Report

Question 1:

The inputs were taken in a separate form meaning that each point is separated to 3 inputs (x,y,z) ,
so the user enter each coordinate separately , this is the same in both cases whether geometric or algebraic.
====> to solve geometrically the user simply enters the inputs required from him then specify whether he wants geometric or algebraic by entering 1 or 2 1 for geo. and 2 for alg. and then the program calls :

gettingIntersectionPointGeometriv(p0x, p0y, p0z, p1x, p1y, p1z, radius, centreX, centreY, centreZ);

which is a method used to calculate the intersection point obviously the parameters are the inputs and then inside the method the parameters are passed into the general equation from the slide of the lecture which is equal to :

$$\dot{\mathbf{P}} = \dot{\mathbf{P}}_0 + \left(\mathbf{a} \bullet \mathbf{v} - \sqrt{r^2 - \left(\mathbf{a} \bullet \mathbf{a} - (\mathbf{a} \bullet \mathbf{v})^2\right)}\right) \mathbf{v}$$

but there is a twist which is that we are using the normalized version of this rule and then the method prints the intersection point or points.

=====> as for the algebraic method it is the same the only difference is the user enters 2 for choosing this method and then program calls:

gettingIntersectionPointAlgebric(p0x, p0y, p0z, p1x, p1y, p1z, radius, centreX, centreY, centreZ);

in this method we try to implement the ray-sphere intersection equation and try to solve the roots of "t" to find the intersection point or points

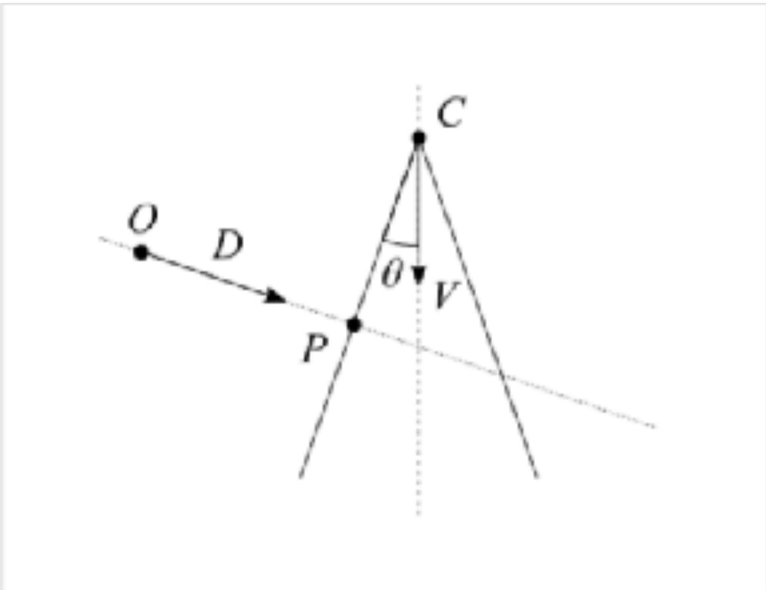
$$\underbrace{\|\mathbf{v}\|^2}_{a} t^2 + \underbrace{\left(2\mathbf{v} \bullet \left[\dot{\mathbf{P}}_0 - \dot{\mathbf{O}}\right]\right)}_{b} t + \underbrace{\left\|\dot{\mathbf{P}}_0 - \dot{\mathbf{O}}\right\|^2 - r^2}_{c} = 0$$

inside the body of the method we calculate the terms "a","b"and"c" and then we check on the so called decider = b^2 - 4 a*c and based on it we calculate our roots and then the intersection points.

Question 2:

First to solve this question we needed to find a useful equation for the ray and cone intersection and thankfully we have found one

=====> so here we have an image of the ray and the cone



Note : here we have the D and the V are both unit vector

O is the p0 of the ray
ceta is the half angle to the axis
C is the vertex of the cone

and for our equation it will be :

$$\begin{cases} a = (\vec{D}\cdot\vec{V})^2 - \cos^2\theta \\ b = 2\Big((\vec{D}\cdot\vec{V})(\vec{CO}\cdot\vec{V}) - \vec{D}\cdot\vec{CO}\cos^2\theta\Big) \\ c = (\vec{CO}\cdot\vec{V})^2 - \vec{CO}\cdot\vec{CO}\cos^2\theta \end{cases}$$

so basically those are our coefficients of a quadratic equation and by replacing them and solving quadratically exactly the same way we did in the algebraic part we will get our intersection points.

Now I am going to provide some examples for each method and their outputs :

Algebraic method example(1):

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
1
Please enter the center of the sphere coordinates( x then y then z ) !!!
-1
0
0
Please enter the radius !!!
3
Please enter P0 coordinates( x then y then z )!!!
2
0
-3
Please enter P1 coordinates( x then y then z )!!! !!!
2
0
7
Please enter '1' for geometric method and '2' for algebric method !!!
2
Roots are real and same.

t1 = t2 =
0.3
possible intersection point:

X =2
Y =0
Z =0
```

The same example(1) but with the geometric method:

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
1
Please enter the center of the sphere coordinates( x then y then z ) !!!
-1
0
0
Please enter the radius !!!
3
Please enter P0 coordinates( x then y then z )!!!
2
0
-3
Please enter P1 coordinates( x then y then z )!!! !!!
2
0
7
Please enter '1' for geometric method and '2' for algebric method !!!
1
1 intersection point

The point:

X =2
Y =0
Z =0
```

Another example(2) of algebraic :

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
1
Please enter the center of the sphere coordinates( x then y then z ) !!!
3
6
2
Please enter the radius !!!
9
Please enter P0 coordinates( x then y then z )!!!
-1
2
3
Please enter P1 coordinates( x then y then z )!!! !!!
5
8
1
Please enter '1' for geometric method and '2' for algebric method !!!
2
Roots are real and different.

t1 =
1
1st possible intersection point:

X =5
Y =8
Z =1
t2 =
0.423077
2nd possible intersection point:

X =1.53846
Y =3.38462
Z =2.15385
```

Same example(2) but with geometric method :

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
1
Please enter the center of the sphere coordinates( x then y then z ) !!!
3
6
2
Please enter the radius !!!
3
Please enter P0 coordinates( x then y then z )!!!
-1
0
3
Please enter P1 coordinates( x then y then z )!!! !!!
5
8
1
Please enter '1' for geometric method and '2' for algebric method !!!
1
2 intersection points

1st point:

X =1.53846
Y =3.38462
Z =2.15385
2nd point:

X =5
Y =8
Z =1
```

Example(1) of solving the ray cone intersection :

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
2
Please enter the center of the cone coordinates( x then y then z ) !!!
0
0
0
Please enter the radius !!!
5
Please enter P0 coordinates( x then y then z )!!!
-10
0
0
Please enter P1 coordinates( x then y then z )!!! !!!
10
0
0
Please enter the height of the cone !!!
10
Roots are real and different.

t1 =
5
1st possible intersection point:

X =-5
Y =0
Z =0
t2 =
15
2nd possible intersection point:

X =5
Y =0
Z =0
```

Example(2) ray cone intersection :

```
Please enter '1' for ray-sphere intersection and '2' for ray-cone
intersection !!!
2
Please enter the center of the cone coordinates( x then y then z ) !!!
0
0
0
Please enter the radius !!!
10
Please enter P0 coordinates( x then y then z )!!!
20
10
0
Please enter P1 coordinates( x then y then z )!!! !!!
-20
10
0
Please enter the height of the cone !!!
40
Roots are real and different.

t1 =
12.5
1st possible intersection point:

X =7.5
Y =10
Z =0
t2 =
27.5
2nd possible intersection point:

X =-7.5
Y =10
Z =0
```