GALGOTIAS UNIVERSITY

NAAC GRADE A+ Accredited University

Plot No.2, Sector 17-A, Yamuna Expressway,
Greater Noida, Gautam Buddha Nagar, U.P., India

School of Computer Science and Engineering

Lab Report

B. Tech- II Sem

Winter: 2023-24

Engineering Mathematics-II(Lab)

(C1UC222B)

Submitted by:

Name:.........................

Batch:...… … … … … ..

Adm No:… … … … … .

Submitted to:

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S.No.	List of Experiments
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S. No.	Experiment	Date (Performed)	Signature (with date)
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Experiment :- 1 Vectors in 2D and 3D

Exercises

To write a Scilab code of the following problems:

Q1. (i) Create a row vector with 3 elements.

```
--> M=[1 4 2]
 M  =

   1.   4.   2.
```

(ii) Create a column vector with 4 elements.

```
--> U=[1;7;0;8]
 U  =

   1.
   7.
   0.
   8.
```

2. By taking the first term a=1 and the last term b=10 create a vector:

(i) By taking the spacing between two consecutive terms d=2,

```
--> S=[1:2:10]
 S  =

   1.   3.   5.   7.   9.
```

(ii) By taking the number of terms n= 12

```
--> K=linspace(1,10,12)
 K  =

         column 1 to 9

   1.   1.8181818   2.6363636   3.4545455   4.2727273   5.0909091   5.9090909   6.7272727   7.5454545

         column 10 to 12

   8.3636364   9.1818182   10.
```

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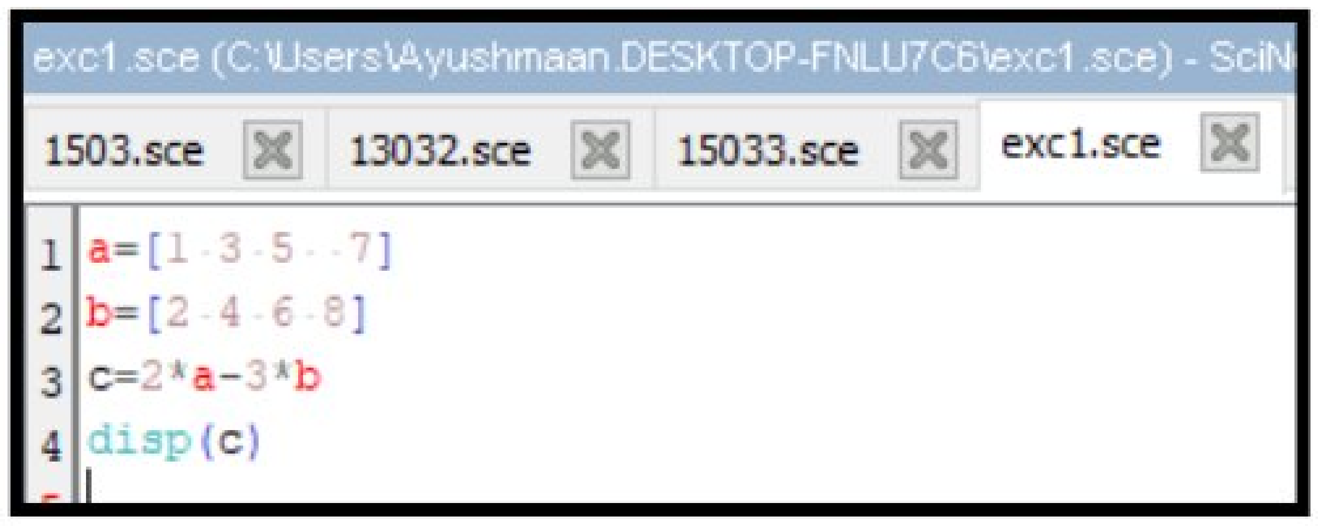
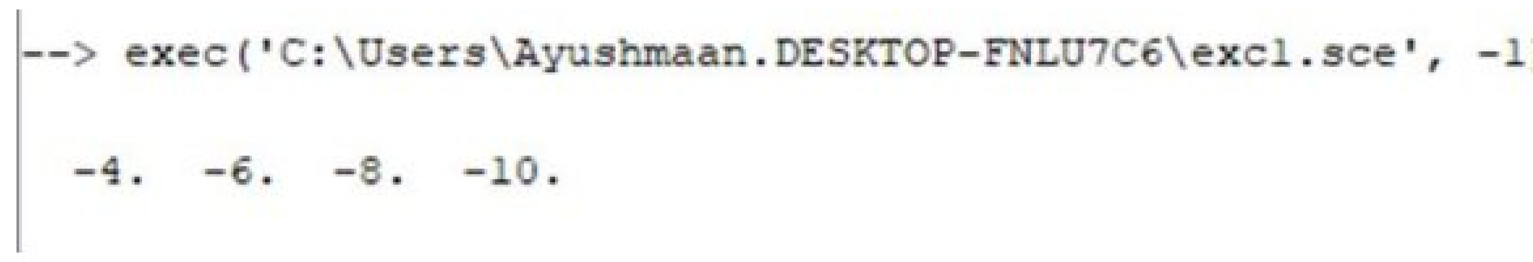
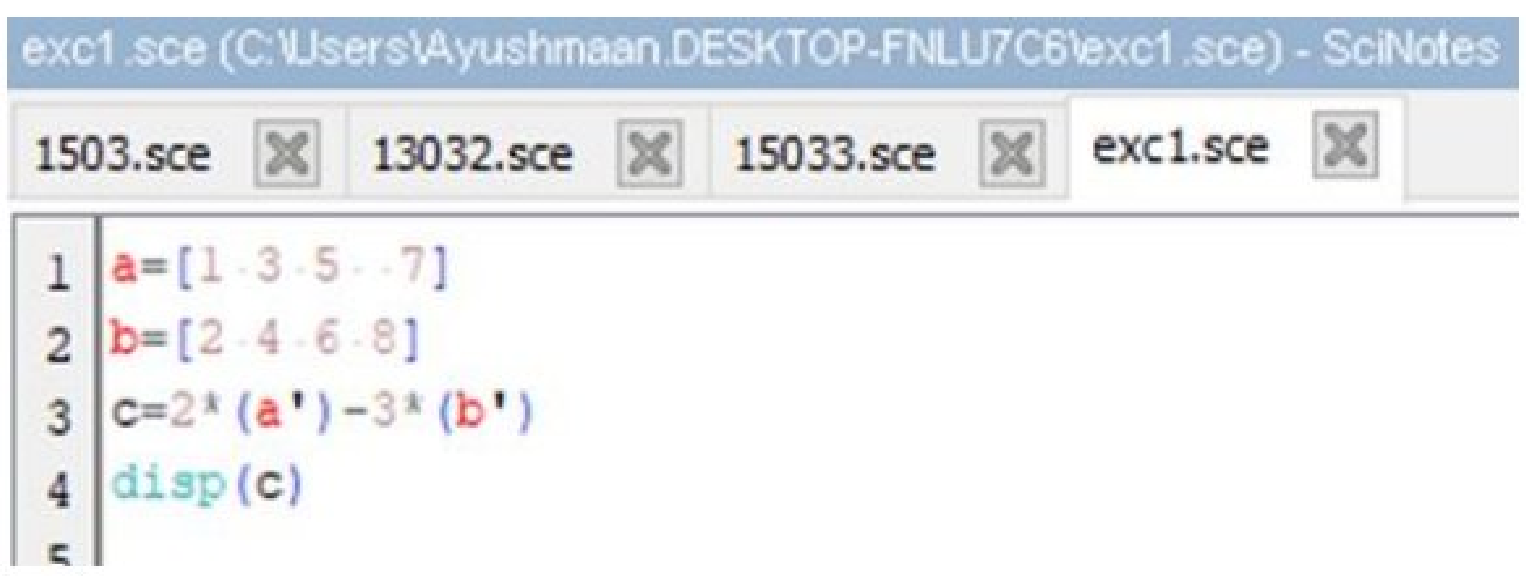
(iii) Create two-row vectors a and b such that the following operations are defined and hence find :

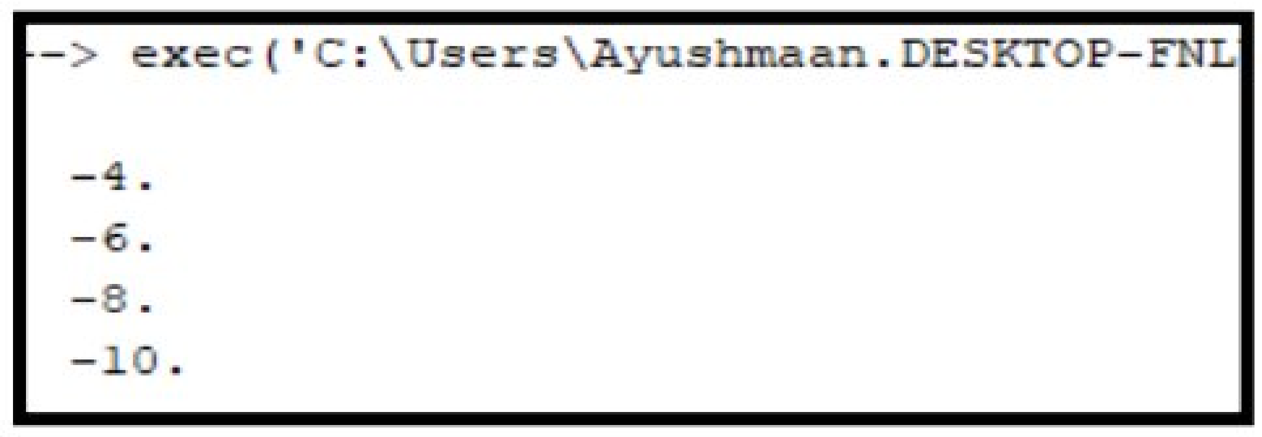
(i) 2a-3b





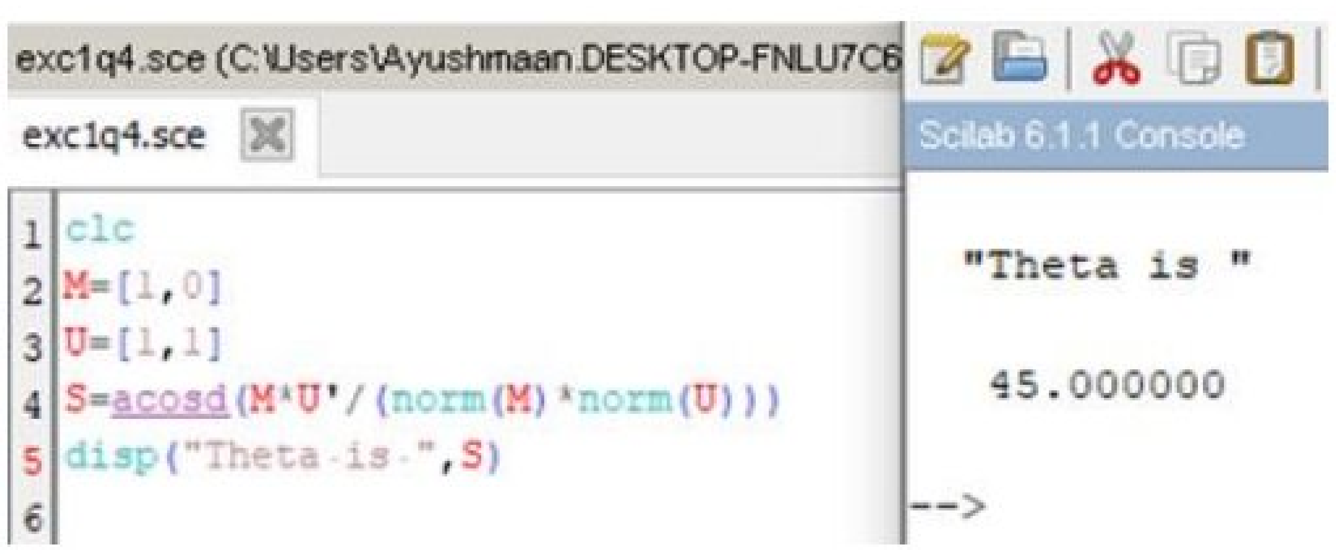
(ii) 2(transpose a) - 3(transpose b)



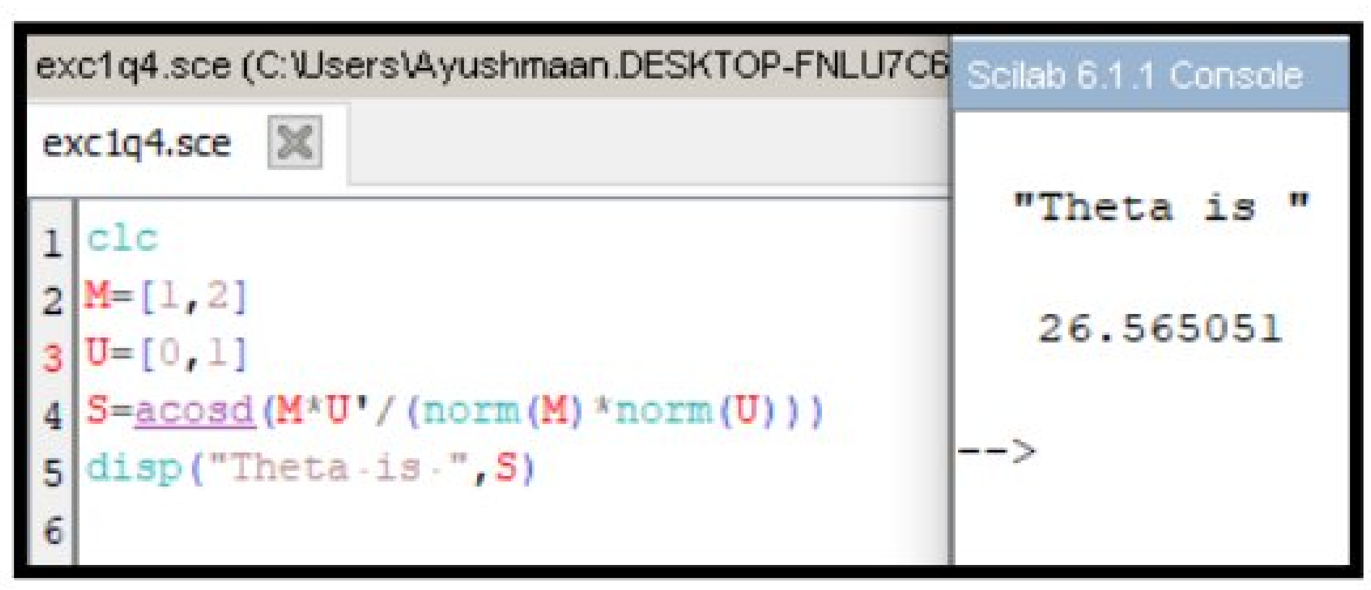


4. Find the angle between the following pair of vectors

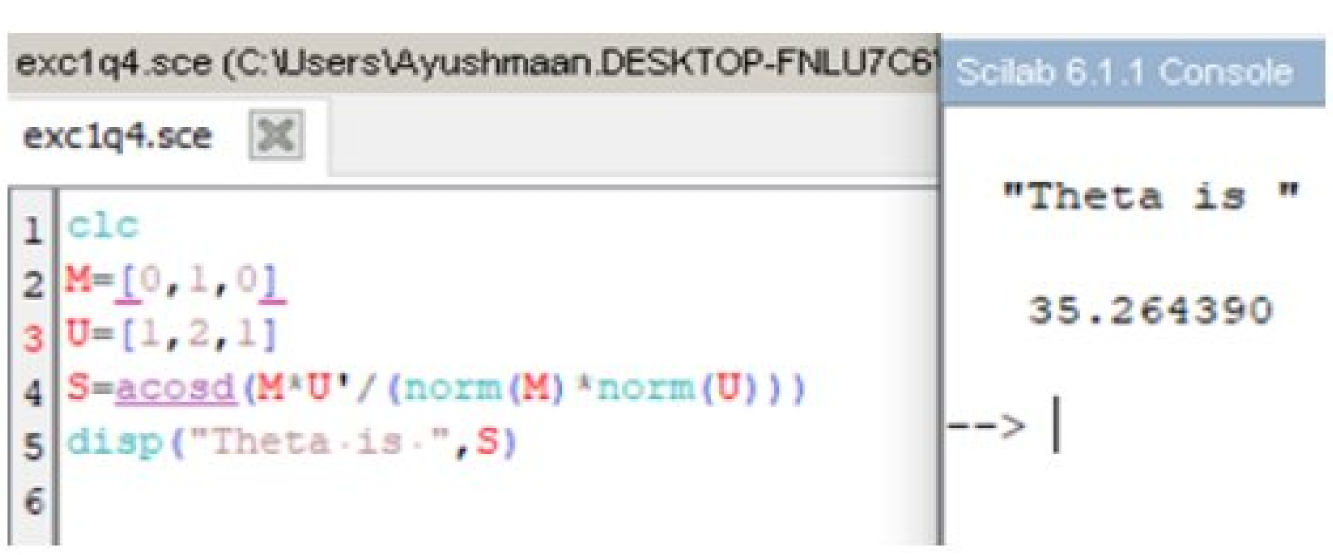
(i) (0,0),(1,1)



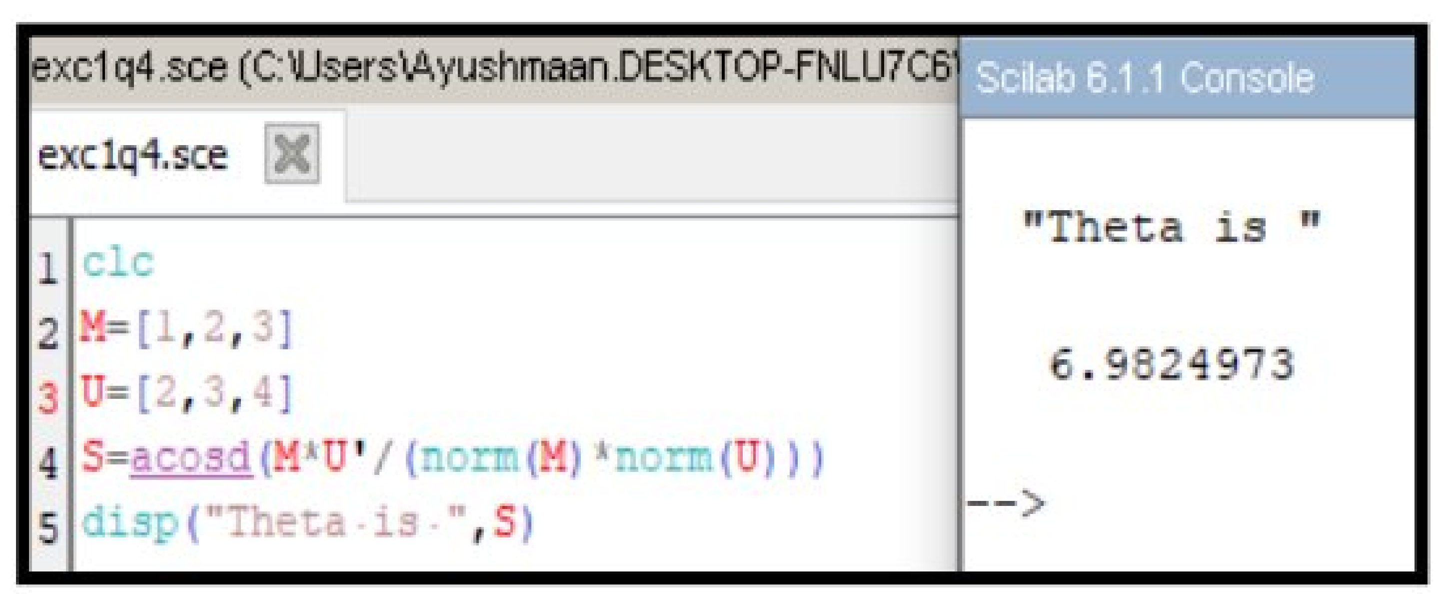
(ii) (1,2), (0,1)



(iii) (0,1,0), (1,2,1)



(iv) (1,2,3), (2,3,4)



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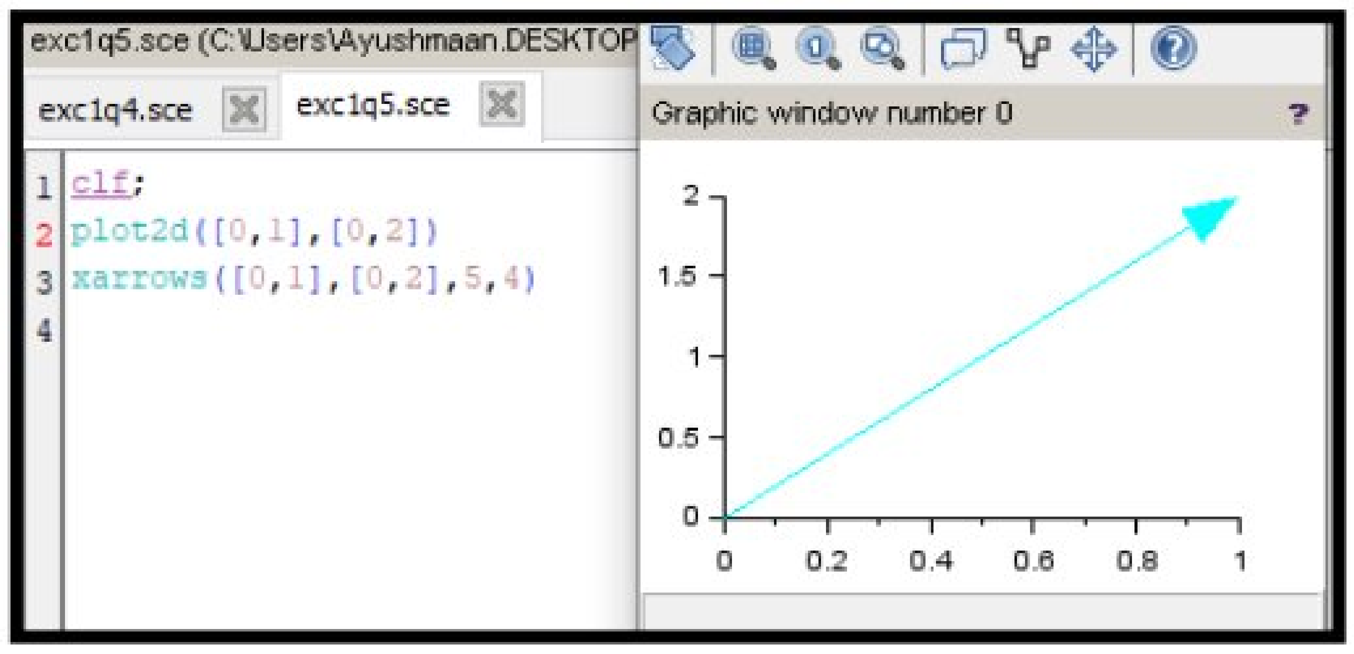
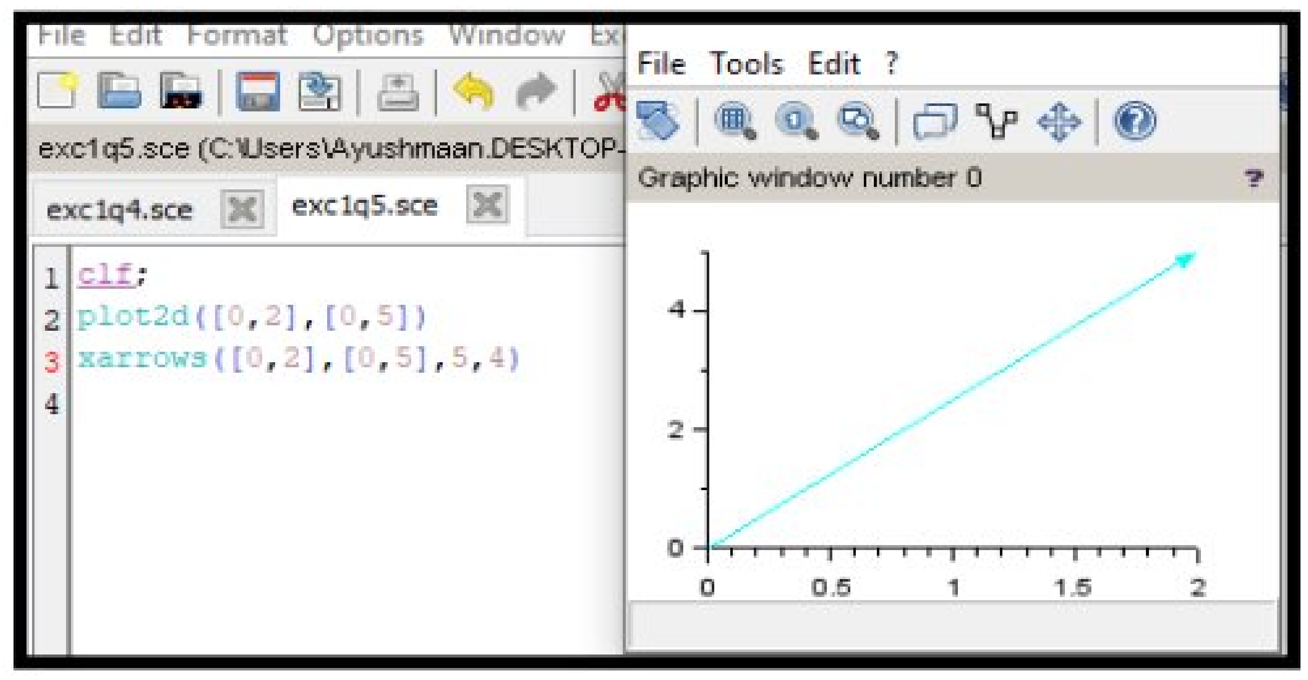
5. Draw the arrows for the following vectors:

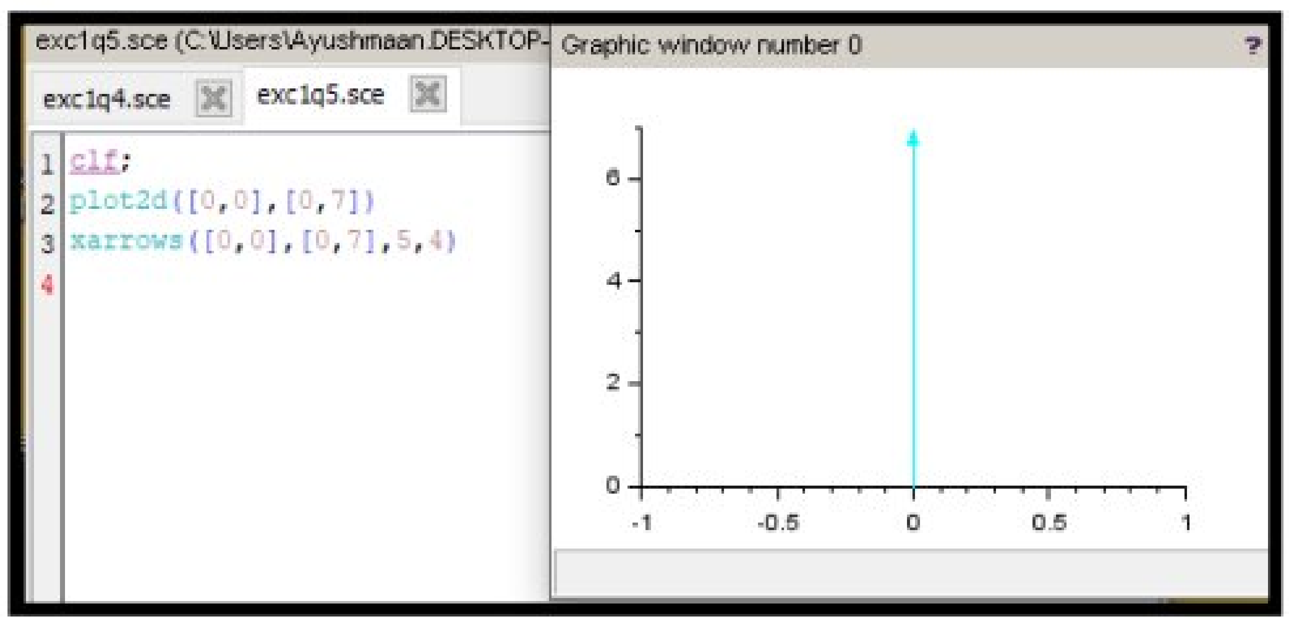
(i) (1,2)



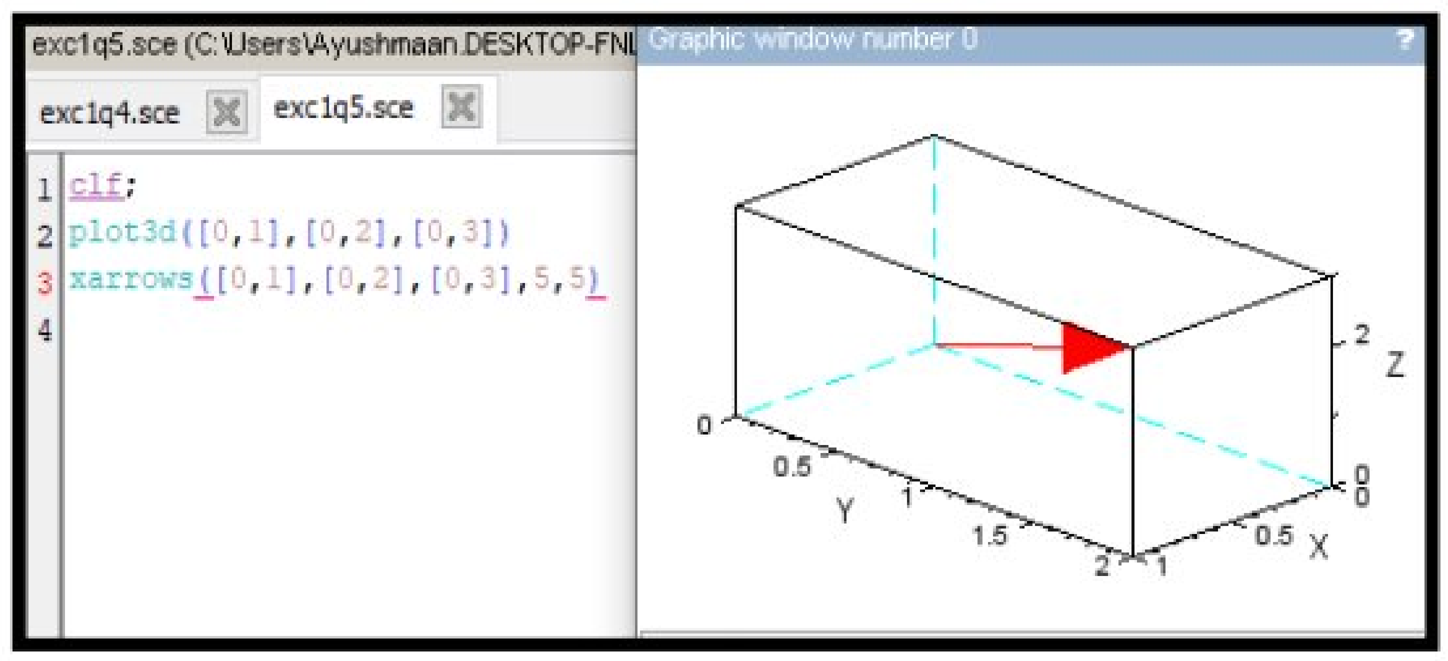
(ii) (2,5)



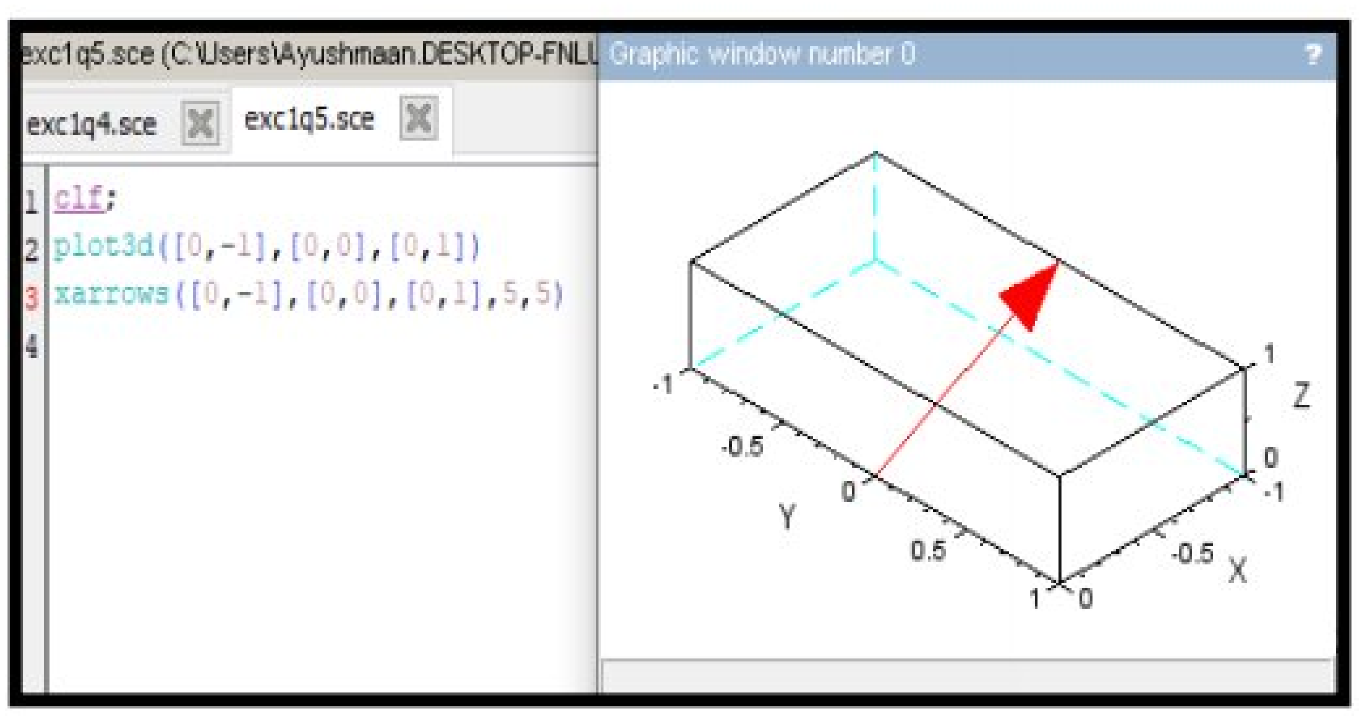
(iii) (0,7)



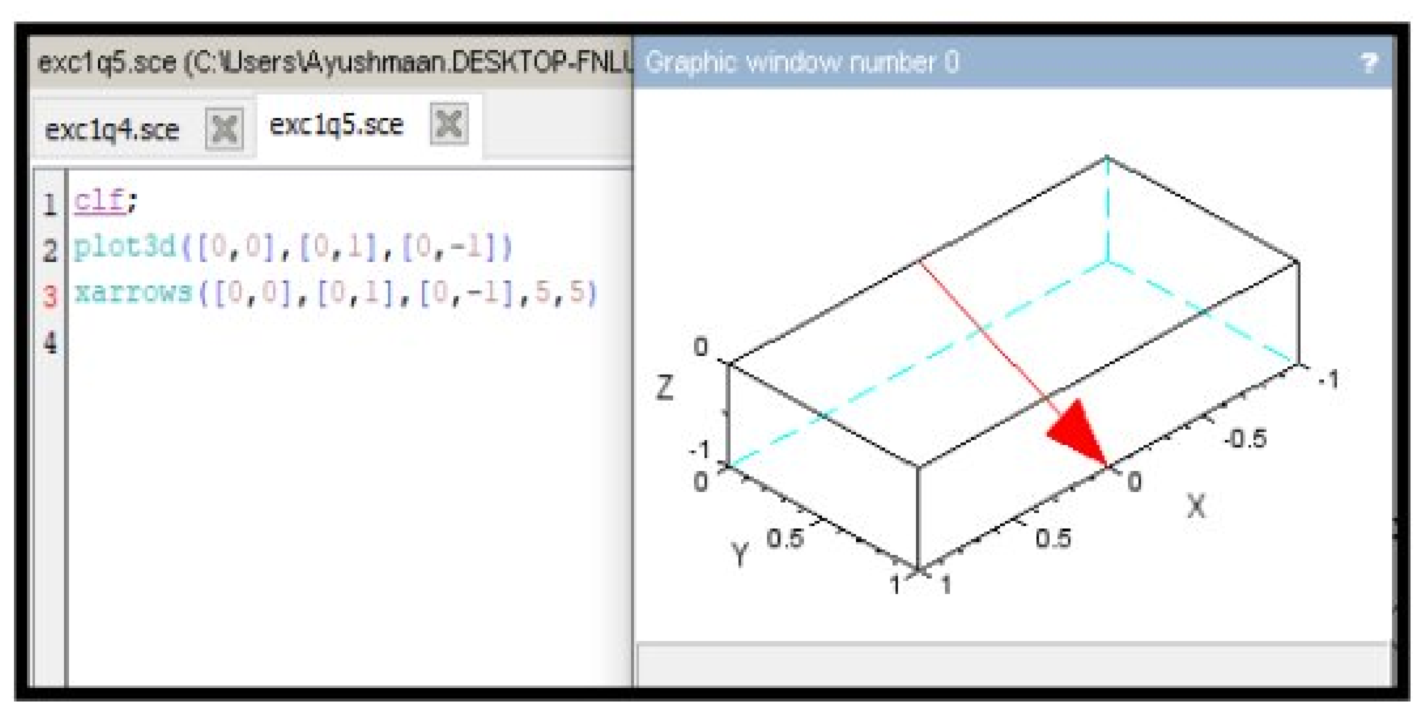
(iv) (1,2,3)



(v) (-1,0,1)



(vi) (0,1,-1)



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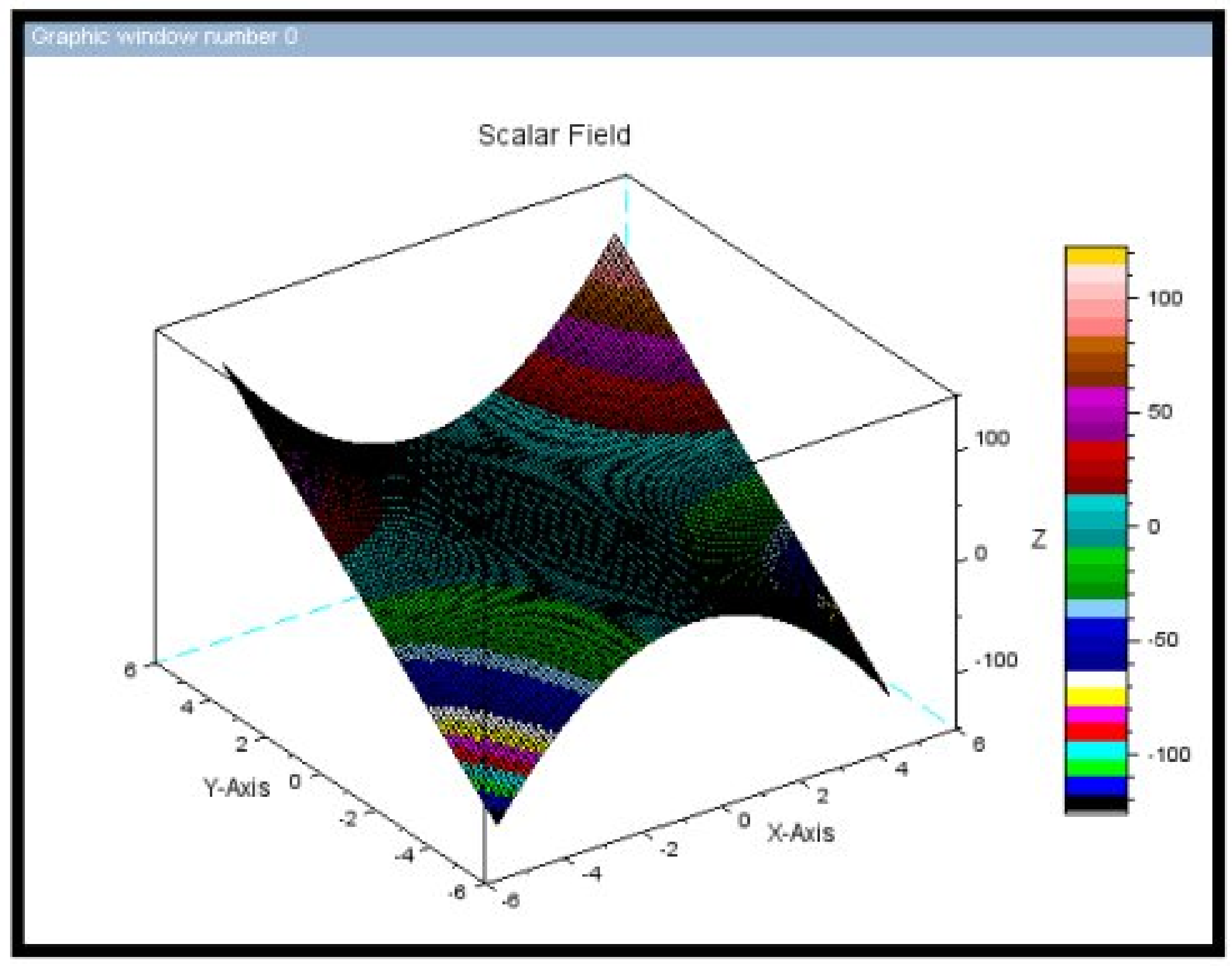
Experiment :- 2

Exercises:

1) Plotting of a Scalar Field $f(x,y)=x^{2y}$

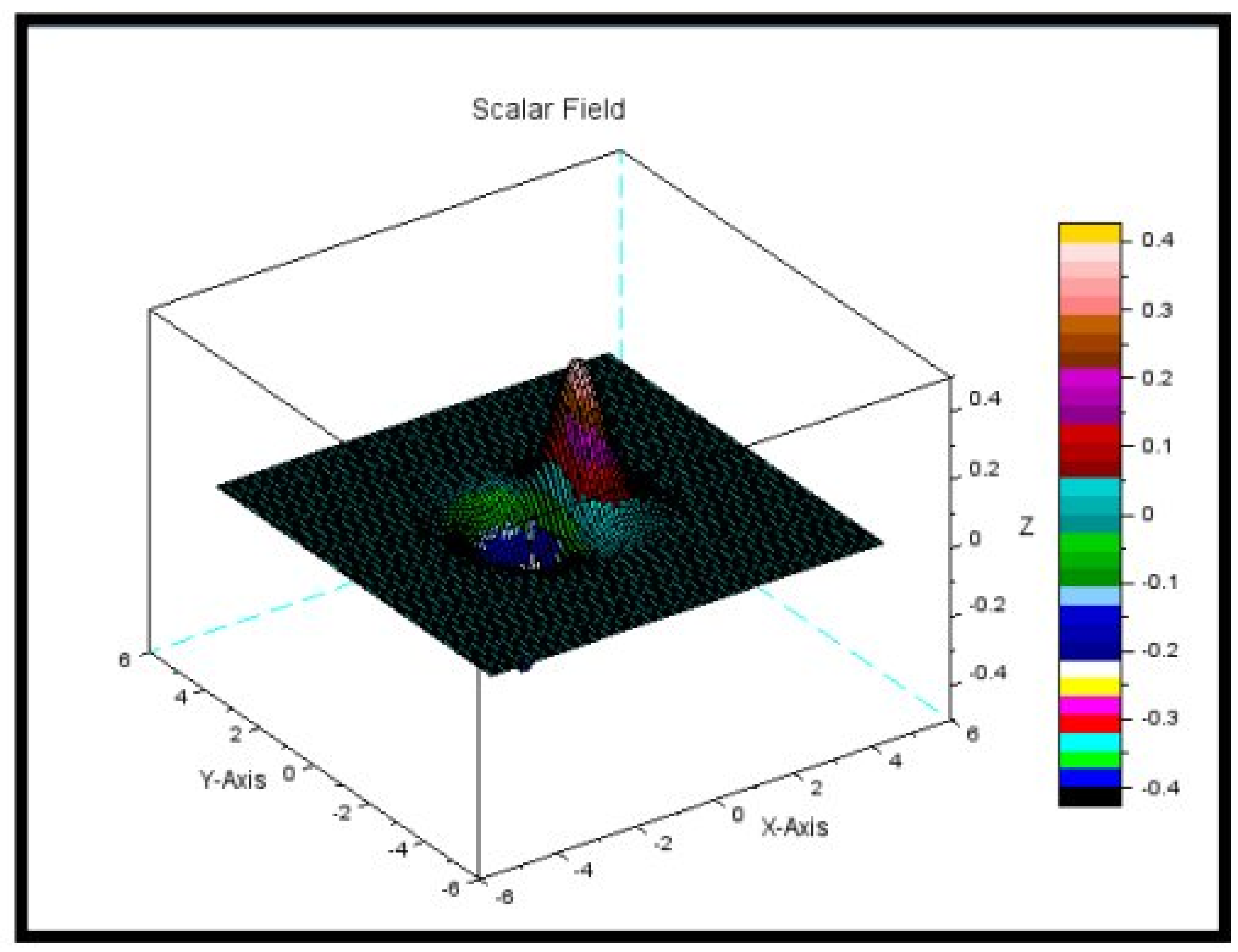
```
clc; clear; clf;
function z=scalarfield(x, y)
   z=(x.^2).*y
endfunction
x=linspace(-5,5,100)
y=linspace(-5,5,100)
[X,Y]=meshgrid(x,y)
z=scalarfield(X,Y)
surf(x,y,z)
xtitle('Scalar Field','X-Axis','Y-Axis')
colorbar
```



2) Plotting of a Scalar Field $f(x,y)= x*e^{-x^2+y^2}$

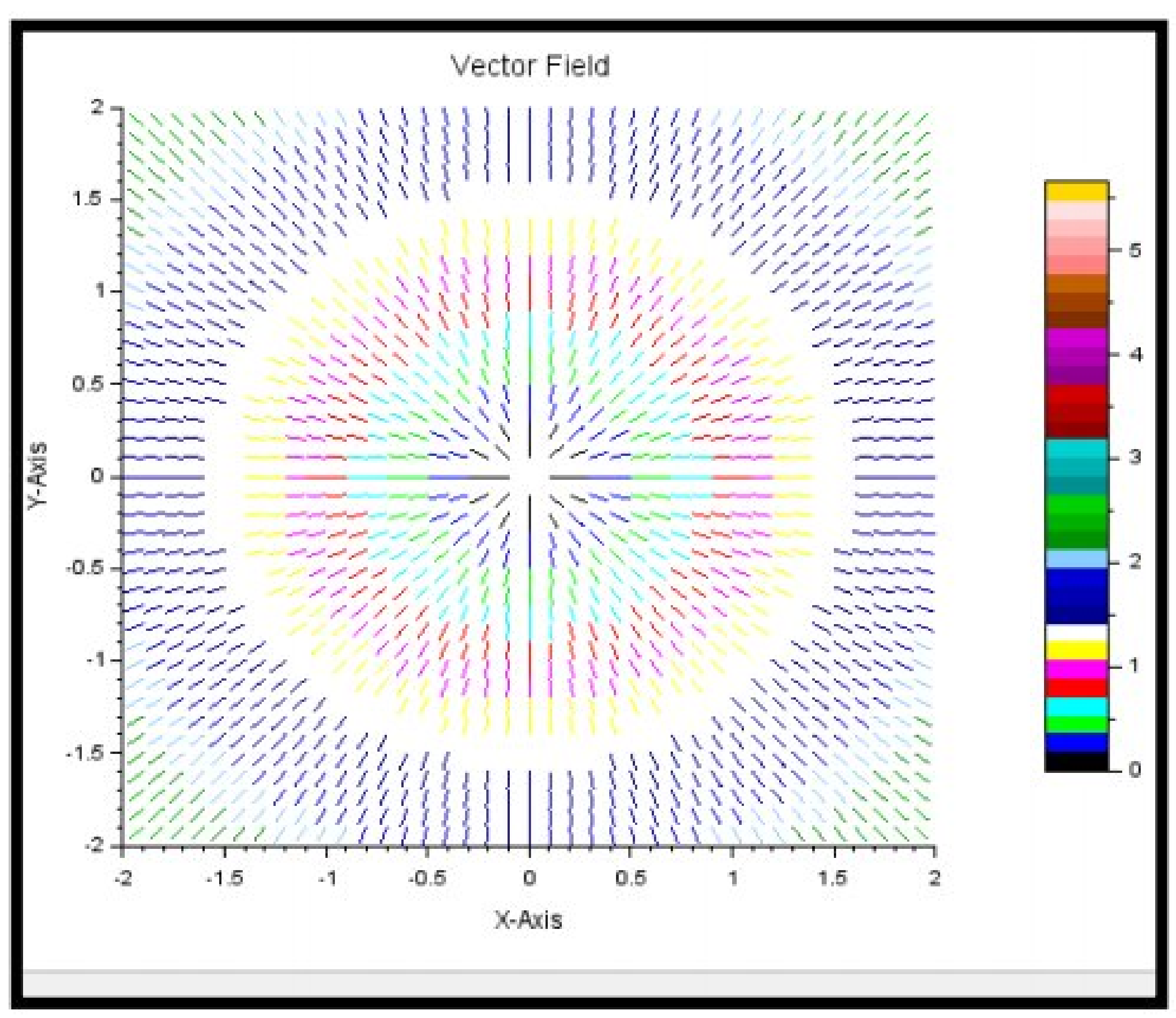
```
clc; clear; clf;

function z=scalarfield(x, y)
   z=x.*exp(-x.^2-y.^2)
endfunction
x=linspace(-5,5,100)
y=linspace(-5,5,100)
[X,Y]=meshgrid(x,y)
z=scalarfield(X,Y)
surf(x,y,z)
xtitle('Scalar Field','X-Axis','Y-Axis')
colorbar
```



3) Plotting of vector field f(x,y)= (x,y)

```
clc; clear; clf;
function [Zx, Zy]=vfield(x, y)
   Zx=x
   Zy=y
endfunction
x=-4:.1:4
y=-4:.1:4
[X,Y]=ndgrid(x,y)
[Zx,Zy]=vfield(X,Y)
champ(x,y,Zx,Zy,0.2,rect=[-2,-2,2,2])
gce.colored="on"
xtitle('Vector Field','X-Axis','Y-Axis')
colorbar
```



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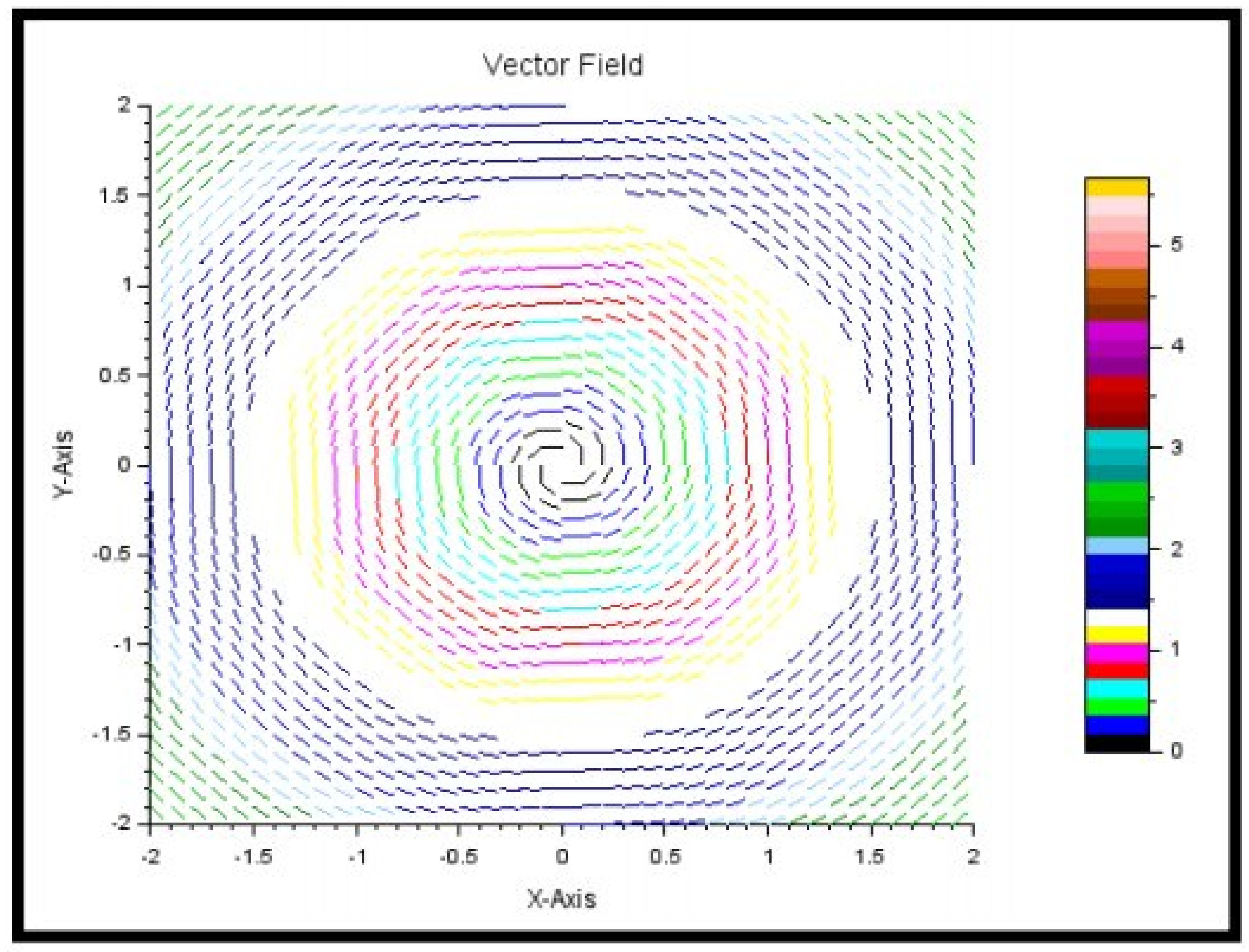
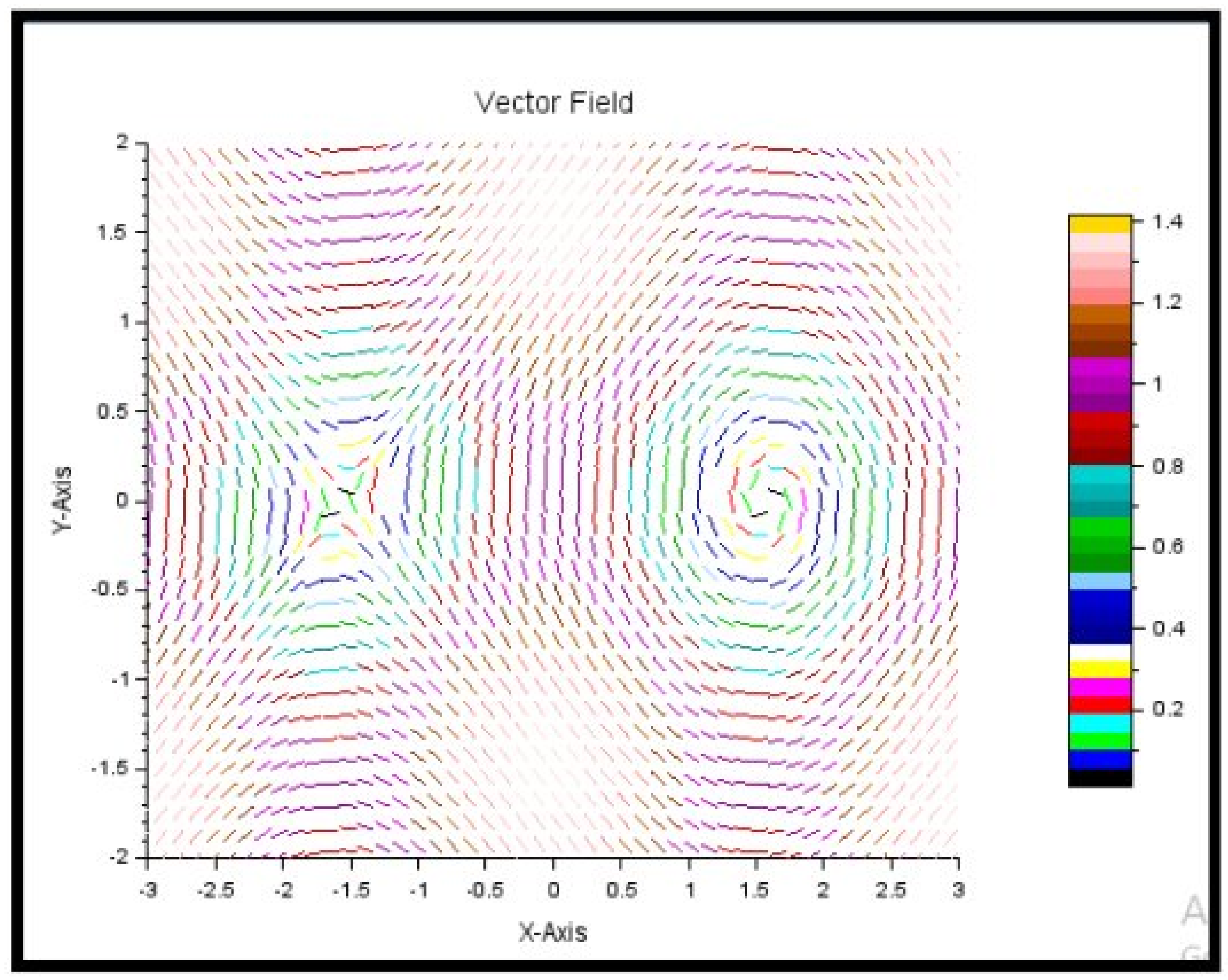
4) Plotting of vector field f(x,y)= (-y,x)




```
clc; clear; clf;
function [Zx, Zy]=vfield(x, y)
   Zx=-y
   Zy=x
endfunction
x=-4:.1:4
y=-4:.1:4
[X,Y]=ndgrid(x,y)
[Zx,Zy]=vfield(X,Y)
champ(x,y,Zx,Zy,0.2,rect=[-2,-2,2,2])
gce.colored="on"
xtitle('Vector Field','X-Axis','Y-Axis')
colorbar
```

5) Plotting of vector field f(x,y)= (Sin y,Cos x)




```
clc; clear; clf;
function [Zx, Zy]=vfield(x, y)
   Zx=sin(y)
   Zy=cos(x)
endfunction
x=linspace(-1,1,100)*2*%pi
y=linspace(-1,1,100)*2*%pi
[X,Y]=ndgrid(x,y)
[Zx,Zy]=vfield(X,Y)
champ(x,y,Zx,Zy,0.2,rect=[-3,-2,3,2])
gce.colored="on"
xtitle('Vector Field','X-Axis','Y-Axis')
colorbar
```

6) Divergence of vector field f(x,y)=(-y,x)

```
clc; clear; clf;
function [Zx, Zy, Div]=vfield(x, y)
Zx=-y; Zy=x; Div=0*x
endfunction
x=-4:.1:4; y=-4:.1:4; [X,Y]=meshgrid(x,y)
[Zx,Zy,Div]=vfield(X,Y)
surf(x,y,Div)
xtitle('Divergence of Vector field f(x,y)=(y,x)','X-Axis','Y-Axis'); colorbar;
scf();
champ(x,y,Zx,Zy,0.2,rect=[-2,-2,2,2])
gce().colored="on"
xtitle('Vector field f(x,y)=(-y,x)','X-Axis','Y-Axis”);
colorbar
```

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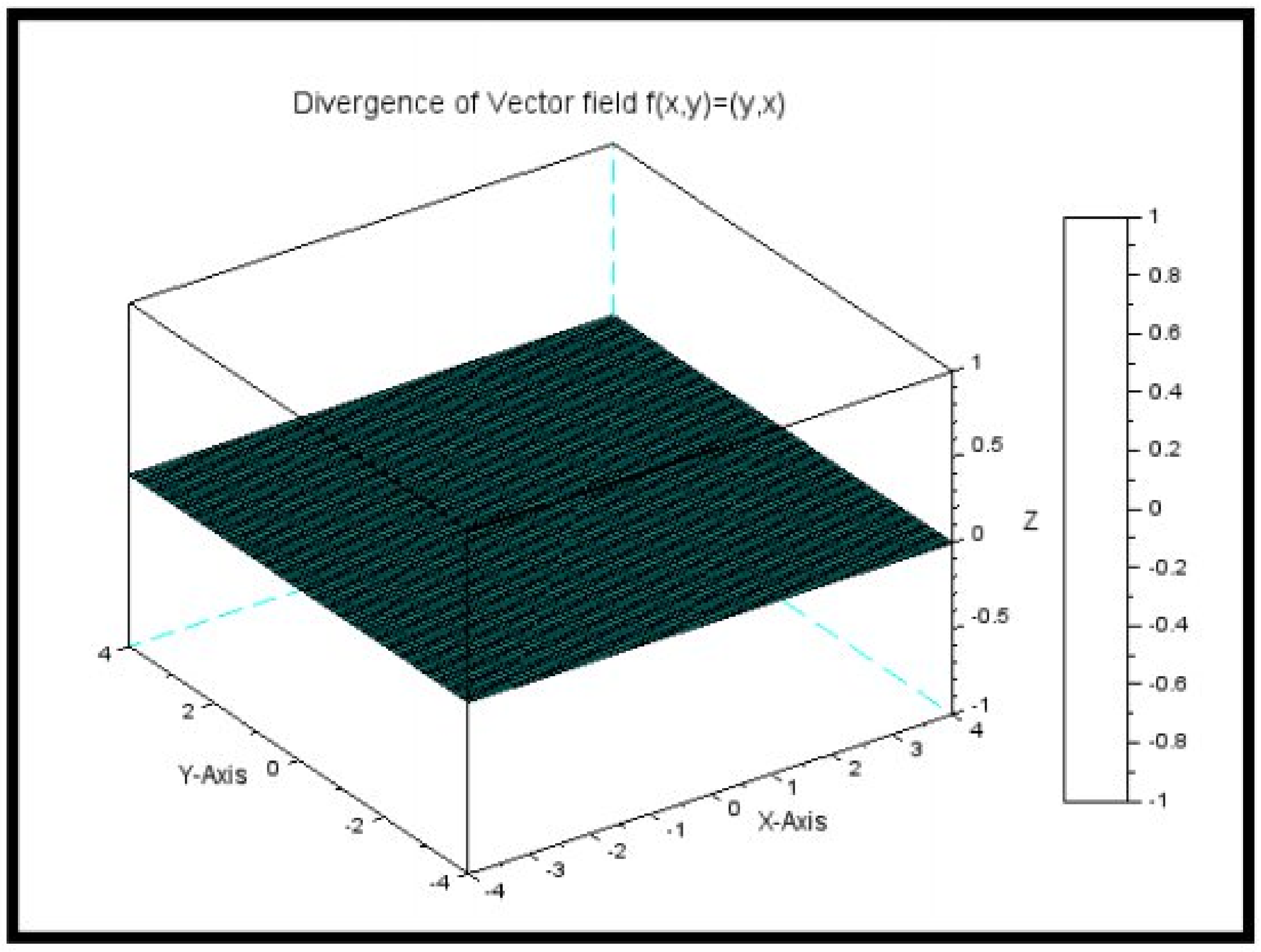
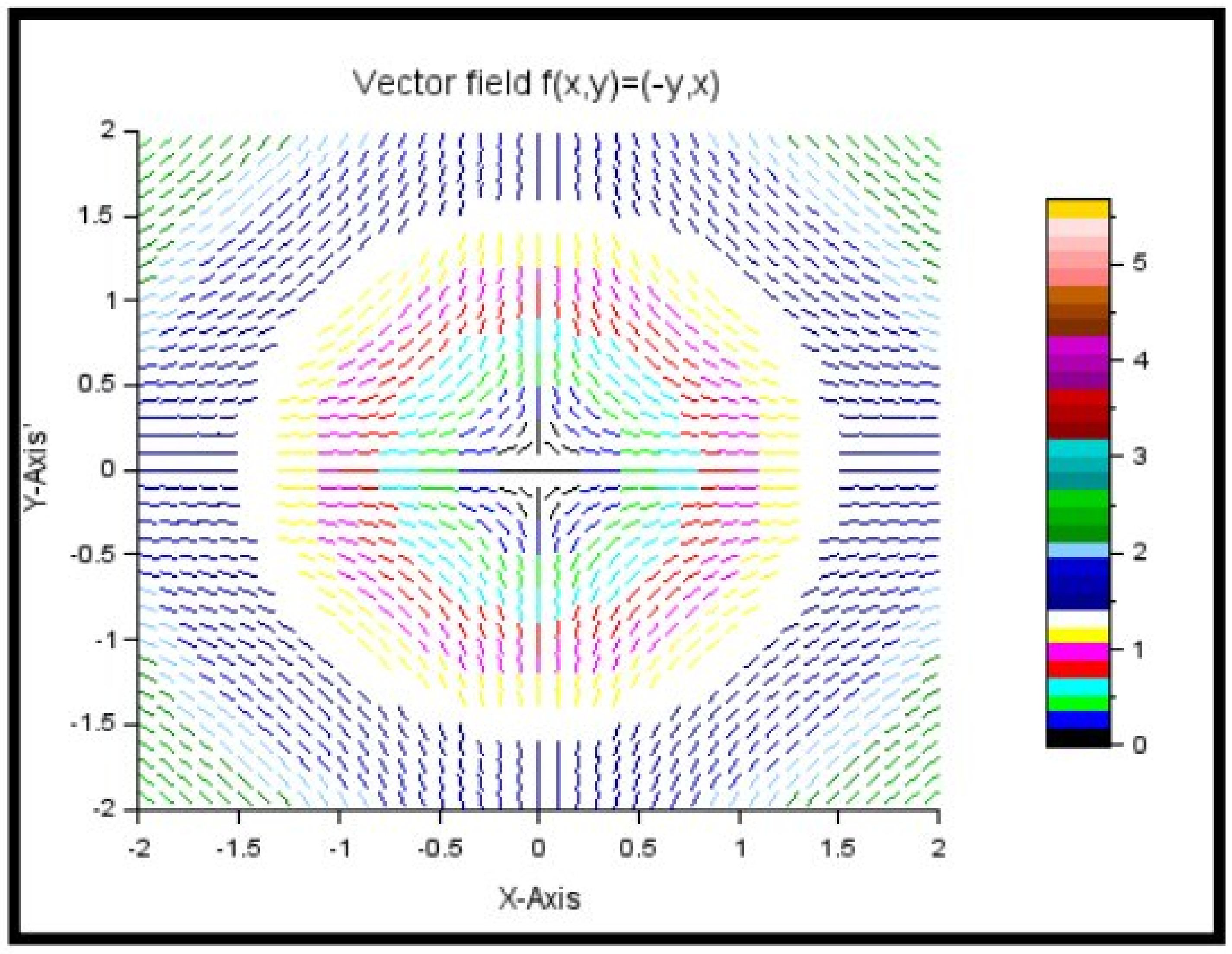
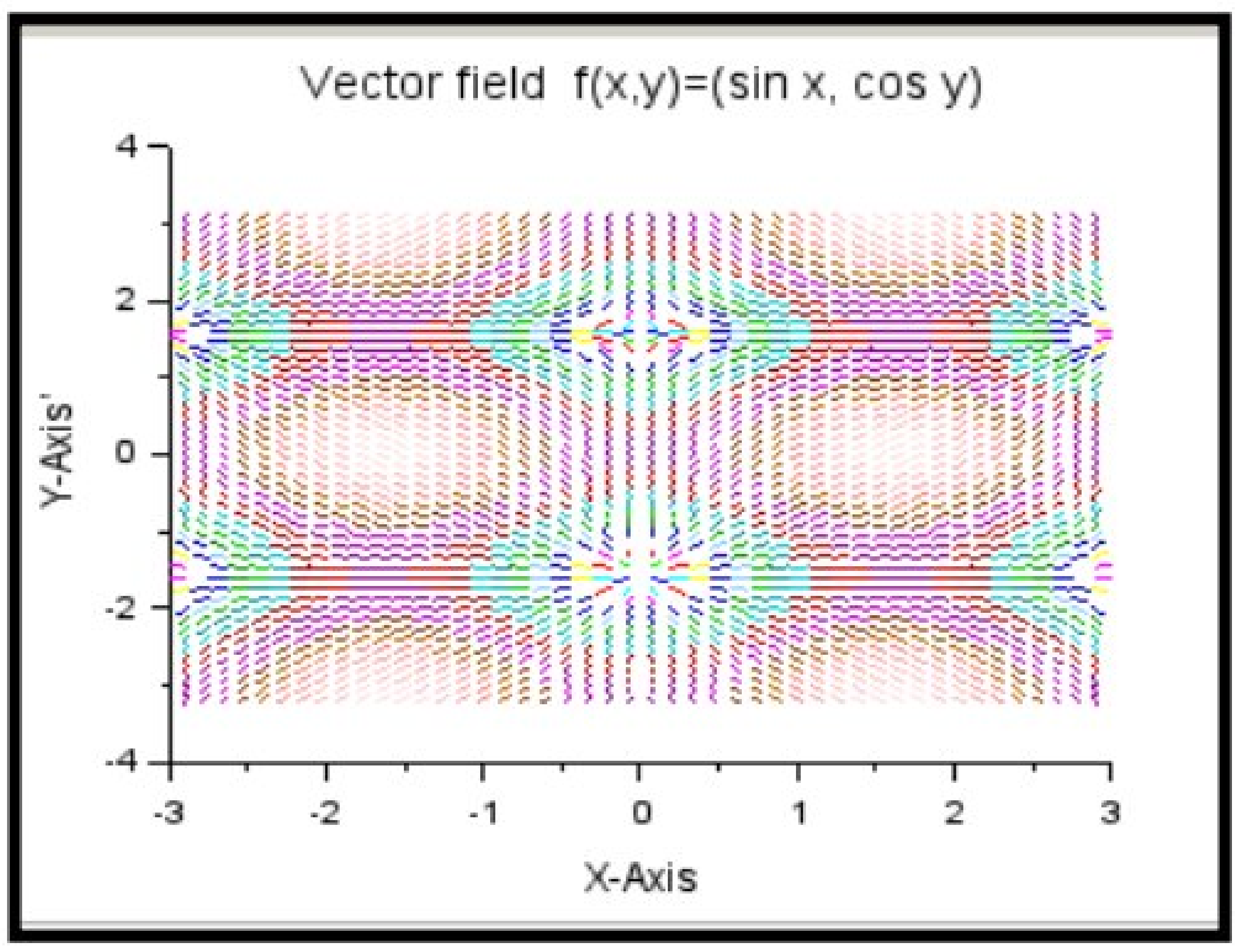
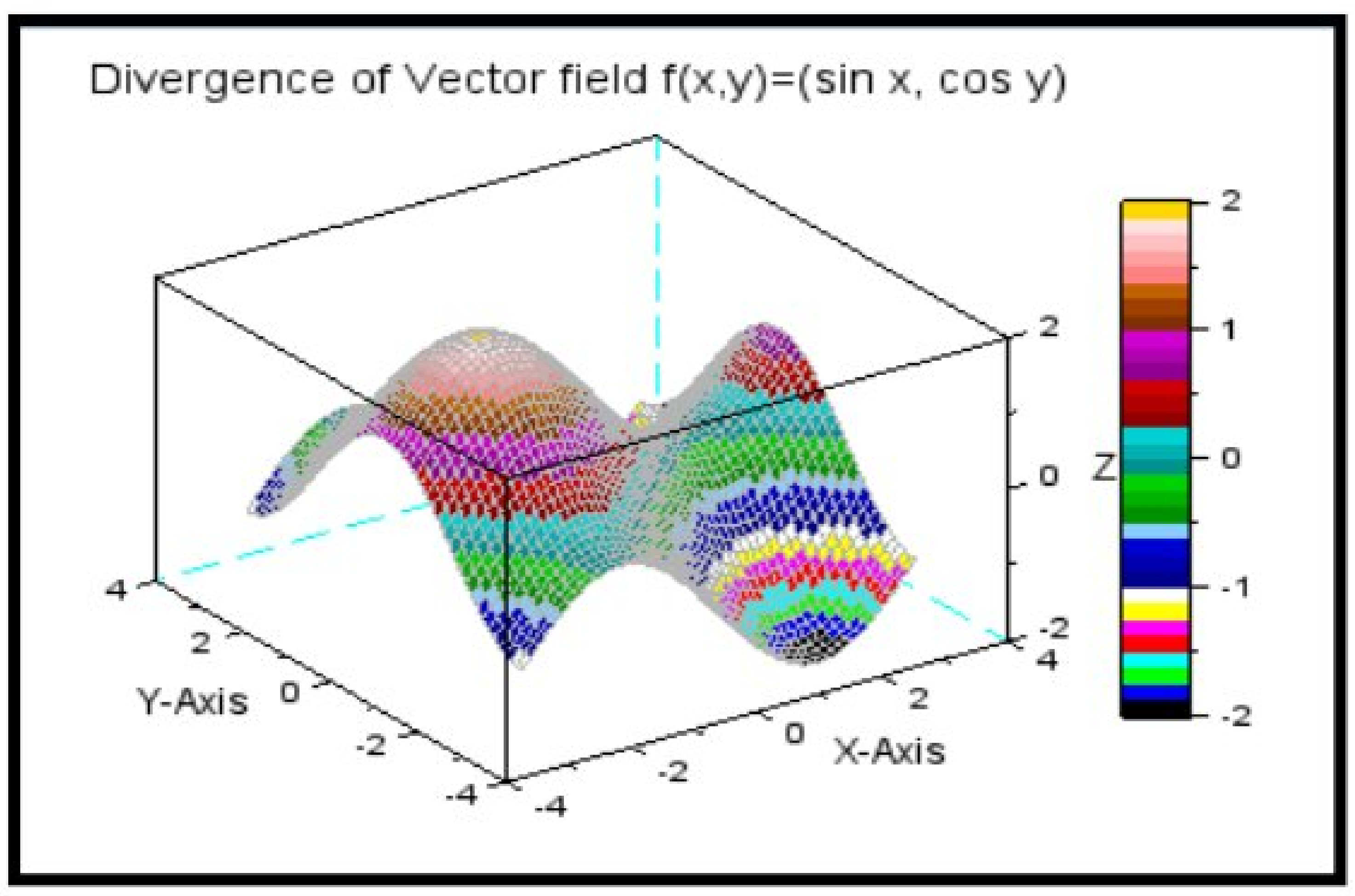




7) Divergence of vector field f(x,y)=(sin x , cos y)

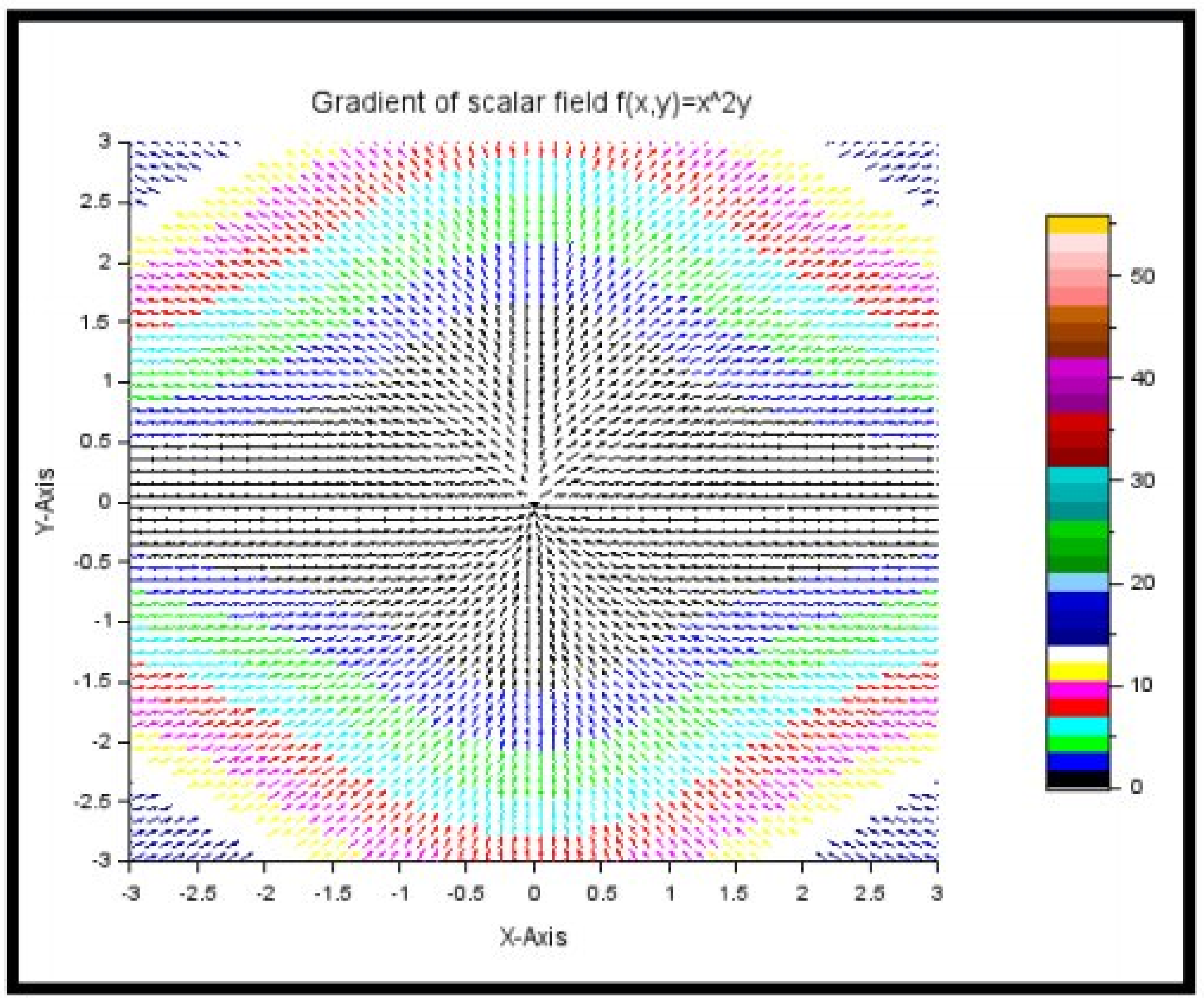
```
clc; clear; clf;
function [Zx, Zy, Div]=vfield(x, y)
Zx=sin (x); Zy=cos (y); Div=cos(x)- sin(y)
endfunction
x=linspace(-1,1,50)*%pi; y=linspace(-1,1,50)*%pi
[X,Y]=ndgrid(x,y)
[Zx,Zy,Div]=vfield(X,Y)
surf(x,y,Div)
xtitle('Divergence of Vector field f(x,y)=(sin x, cos y)','X-Axis','Y-Axis'); colorbar; scf;
champ(x,y,Zx,Zy,0.2,rect=[-3,-%pi,2.5,%pi]); gce().colored="on";
 xtitle('Vector field  f(x,y)=(sin x, cos y)','X-Axis','Y-Axis'');
```

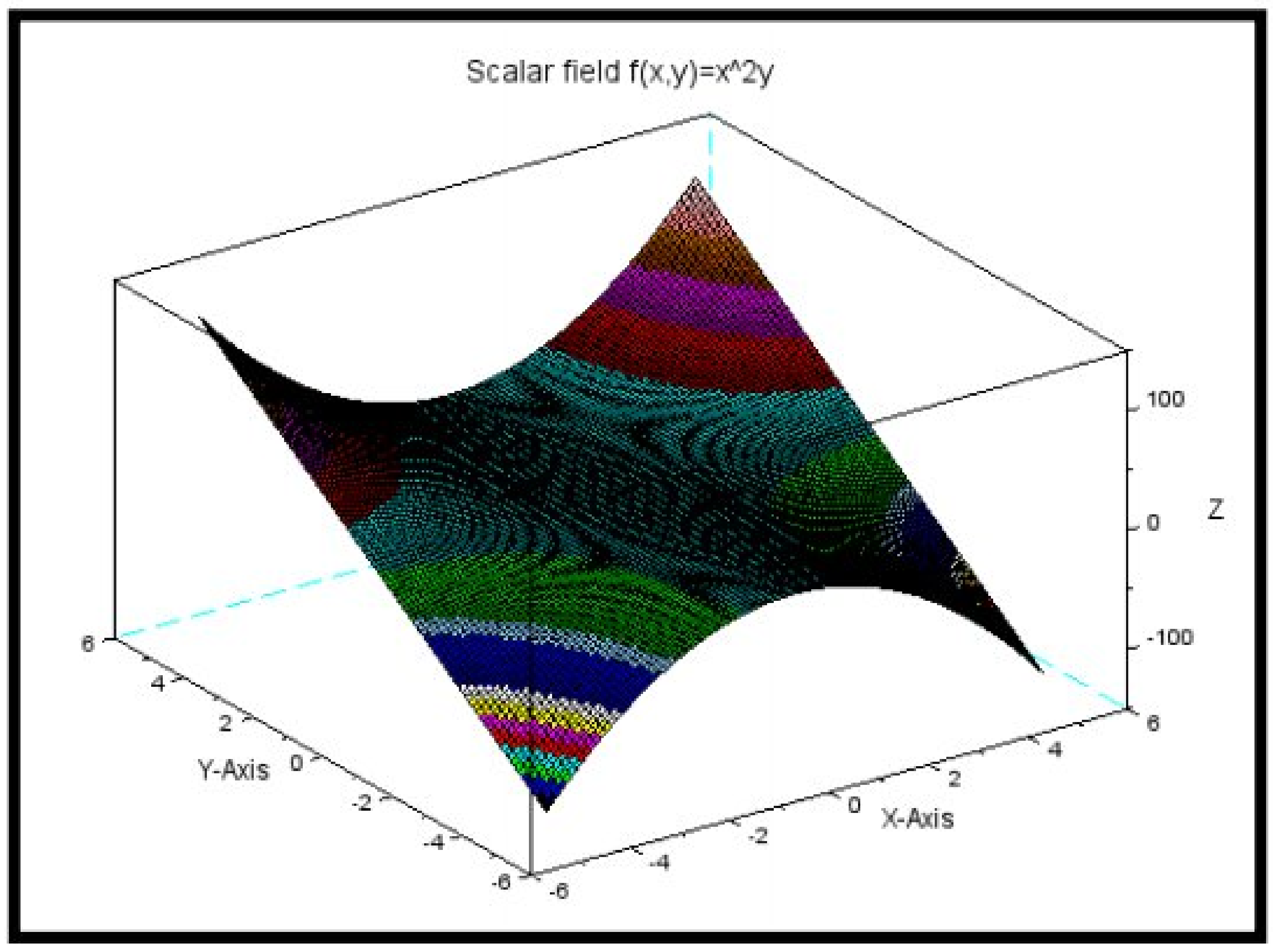




8) The gradient of scalar field $f(x,y)=x^2y$

```
clc; clear; clf;
function [z, DZx, DZy]=scalarfield(x, y)
   z = x.^2 .* y;
   DZx = 2 * x .* y;
   DZy = x.^2;
endfunction
x = linspace(-5, 5, 100);
y = linspace(-5, 5, 100);
[X, Y] = meshgrid(x, y);
[z, DZx, DZy] = scalarfield(X, Y);
surf(x, y, z);
xtitle('Scalar field f(x,y)=x^2y', 'X-Axis', 'Y-Axis');  scf();
champ(x, y, DZx, DZy, 0.5, rect=[-3, -3, 3, 3]);
gce().colored = "on";
xtitle('Gradient of scalar field f(x,y)=x^2y', 'X-Axis', 'Y-Axis');
colorbar
```





Experiment :- 3 Linear dependence and Independence

Exercises:

Determine LI of the following vectors:

1) (0,1), (1,0)

```
clc
clear
v1=[0,1]
v2=[1,0]
n=input('Enter the number of vector: ')
A=[v1;v2]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 2

  "L.I."

-->
```

2) (2,4), (1,2)

```
clc
clear
v1=[2,4]
v2=[1,2]
n=input('Enter the number of vector: ')
A=[v1;v2]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 1

  "L.I."

-->
```

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3) (1,1), (1,3), (2,5)

```
clc
clear
v1=[1,1]
v2=[1,3]
v3=[2,5]
n=input('Enter the number of vector: ')
A=[v1;v2;v3]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 2

  "L.I."

-->
```

4) (1,2,3), (1,2,4)

```
clc
clear
v1=[1,2,3]
v2=[1,2,4]
n=input('Enter the number of vector: ')
A=[v1;v2]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 2

  "L.I."

-->
```

5) (1,1,0), (1,0,1), (0,1,1)

```
clc
clear
v1=[1,1,0]
v2=[1,0,1]
v3=[0,1,1]
n=input('Enter the number of vector: ')
A=[v1;v2;v3]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 3

  "L.I."

-->
```

6) (2,2,1), (1,-1,1), (1,0,1)

```
clc
clear
v1=[2,2,1]
v2=[1,-1,1]
v3=[1,0,1]
n=input('Enter the number of vector: ')
A=[v1;v2;v3]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 3

  "L.I."

-->
```

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7)(1,2,3,1), (2,1,-1,1), (4,5,5,3), (5,4,1,3)

```
clc
clear
v1=[1,2,3,1]
v2=[2,1,-1,1]
v3=[4,5,5,3]
v4=[5,4,1,3]
n=input('Enter the number of vector: ')
A=[v1;v2;v3;v4]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 2

  "L.I."

-->
```

8) (1,2,3), (1,2,4), (0, 0, 0)

```
clc
clear
v1=[1,2,3]
v2=[1,2,4]
v3=[0,0,0]
n=input('Enter the number of vector: ')
A=[v1;v2;v3]
if rank (A)== n then
    disp('L.I.')
else
    disp('L.D.')
end
```

```
Enter the number of vector: 2

  "L.I."

-->
```

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Experiment :- 4 Matrix representation of a linear Transformation

To find Matrix representation of any linear transformation T and use it to determine the inverse of T if the inverse exists.

Let T: $\boldsymbol{R}3$ to $\boldsymbol{R}3$ be a linear transformation with basis B={(1, 1,1), (1,1,0), (1,0,0)} and B' ={(1, 0,1), (-1,2,1), (2,1,1)} respectively and defined by T(a,b,c)= (3a+b, a+b, a-b).

(i) Find matrix [T;B,B']
(ii) Determine, if T is invertible

```
// Define basis vectors in B
b1 = [1; 1; 1];
b2 = [1; 1; 0];
b3 = [1; 0; 0];
// Define basis vectors in B'
bp1 = [1; 0; 1];
bp2 = [-1; 2; 1];
bp3 = [2; 1; 1];
// Define the linear transformation function
function [y] = T(x)
  y = [3*x(1) + x(2); x(1) + x(2); x(1) - x(2)];
endfunction
// Apply T to each basis vector in B
T_b1 = T(b1);
T_b2 = T(b2);
T_b3 = T(b3);
// Create the transformed basis in B' (optional, not used directly)
transformed_basis_B = [T_b1 T_b2 T_b3];
// Create the matrix representation of B' (optional, not used directly)
B_prime = [bp1 bp2 bp3];
// Calculate the coordinates of T(v1), T(v2), and T(v3) with respect to B'
C1 = inv(B_prime) * T(b1);
C2 = inv(B_prime) * T(b2);
C3 = inv(B_prime) * T(b3);
// Combine the coordinates into a single matrix
C = [C1 C2 C3];
// Display the coordinates of T(v1), T(v2), and T(v3) with respect to B'
disp(C);// Check for invertibility (assuming T_BBp is square)

// Check for invertibility
det_C = det(C);
if (det_C~=0)
  disp("T is invertible.");
else
  disp("T is not invertible.");
end
```

```
-2.5   -2.5   -0.25
-0.5   -0.5   -0.25
 3.     3.     1.5

"T is invertible."
```

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Find the matrix representation of linear map T given below with respect to the user input basis of domain and codomain.

(a) T(x,y,x) = (x+y,y+z,z+x)

```
clc;
clear;
function T = linear(v)
    T = [v(1) + v(2); v(2) + v(3); v(3) + v(1)];
endfunction
v1 = input("Enter v1 of Basis of domain vector space: ");
v2 = input("Enter v2 of Basis of domain vector space: ");
v3 = input("Enter v3 of Basis of domain vector space: ");

w1 = input("Enter w1 of Basis of co-domain vector space: ");
w2 = input("Enter w2 of Basis of co-domain vector space: ");
w3 = input("Enter w3 of Basis of co-domain vector space: ");
Tv1 = linear(v1);
Tv2 = linear(v2);
Tv3 = linear(v3);

B = [w1, w2, w3]';

c1 = B \ Tv1;
c2 = B \ Tv2;
c3 = B \ Tv3;
C = [c1, c2, c3];

disp("Matrix of Linear map with respect to (A,B) is given by the matrix:");
disp(C);
```

```
Enter v1 of Basis of domain vector space: [1;0;0]

Enter v2 of Basis of domain vector space: [0;1;0]

Enter v3 of Basis of domain vector space: [0;0;1]

Enter w1 of Basis of co-domain vector space: [1;1;0]

Enter w2 of Basis of co-domain vector space: [1;0;1]

Enter w3 of Basis of co-domain vector space: [0;1;1]


  "Matrix of Linear map with respect to (A,B) is given by the matrix:"

   0.   1.   0.
   1.   0.   0.
   0.   0.   1.
```

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(b) T(x,y,z) = (x-y,y-z,z-x)

```
clc;
clear;
function T = linear_a(v)
    T = [v(1) - v(2); v(2) - v(3); v(3) - v(1)];
endfunction


v1 = [1; 0; 0];
v2 = [0; 1; 0];
v3 = [0; 0; 1];

w1 = [1; 1; 0];
w2 = [1; 0; 1];
w3 = [0; 1; 1];

Tv1 = linear_a(v1);
Tv2 = linear_a(v2);
Tv3 = linear_a(v3);

B = [w1, w2, w3]';

c1 = B \ Tv1;
c2 = B \ Tv2;
c3 = B \ Tv3;

C = [c1, c2, c3];

disp("Matrix of Linear map (a) with respect to (A,B) is given by the matrix:");
disp(C);
```

```
"Matrix of Linear map (a) with respect to (A,B) is given by the matrix:"

  1.   0.  -1.
  0.  -1.   1.
 -1.   1.   0.
```

(c) (c) T(x,y) = (x+2y,y-2x)

```
clc;
clear;

function T = linear_c(v)
    T = [v(1) + 2*v(2); v(2) - 2*v(1)];
endfunction

v1 = input("Enter v1 of Basis of domain vector space: ");
v2 = input("Enter v2 of Basis of domain vector space: ");


w1 = input("Enter w1 of Basis of co-domain vector space: ");
w2 = input("Enter w2 of Basis of co-domain vector space: ");

Tv1 = linear_c(v1);
Tv2 = linear_c(v2);

B = [w1, w2]';

c1 = B \ Tv1;
c2 = B \ Tv2;
C = [c1, c2];

disp("Matrix of Linear map (c) with respect to (A,B) is given by the matrix:");
disp(C);
```

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```
Enter v1 of Basis of domain vector space: [1;0]

Enter v2 of Basis of domain vector space: [0;1]

Enter w1 of Basis of co-domain vector space: [1;1]

Enter w2 of Basis of co-domain vector space: [1;-1]


  "Matrix of Linear map (c) with respect to (A,B) is given by the matrix:"

  -0.5   1.5
   1.5   0.5
```

(d) $T(x,y) = (-y,x)$

```
clc;
clear;
function T = linear_d(v)
    T = [-v(2); v(1)];
endfunction
v1 = input("Enter v1 of Basis of domain vector space: ");
v2 = input("Enter v2 of Basis of domain vector space: ");
w1 = input("Enter w1 of Basis of co-domain vector space: ");
w2 = input("Enter w2 of Basis of co-domain vector space: ");
Tv1 = linear_d(v1);
Tv2 = linear_d(v2);
B = [w1, w2]';
c1 = B \ Tv1;
c2 = B \ Tv2;
C = [c1, c2];
disp("Matrix of Linear map (d) with respect to (A,B) is given by the matrix:");
disp(C);
```

```
Enter v1 of Basis of domain vector space: [1;0]

Enter v2 of Basis of domain vector space: [0;1]

Enter w1 of Basis of co-domain vector space: [1;0]

Enter w2 of Basis of co-domain vector space: [0;1]


  "Matrix of Linear map (d) with respect to (A,B) is given by the matrix:"

   0.  -1.
   1.   0.
```

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Experiment :- 5 Gram Schmidt Orthogonalization Process

Find an orthogonal set corresponding to the given sets

(a) B={(1,1),(1,0)}

```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 2

Enter vector: [1,1]

Enter vector: [1,0]


  "Input vectors:"

   1.   1.
   1.   0.

  "Orthogonal vectors:"

   1.   0.5
   1.  -0.5

-->
```

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(b) {(1,2),(1,-1)}

```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 2

Enter vector: [1,2]

Enter vector: [1,-1]


  "Input vectors:"

   1.   1.
   2.  -1.

  "Orthogonal vectors:"

   1.   1.2
   2.  -0.6
```

(c) {(1,1,1),(1,0,1)}

```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 2

Enter vector: [1,1,1]

Enter vector: [1,0,1]


  "Input vectors:"

   1.   1.
   1.   0.
   1.   1.

  "Orthogonal vectors:"

   1.   0.3333333
   1.  -0.6666667
   1.   0.3333333
```

(d) {(1,1,2),(1,0,1),(1,3,2)}

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```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 3

Enter vector: [1 1 2]

Enter vector: [1 0 1]

Enter vector: [1 3 2]


  "Input vectors:"

   1.   1.   1.
   1.   0.   3.
   2.   1.   2.

  "Orthogonal vectors:"

   1.   0.5   0.6666667
   1.  -0.5   0.6666667
   2.   0.   -0.6666667
```

(e) {(1,2,3),(2,0,3),(1,4,2)}

```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 3

Enter vector: [1 2 3]

Enter vector: [2 0 3]

Enter vector: [1 4 2]


  "Input vectors:"

   1.   2.   1.
   2.   0.   4.
   3.   3.   2.

  "Orthogonal vectors:"

   1.   1.2142857   0.9836066
   2.  -1.5714286   0.4918033
   3.   0.6428571  -0.6557377
```

(f) {(1,2,3,4),(2,3,4,5),(3,4,5,6)}

```
clc;
clear;
n = input("Enter number of vectors: ");
for i = 1:n
    v(:,i) = input("Enter vector: ");
end

disp("Input vectors:");
disp(v);

w(:,1) = v(:,1);

for i = 2:n
    sum = 0;
    for j = 1:i-1
        sum = sum + ((w(:,j)' * v(:,i)) / (w(:,j)' * w(:,j))) * w(:,j);
    end
    w(:,i) = v(:,i) - sum;
end

disp("Orthogonal vectors:");
disp(w);
```

```
Enter number of vectors: 3

Enter vector: [1 2 3 4]

Enter vector: [2 3 4 5]

Enter vector: [3 4 5 6]


  "Input vectors:"

   1.   2.   3.
   2.   3.   4.
   3.   4.   5.
   4.   5.   6.

  "Orthogonal vectors:"

   1.   0.6666667  -2.220D-15
   2.   0.3333333  -1.776D-15
   3.   0.          0.
   4.  -0.3333333   0.
```

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