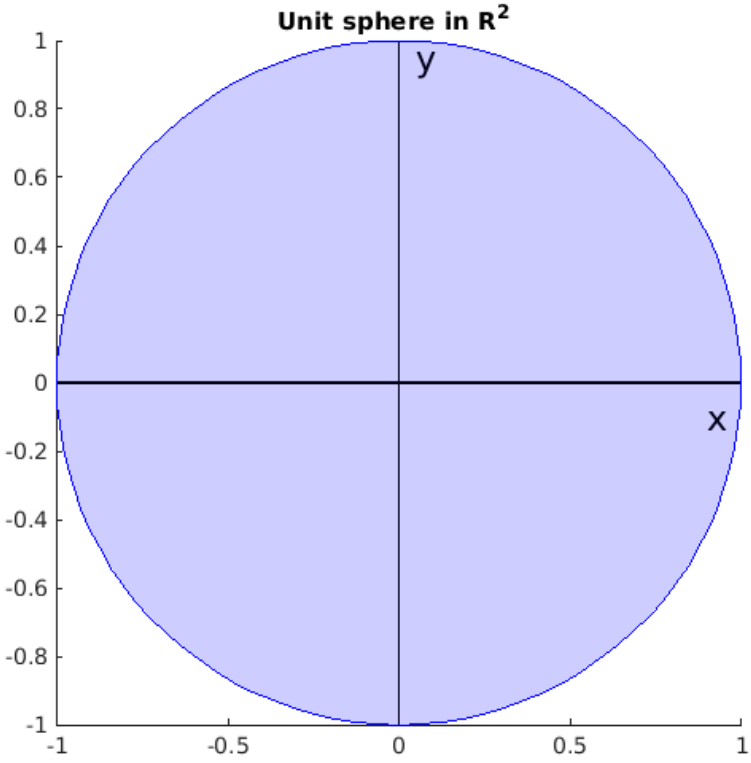
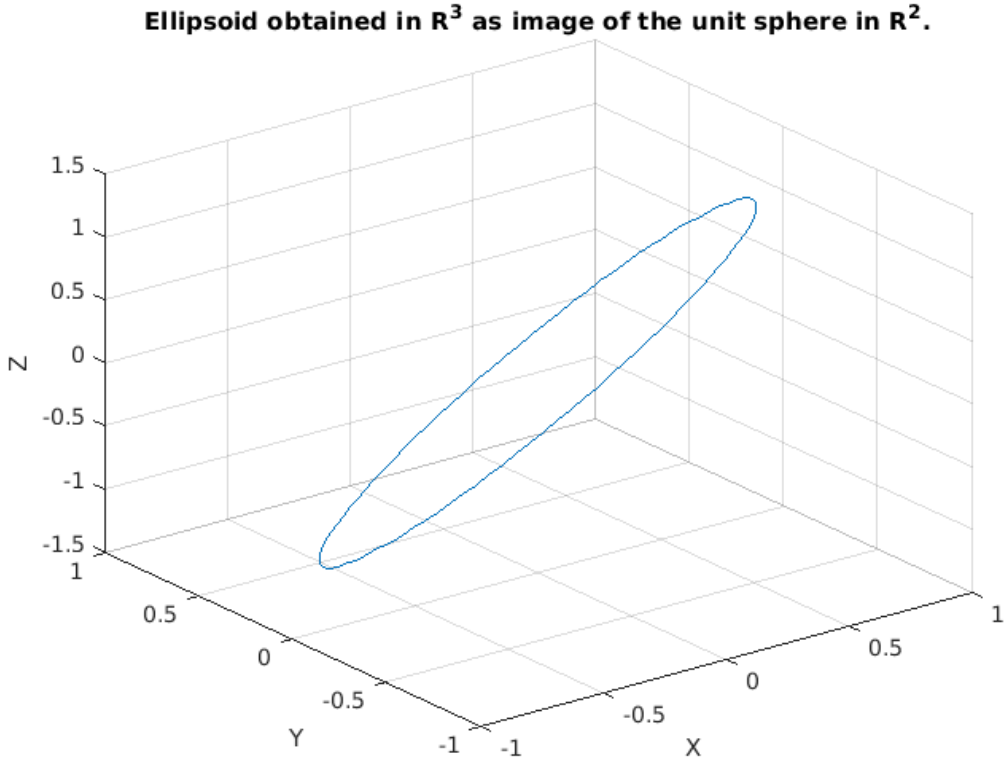
Q9 -- PULKIT SINGHVI -- 17EE10035

(a)

```
A=[(-1/(2^(1/2))) 0; 0 (-1/(2^(1/2))); -1 1];
N = 100;
k = 0:N;
p = exp(1i*2*pi*k./N);
X=[real(p);imag(p)];
Y = A*X;
figure(13);
drawSphere(eye(2), [0 0], .1);
title('Unit sphere in R^{2} ');
snapnow;
figure(14)
x=Y(1,:)';
y=Y(2,:)';
z=Y(3,:)';
plot3(x, y, z)
xlabel('X')
ylabel('Y')
zlabel('Z')
grid on
title('Ellipsoid obtained in R^{3} as image of the unit sphere in
 R^{2}.')
snapnow;
disp('Condition Number of A:')
disp(cond(A))
```

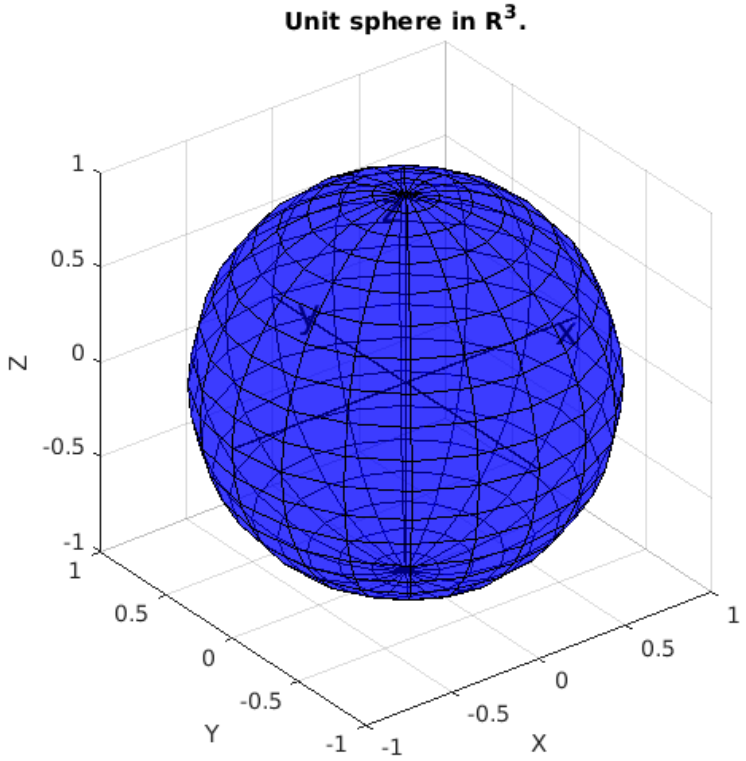

Unit sphere in R2
y
x
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1

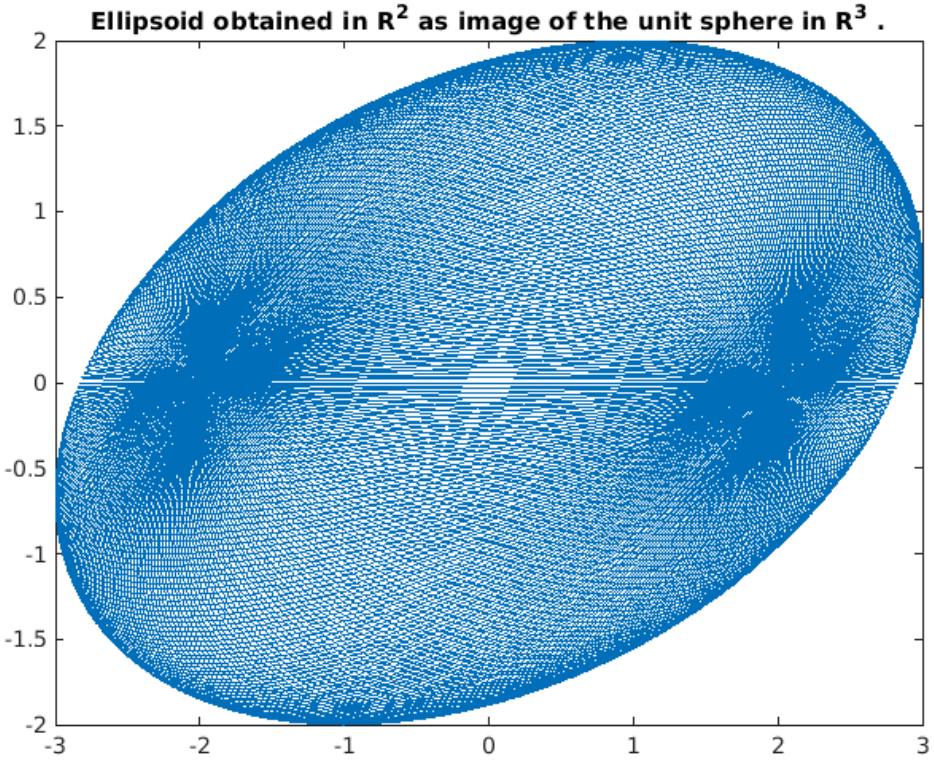

Ellipsoid obtained in R3 as image of the unit sphere in R2.
Z
1.5
1
0.5
0
-0.5
-1
-1.5
Y
1
0.5
0
-0.5
-1
X
-1
-0.5
0
0.5
1

```
Condition Number of A:
    2.2361
```

(b)

```
A=[-2 1 2; 0 2 0];
N = 300;
[x, y, z] = sphere(N);
figure(11);
drawSphere
xlabel('X')
ylabel('Y')
zlabel('Z')
title('Unit sphere in R^{3}.')
axis equal
snapnow;
figure(12)
X = [ x(:)'; y(:)'; z(:)' ];
Y = A*X;
plot(Y(1,:), Y(2,:));
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{3} .')
snapnow;
disp('Condition Number of A:')
disp(cond(A))
```

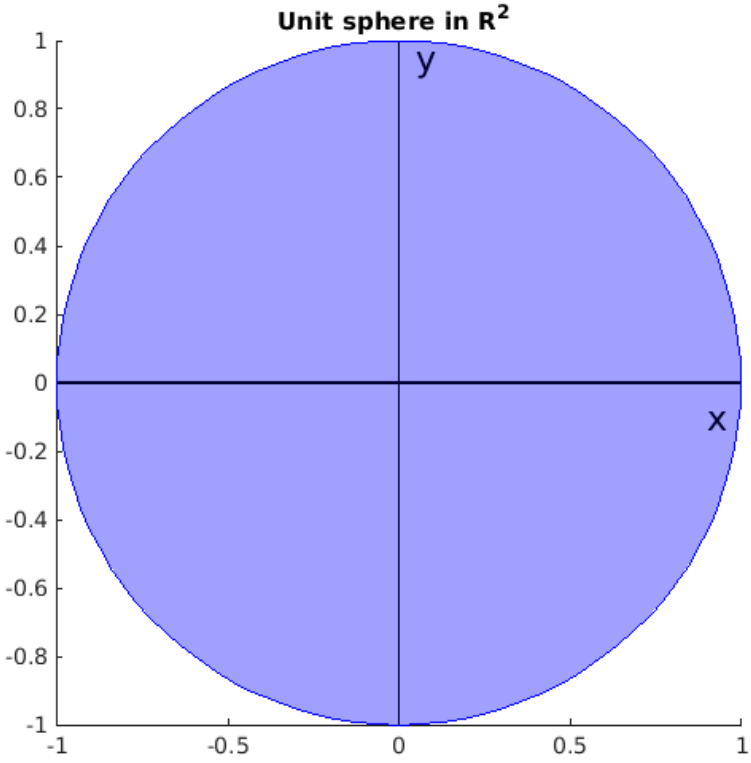


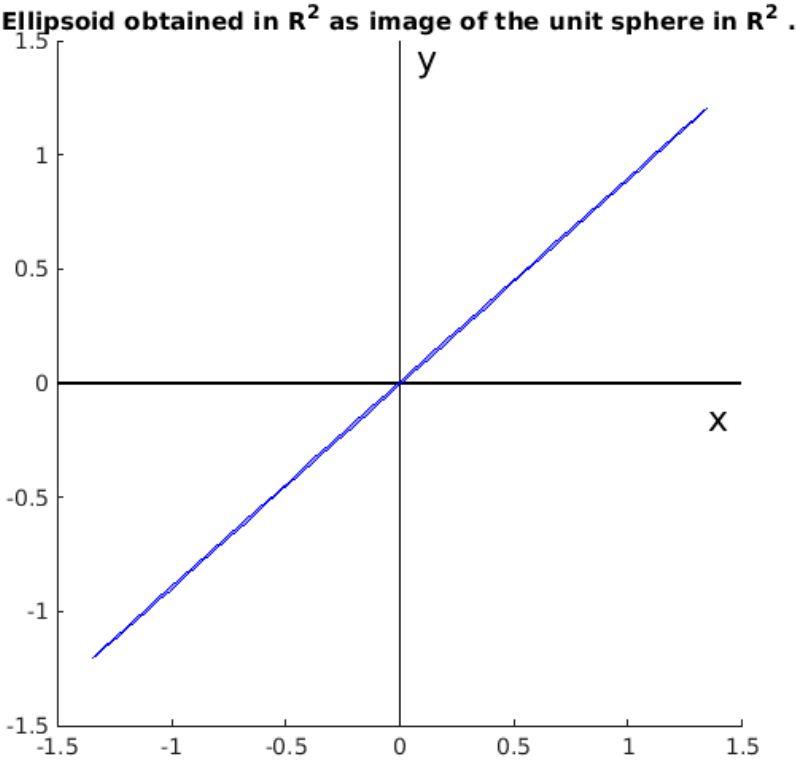


Condition Number of A:
1.7150

(c)

```
A=[1 0.9; 0.9 0.8];
figure(1)
drawSphere(eye(2), [0 0], .2);
title('Unit sphere in R^{2} ');
snapnow;
figure(2)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```

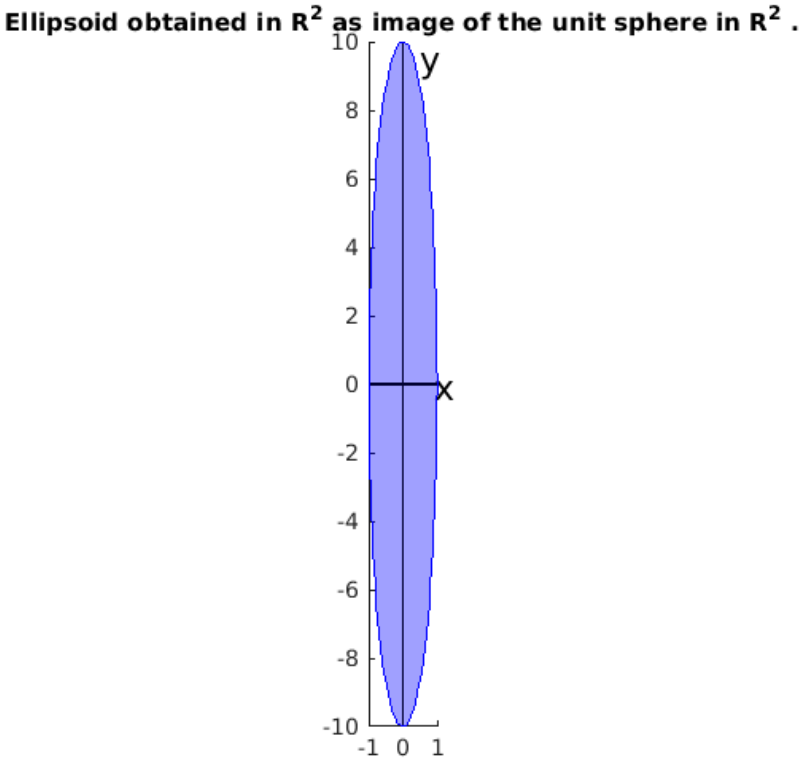

Unit sphere in R2
y
x
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1


Ellipsoid obtained in R2 as image of the unit sphere in R2 .
y
x
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5

```
Determinant of A:
   -0.0100

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
  325.9969
```

(d)

```
A=[1 0; 0 -10];
figure(3)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```



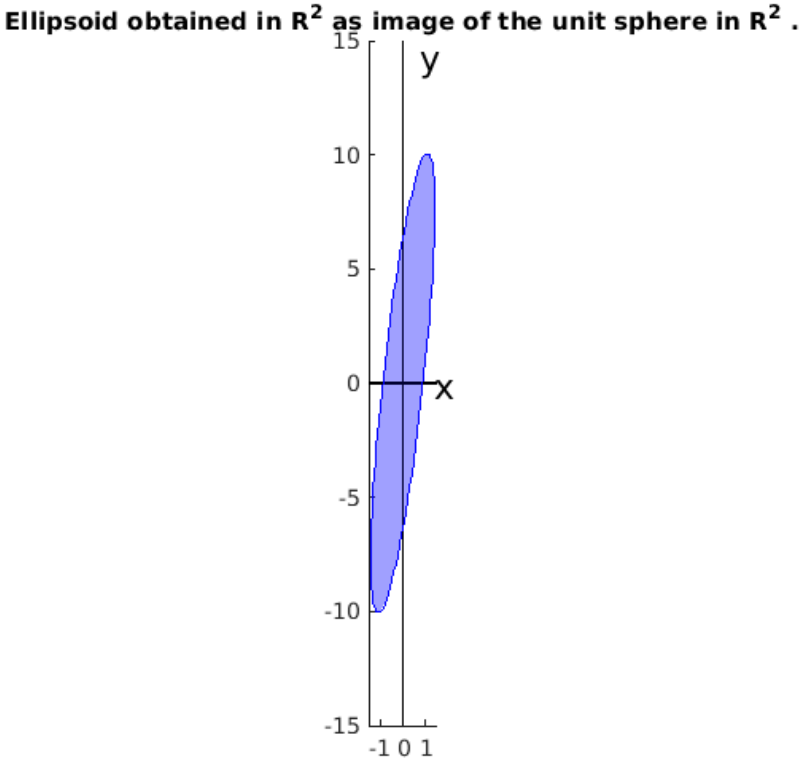

```
Determinant of A:
   -10

Since the determinant of A is not equal to zero, A is invertible.
```

```
Condition Number of A:
    10
```

(e)

(1) : $\epsilon = 10$

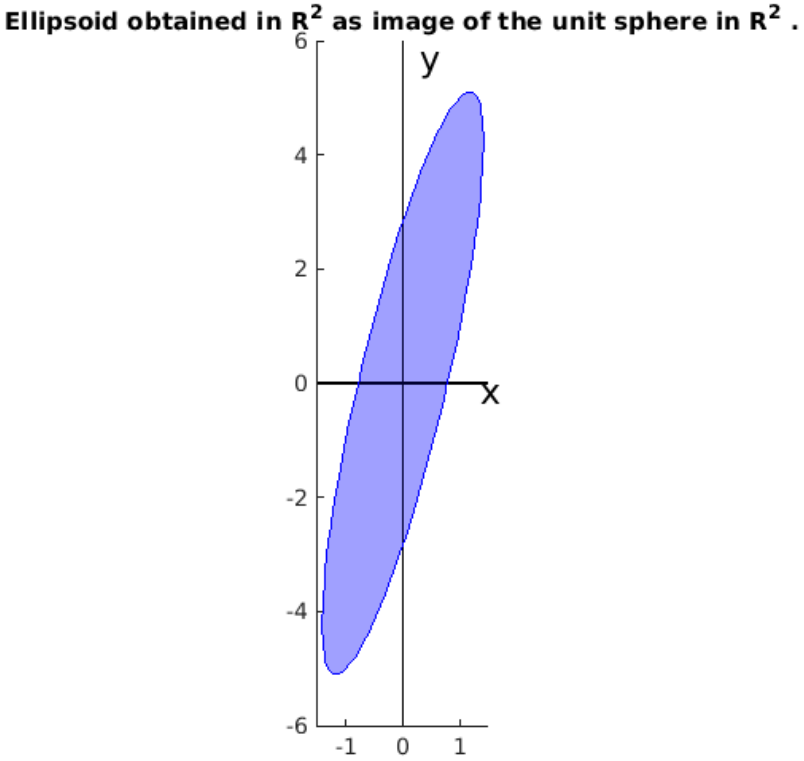
```
A=[1 1; 1 10];
figure(4)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```




```
Determinant of A:
     9

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
   11.3564
```

(2) : $\epsilon = 5$

```
A=[1 1; 1 5];
figure(5)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```

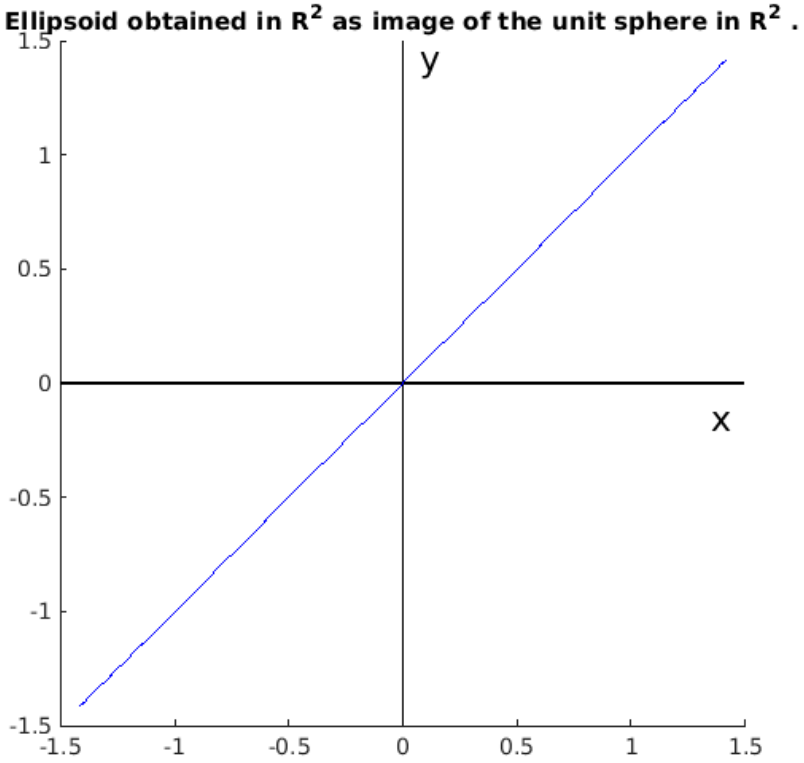



```
Determinant of A:
     4

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
    6.8541
```

(3) : $\epsilon = 1$

```
A=[1 1; 1 1];
```

```
figure(6)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is equal to zero, A is not
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```

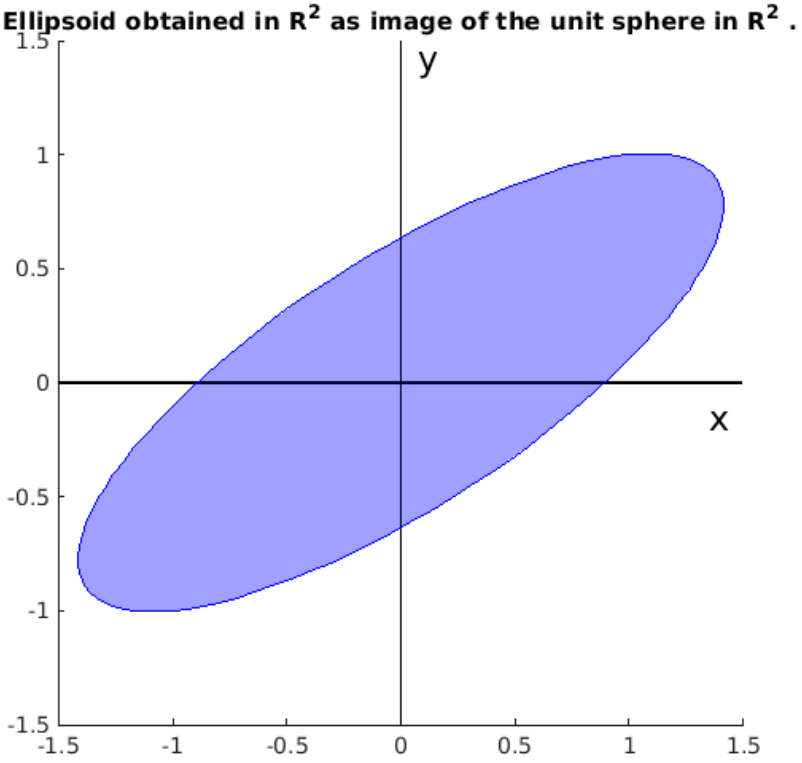



```
Determinant of A:
     0

Since the determinant of A is equal to zero, A is not invertible.
Condition Number of A:
   5.9618e+16
```

(4) : $\epsilon = 10^{-1}$

```
A=[1 1; 1 10^(-1)];
figure(7)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
```

```
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```

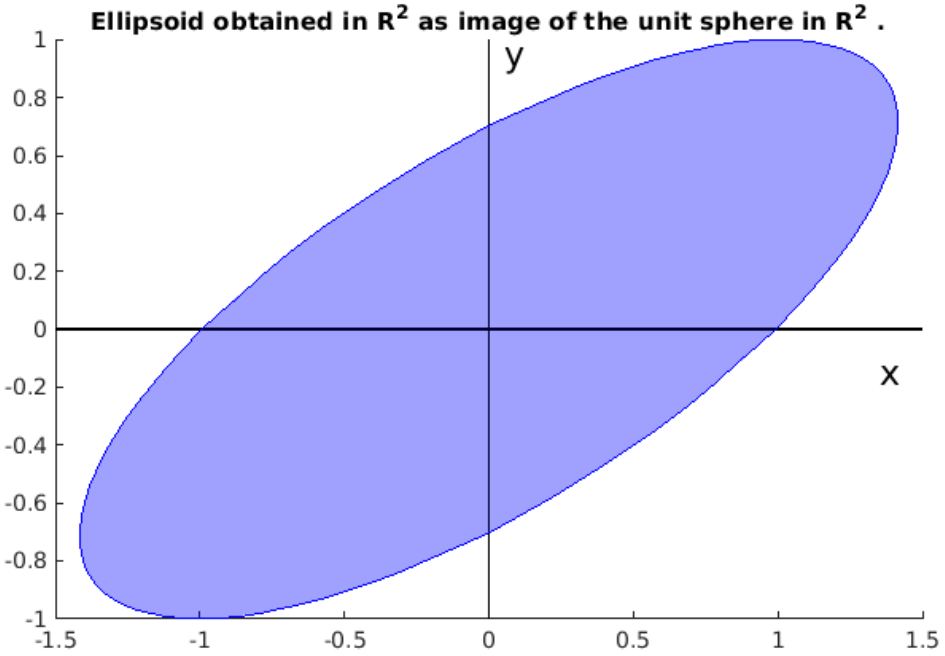



```
Determinant of A:
   -0.9000

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
    3.0125
```

(5) : $\epsilon = 10^{-2}$

```
A=[1 1; 1 10^(-2)];
figure(8)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
```

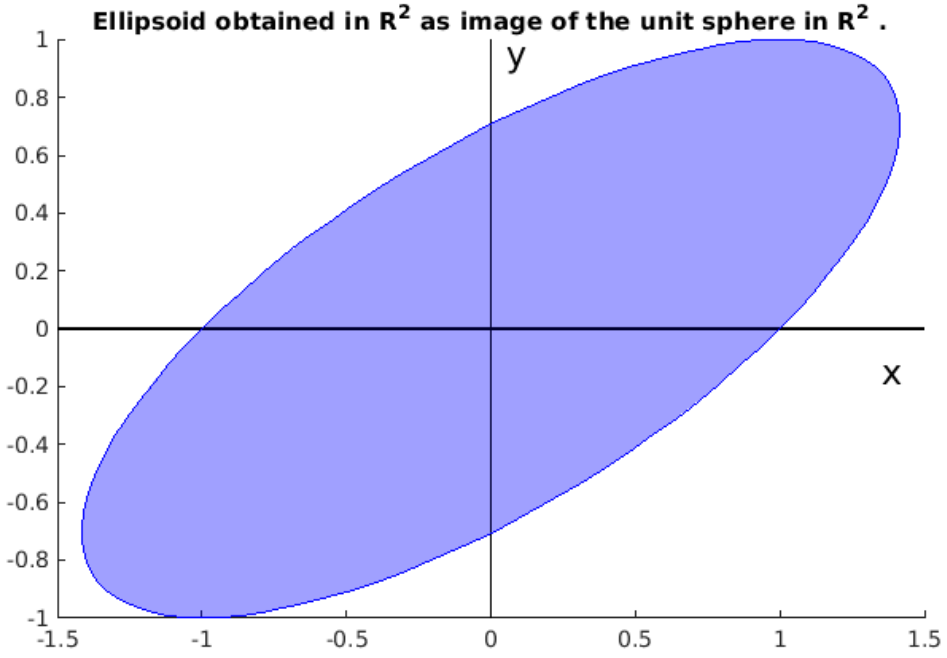
```
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```




```
Determinant of A:
   -0.9900

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
    2.6536
```

(6) : $\epsilon = 10^{-4}$

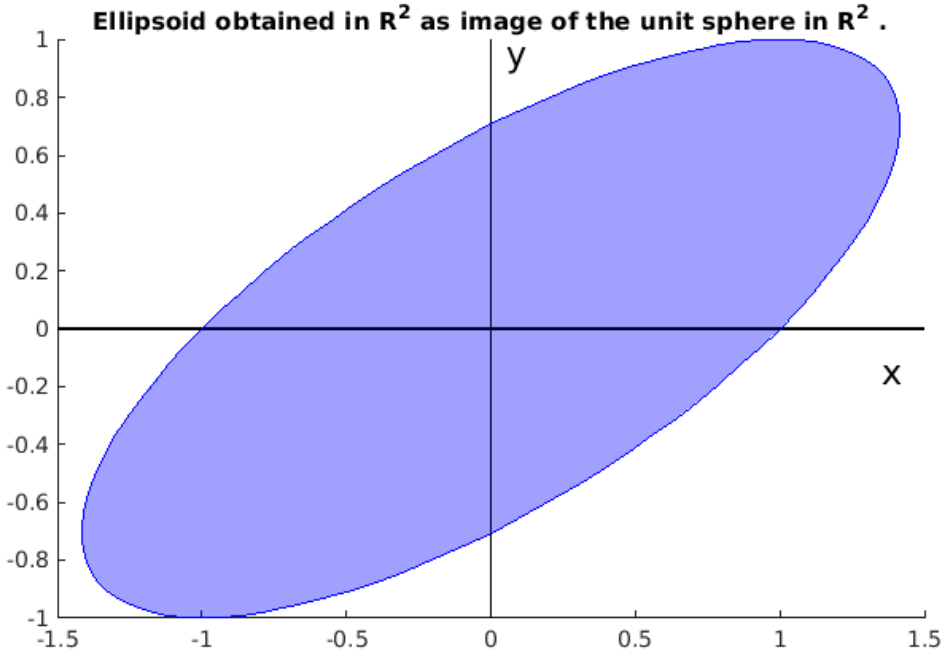
```
A=[1 1; 1 10^(-4)];
figure(9)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```




```
Determinant of A:
   -0.9999

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
    2.6184
```

(7) : $\epsilon = 0$

```
A=[1 1; 1 0];
figure(10)
drawSphere(A, [0 0],.2);
title('Ellipsoid obtained in R^{2} as image of the unit sphere in
 R^{2} .')
snapnow;
disp('Determinant of A:')
disp(det(A))
disp('Since the determinant of A is not equal to zero, A is
 invertible.')
disp('Condition Number of A:')
disp(cond(A))
```




```
Determinant of A:
    -1

Since the determinant of A is not equal to zero, A is invertible.
Condition Number of A:
    2.6180
```

Relationship between determinant and condition number :

As observed in the results of parts (c), (d) and (e), determinant and condition number tend to follow an inverse relationship where larger condition number implies matrix is close to being singular or is infact singular.

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