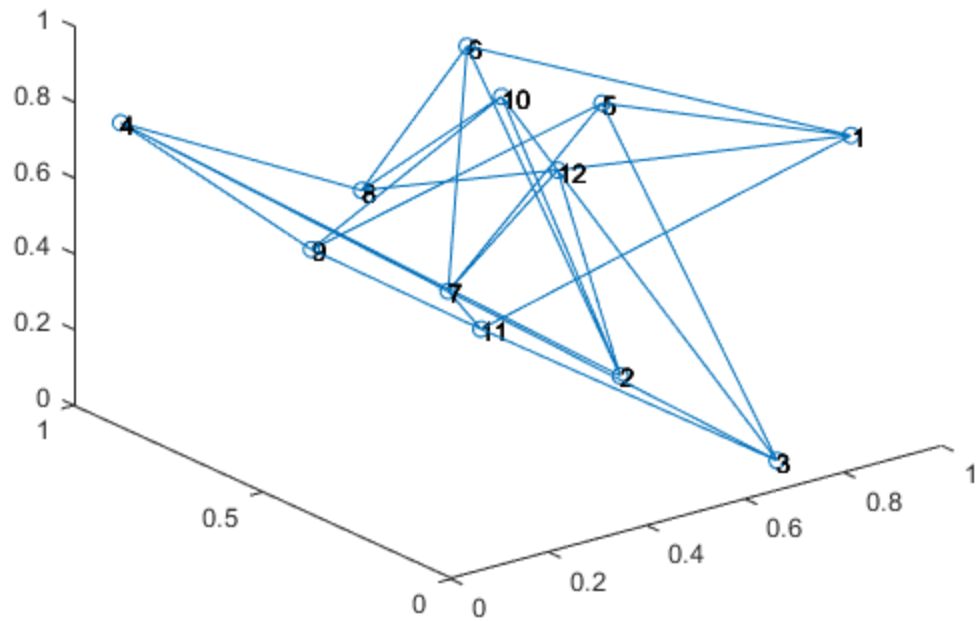
```matlab
%              k1 = int2str(k);                    %Converting node number
 to
%                                                  string
%              text(ran(k,1),ran(k,2),ran(k,3),k1) % Naming the node
%              line(x,y,z); % Drawing line
%          end
%     end
%end
%end


% To find kronecker product

%function D = kronecker(A,B)
%C = []
%D = []
%for i = 1:length(A)
%    C = []
%    for j = 1:length(A)
%        C = [C A(i,j).*B]
%    end
%    D = [D; C]
%end
%end


% To find cartesian product

%function D = cartesian(A,B)
%I1 = eye(length(A))
%I2 = eye(length(B))
%D1 = kronecker(A,I2)
%D2 = kronecker(I1,B)
%D = D1 + D2
%end


% To plot vectors on graph

%function plot3Dv2(A,ran,val)
%figure
%plot3(ran(:,1),ran(:,2),ran(:,3),'O')
%for k = 1: length(A)
%    row = A(k,:);
%    for i = 1:length(row)
%        if A(k,i) == 1
%            x = [ran(k,1) ran(i,1) ran(k,1)];
%            y = [ran(k,2) ran(i,2) ran(k,2)];
%            z = [ran(k,3) ran(i,3) ran(k,3)];
%            k1 = int2str(k-1);
%            text(ran(k,1),ran(k,2),ran(k,3),k1)
%            line(x,y,z);
%        end
%    end
%        x1 = [ran(k,1) ran(k,1) ];
%        y1 = [ran(k,2) ran(k,2) ];
%        z1 = [ran(k,3) (ran(k,3) + val(k))];
```

```
%        line(x1,y1,z1)
%end
%end
```

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