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## Lab 2 Report: Parametric Curves

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CZ2003 – Computer Graphics & Visualization

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Lab Group: SSR2

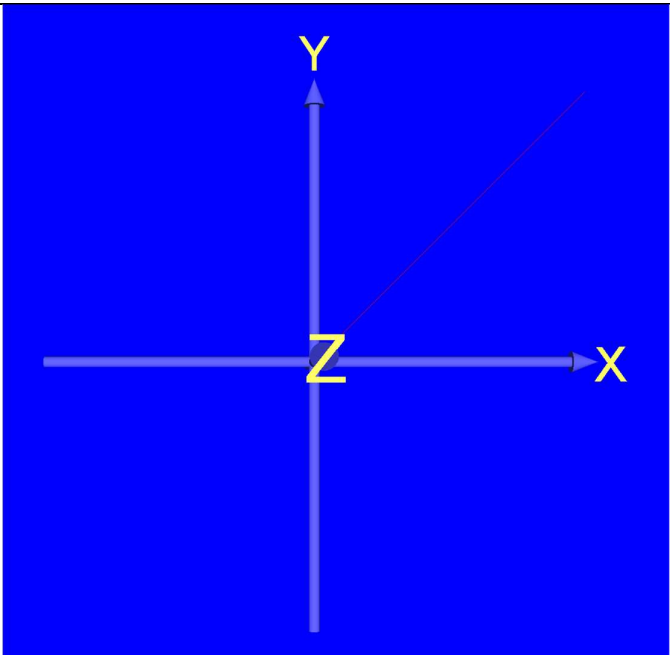
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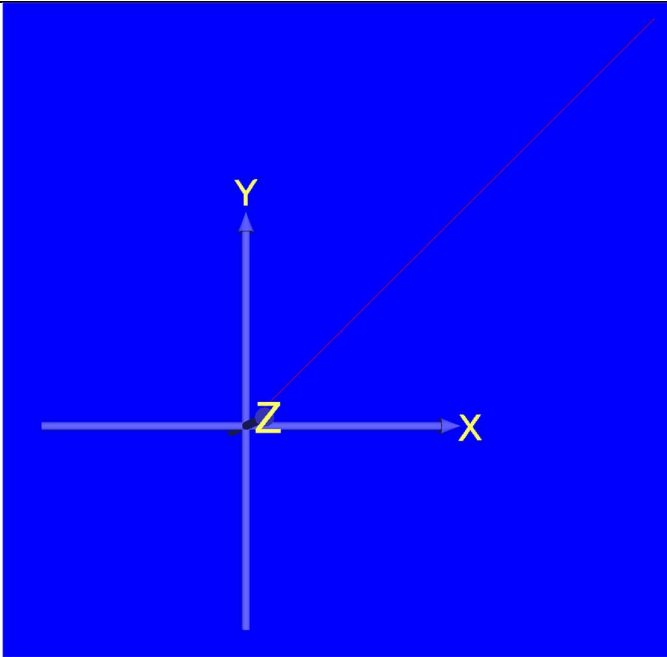
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Lab 2

2.1 Lines/Curves to be Drawn

Changes from previous examples are in bold to show the resultant change when a parameter is adjusted.

Straight Line Segment	Remarks
 <p>line1.wrl</p>	<p>Straight line defined by parametric equations <math>[x=u, y=u, z=0]</math> with domain <math>[0,1]</math>. Sampling resolution is 100.</p>

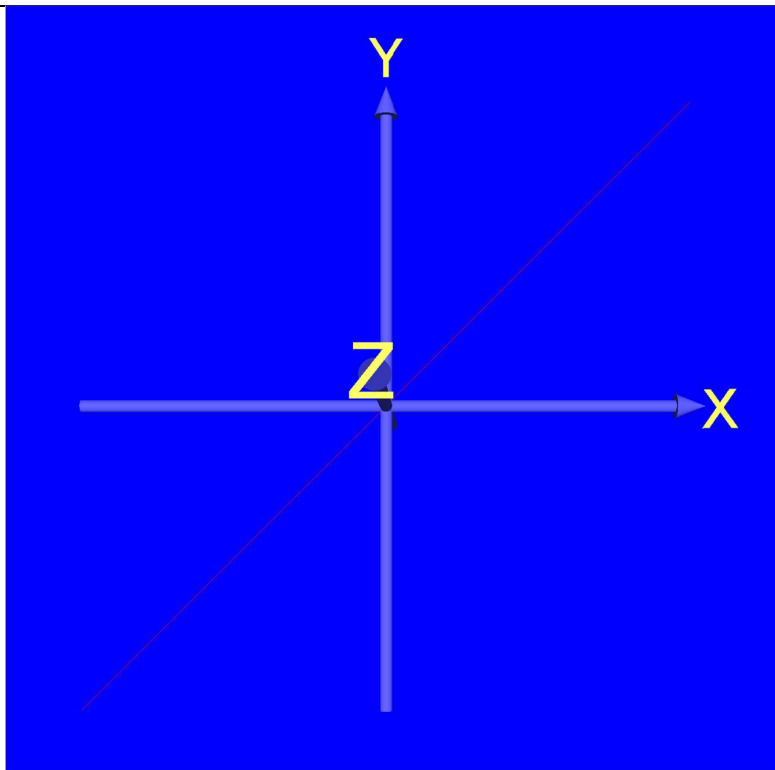


line2.wrl

Straight line defined by parametric equations  $[x=u, y=u, z=0]$  with **domain**  $[0,2]$ .  
Sampling resolution is 100.

**Note:**

The length of the straight line is now twice the original due to the domain change from  $[0,1]$  to  $[0,2]$ .

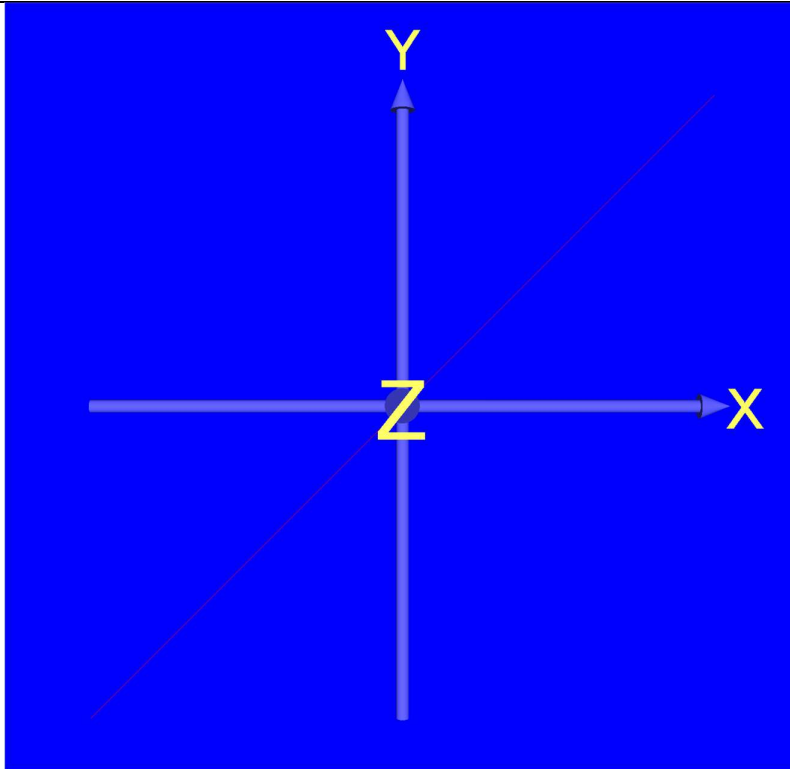


line3.wrl

Straight line defined by parametric equations  $[x=u, y=u, z=0]$  with **domain**  $[-1,1]$ .  
Sampling resolution is 100.

**Note:**

It is also possible to have a negative domain. Since the domain of the straight line extended from  $[0,1]$  to  $[-1,1]$ . The line will extend in the negative x direction by its original length.



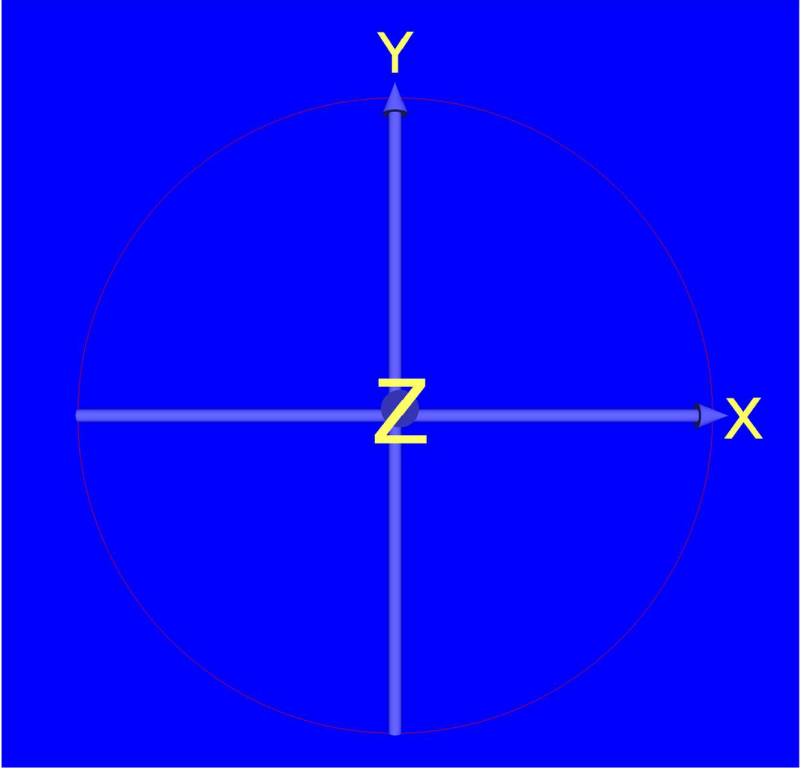
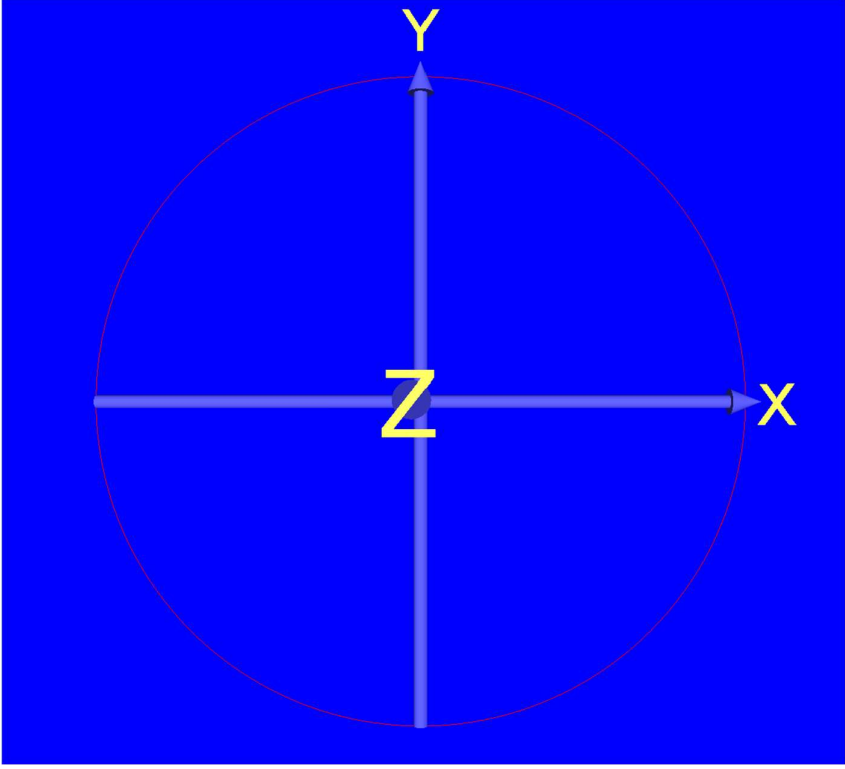
line4.wrl

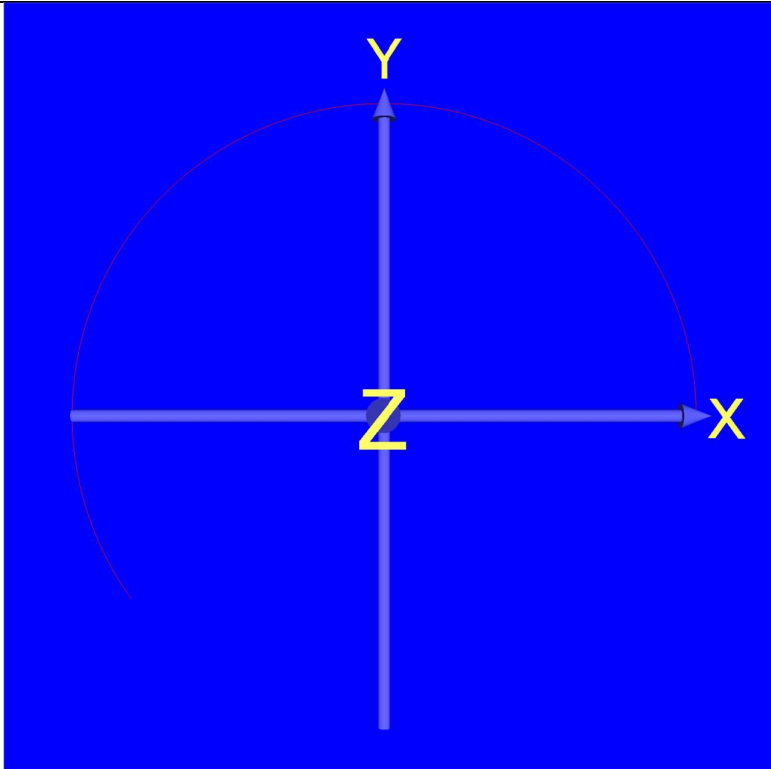
Straight line defined by parametric equations  $[x=u, y=u, z=0]$  with domain  $[-1,1]$ .

**Sampling resolution is 2.**

**Note:**

Although sampling resolution is 2, there is no difference between this line and **line3.wrl**. This is because the lesser number of points sampled across the line does not affect a straight-line segment.

Circles and its arc		Remarks
	circle1.wrl	<p>Straight line defined by parametric equations <math>[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]</math>, with domain <math>[0,1]</math>. Sampling resolution is 5000.</p>
	circle2.wrl	<p>Straight line defined by parametric equations <math>[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]</math>, with <b>domain <math>[0,2]</math></b>. Sampling resolution is 5000.</p> <p><b>Note:</b> There seems to be no change to the circle even though the domain is increased from <math>[0,1]</math> to <math>[0,2]</math>. However, the circle here is rendered twice.</p>

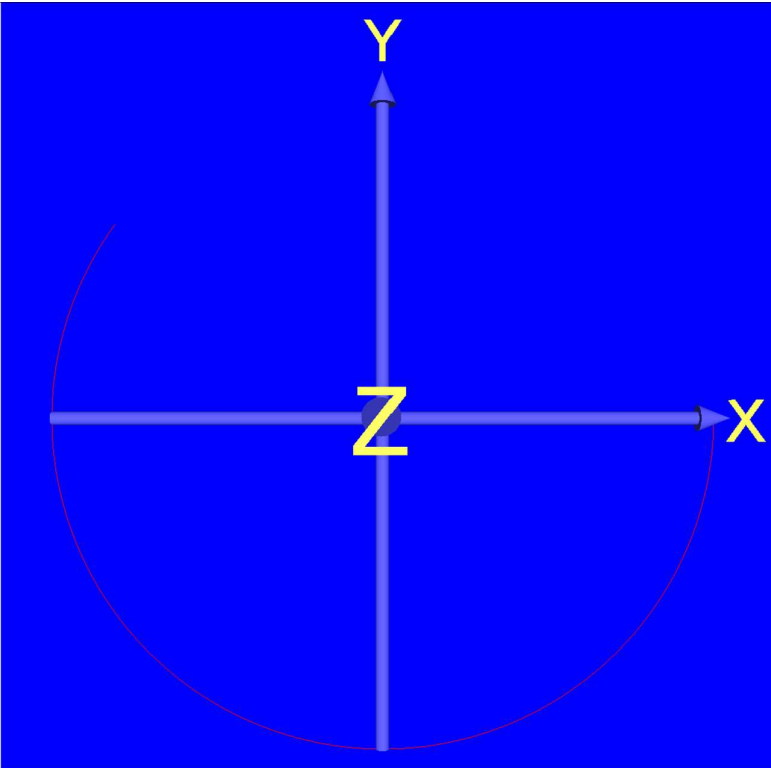


circle3.wrl

Straight line defined by parametric equations  $[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]$ , with **domain**  $[0,0.6]$ . Sampling resolution is 5000.

**Note:**

As observed, the curve starts from the x-axis and continues anti-clockwise to form 0.6 of a circle as the domain is  $[0,0.6]$ .

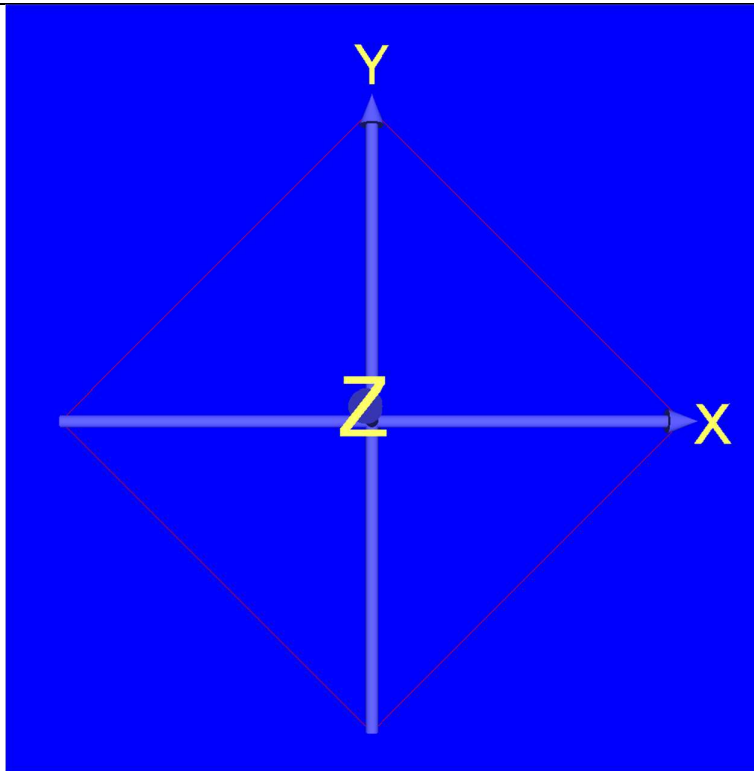


circle4.wrl

Straight line defined by parametric equations  $[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]$ , with **domain**  $[-0.6,0]$ . Sampling resolution is 5000.

**Note:**

Since the domain is  $[-0.6,0]$ , the starts from the -0.6 part of the arc and turns clockwise until it reaches the x-axis.



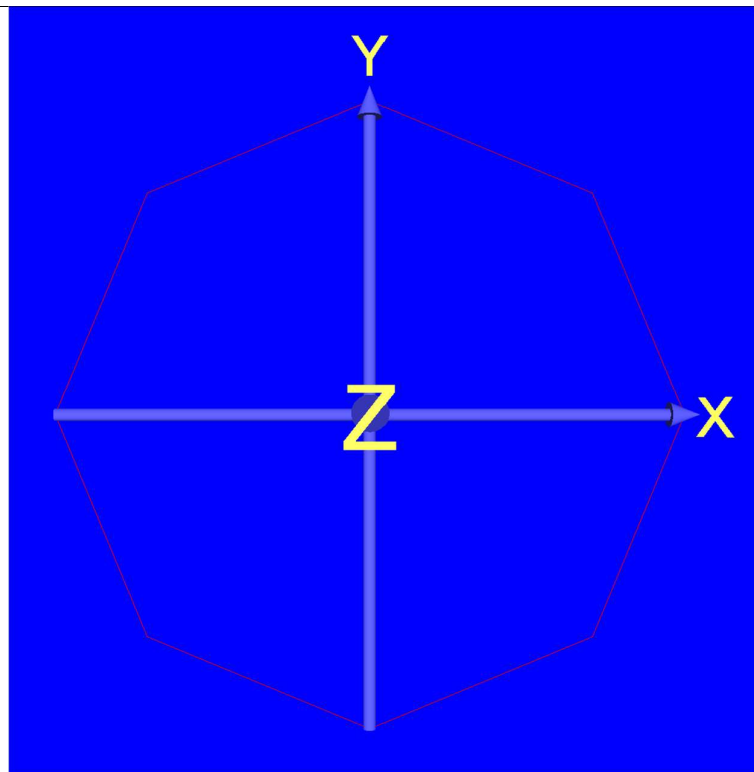
circle5.wrl

Straight line defined by parametric equations  $[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]$ , with domain  $[0,1]$ .

**Sampling resolution is 4.**

**Note:**

As observed, since the sampling resolution is 4, only 4 points are sampled starting from (1,0,0) and turning anti-clockwise to (0,1,0) and so on, to form a square/diamond.



circle6.wrl

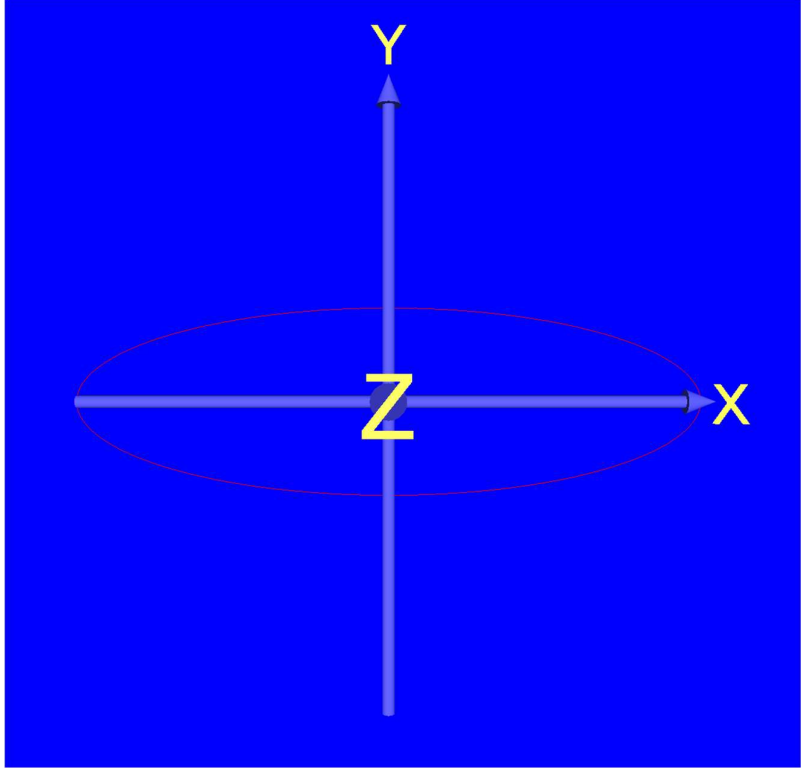
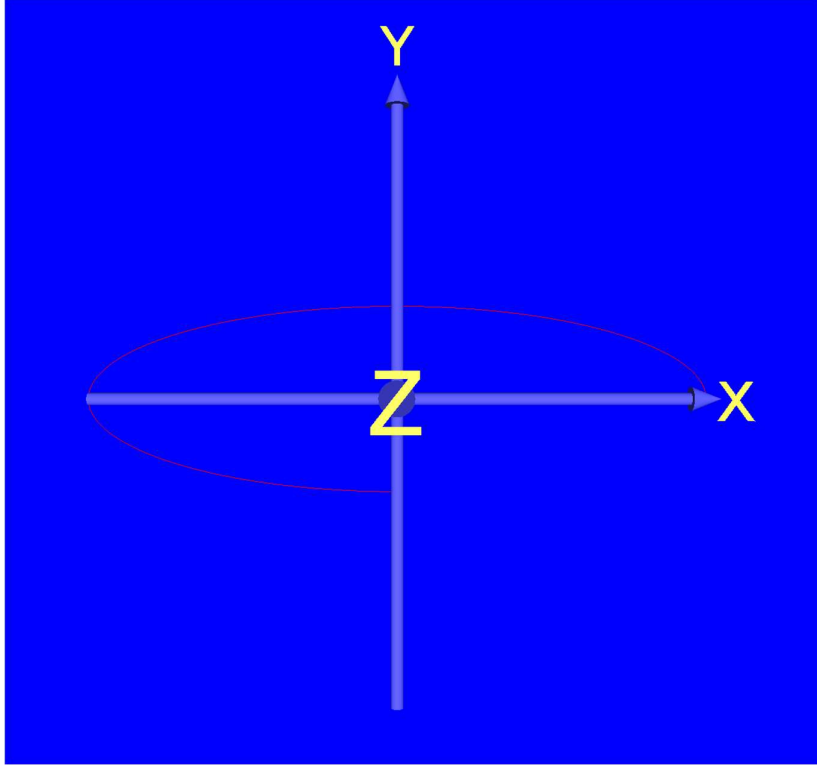
Straight line defined by parametric equations  $[x=\cos(u*2*\text{Pi}), y=\sin(u*2*\text{Pi}), z=0]$ , with domain  $[0,1]$ .

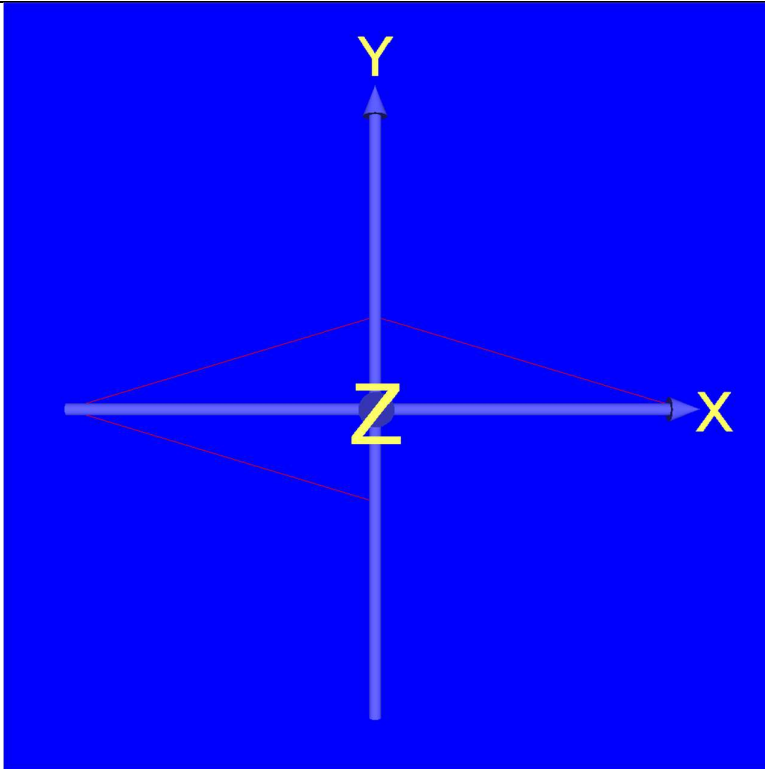
**Sampling resolution is 8.**

**Note:**

As observed, since the sampling resolution is 8, only 8 points are sampled, and when those 8 points are linked up together using straight lines, an octagon is formed.



Ellipse and its arc		Remarks
		<p>Straight line defined by parametric equations <math>[x=\cos(u*2*Pi), y=0.3*\sin(u*2*Pi), z=0]</math>, with domain <math>[0,1]</math>. Sampling resolution is 5000.</p>
ellipse1.wrl		
		<p>Straight line defined by parametric equations <math>[x=\cos(u*2*Pi), y=0.3*\sin(u*2*Pi), z=0]</math>, with <b>domain <math>[0,0.75]</math></b>. Sampling resolution is 5000.</p> <p><b>Note:</b> The arc starts from (1,0) and turns anti-clockwise to form 0.75 of an ellipse.</p>
ellipse2.wrl		



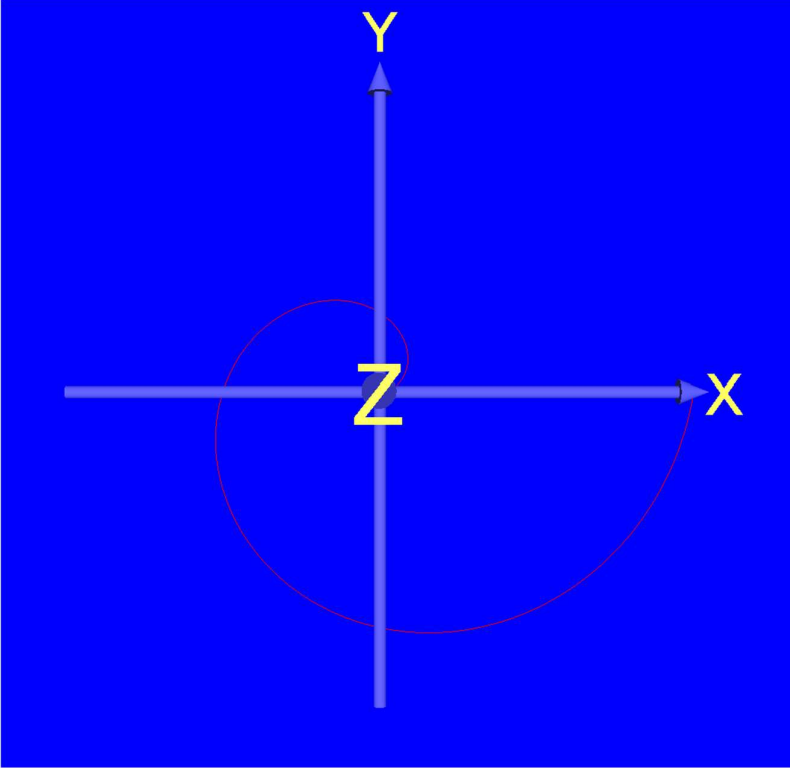
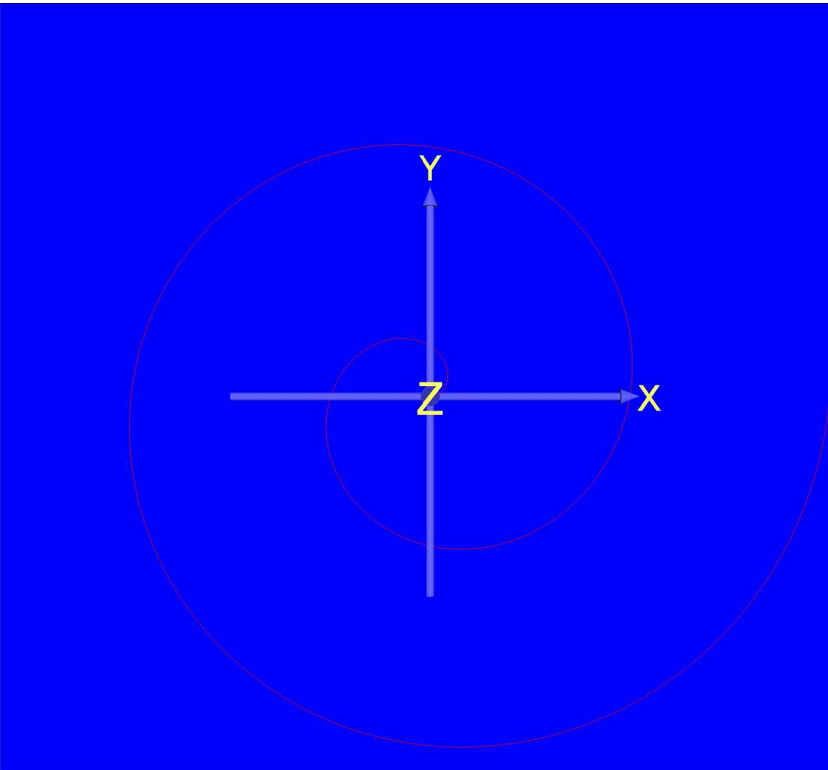
ellipse3.wrl

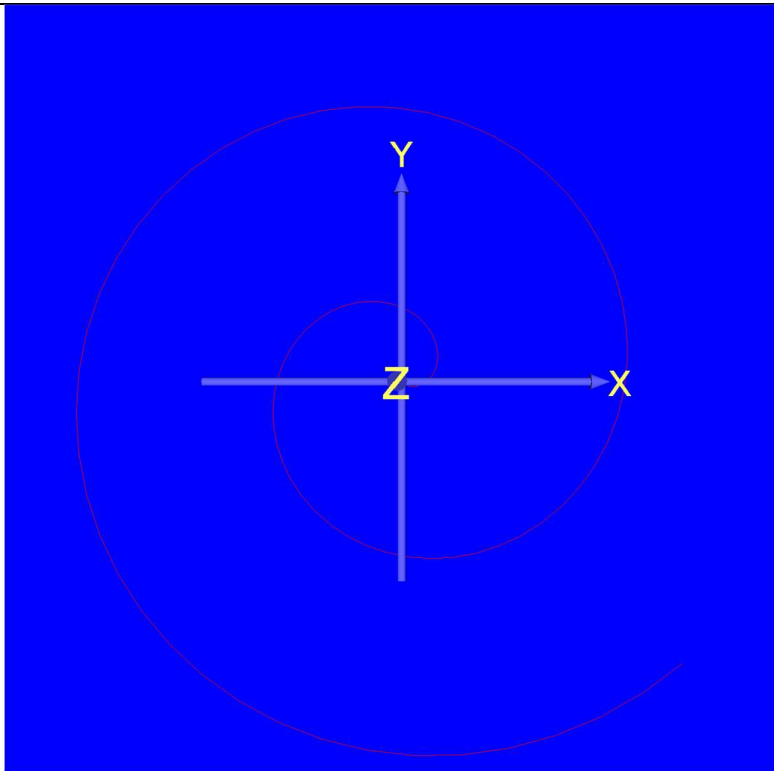
Straight line defined by parametric equations  $[x=\cos(u*2*\text{Pi}), y=0.3*\sin(u*2*\text{Pi}), z=0]$ , with domain  $[0,0.75]$ .

**Sampling resolution is 3.**

**Note:**

Since sampling resolution is 3, 3 points beside the starting point (1,0) is sampled, therefore forming 0.75 of a diamond.

2D Spiral	Remarks
 <p data-bbox="430 997 597 1024">2D_spiral1.wrl</p>	<p data-bbox="950 226 1461 367">Straight line defined by parametric equations <math>[x=u*\cos(u*2*\text{Pi}), y=u*\sin(u*2*\text{Pi}), z=0]</math>, with domain <math>[0,1]</math>. Sampling resolution is 100.</p>
 <p data-bbox="430 1795 597 1822">2D_spiral2.wrl</p>	<p data-bbox="950 1029 1461 1165">Straight line defined by parametric equations <math>[x=u*\cos(u*2*\text{Pi}), y=u*\sin(u*2*\text{Pi}), z=0]</math>, with <b>domain <math>[0,2]</math></b>. Sampling resolution is 100.</p> <p data-bbox="950 1207 1461 1344"><b>Note:</b> Since domain increase from <math>[0,1]</math> to <math>[0,2]</math>, the number of rotations increased, resulting in a longer arc.</p>

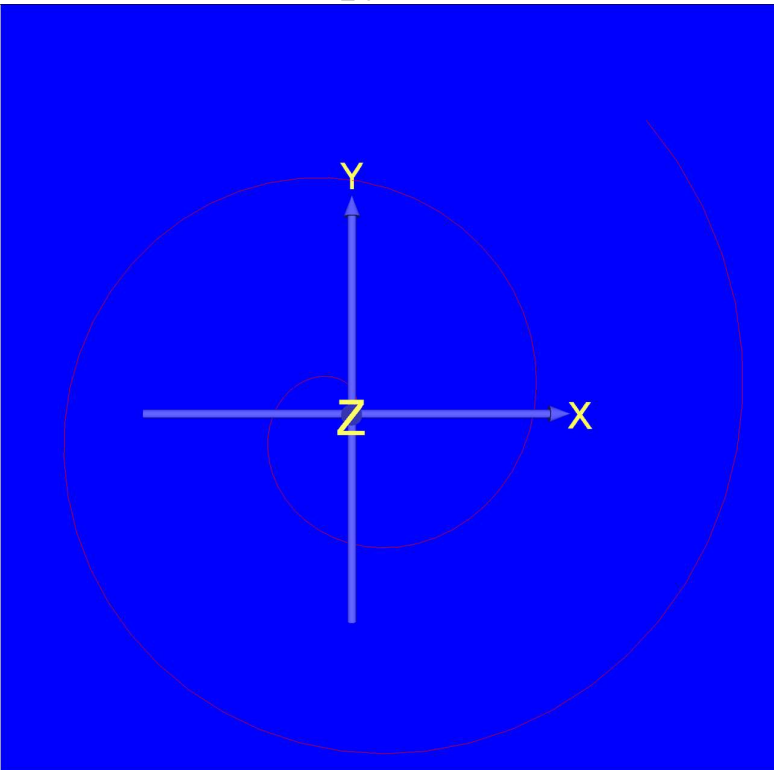


2D\_spiral3.wrl

Straight line defined by parametric equations  $[x=u*\cos(u*2*\pi) - \pi/4, y=u*\sin(u*2*\pi) - \pi/4, z=0]$ , with domain  $[0,2]$ . Sampling resolution is 100.

**Note:**

By using an offset of  $-\pi/4$  in the cos and sin functions, the curve was rotated by  $\pi/4$  in the **clockwise** direction.

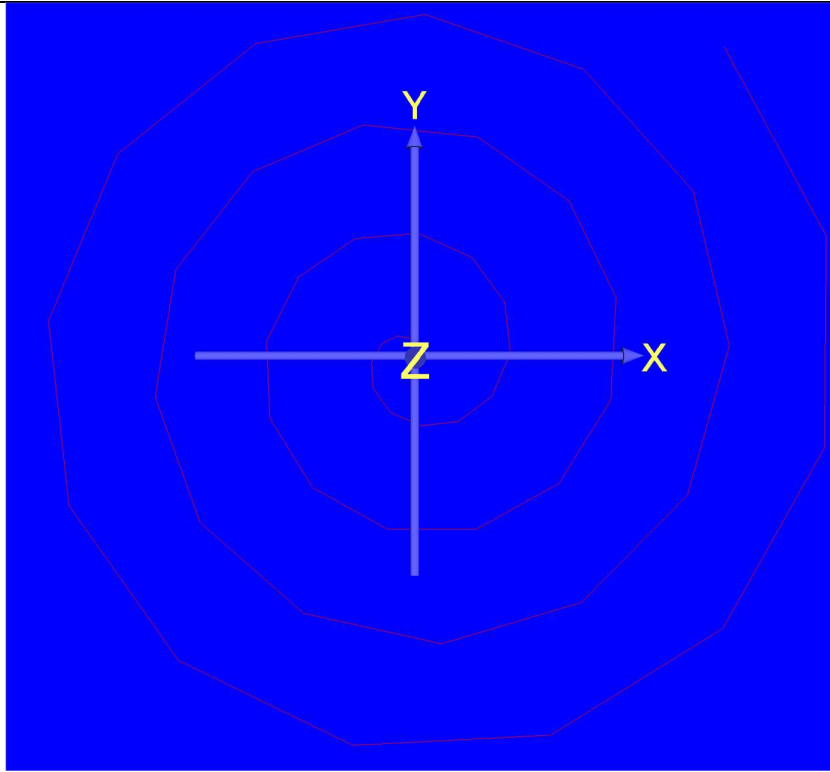


2D\_spiral4.wrl

Straight line defined by parametric equations  $[x=u*\cos(u*2*\pi) + \pi/4, y=u*\sin(u*2*\pi) + \pi/4, z=0]$ , with domain  $[0,2]$ . Sampling resolution is 100.

**Note:**

On the other hand, by using an offset of  $\pi/4$  in the cos and sin functions, the curve was rotated by  $\pi/4$  in the **anti-clockwise** direction.



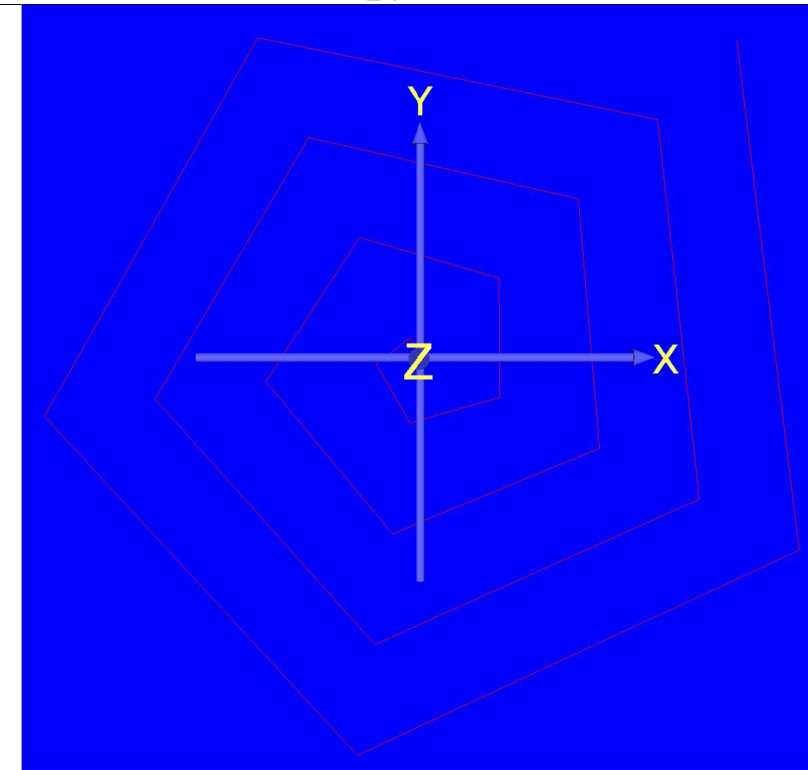
2D\_spiral5.wrl

Straight line defined by parametric equations  $[x=u*\cos(u*4*\pi) + \pi/4, y=u*\sin(u*4*\pi) + \pi/4, z=0]$ , with domain  $[0,2]$ . Sampling resolution is 100.

**Note:**

The number of rotations can also be increased by increasing the angle, in the case, from  $2*\pi$  to  $4*\pi$ .

However, due to the elongation, the spiral appears to have distinct points where straight lines are joined together to form the spiral. This can be mitigated by having a higher resolution. Therefore, whenever there is an elongation, either through the increase in domain or an increase in angle, the resolution should also be increased accordingly to generate a smooth curve.



2D\_spiral6.wrl

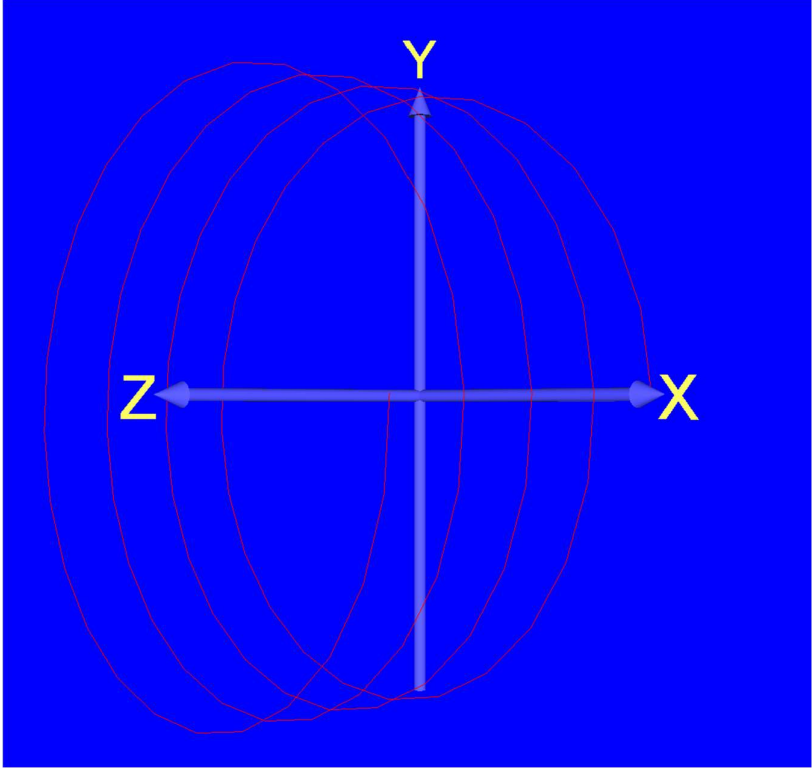
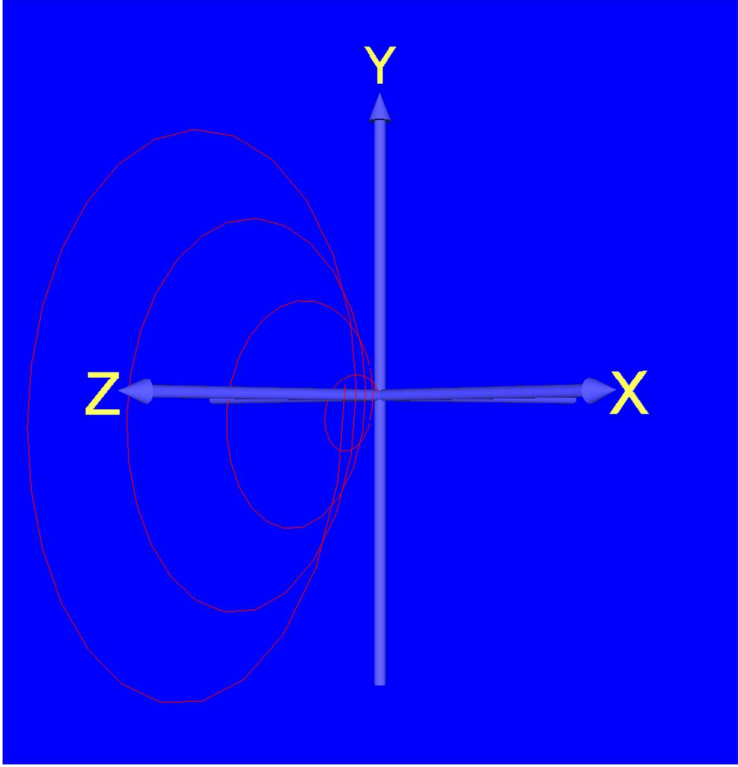
Straight line defined by parametric equations  $[x=\cos(u*4*\pi) + \pi/4, y=0.3*\sin(u*4*\pi) + \pi/4, z=0]$ , with domain  $[0,1]$ . Sampling resolution is 20.

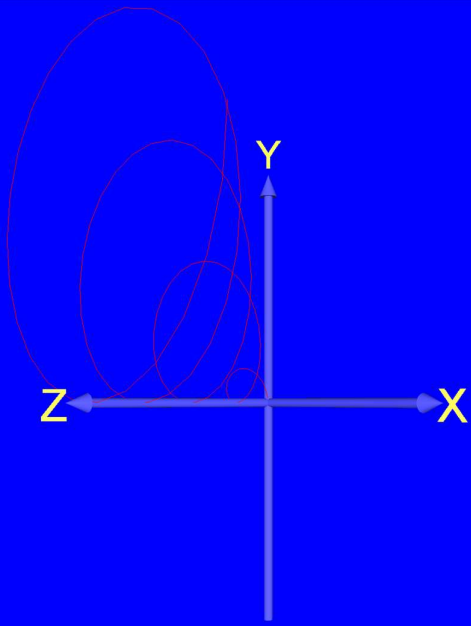
**Sampling resolution is 20.**

**Note:**

To further illustrate the effect of a low sampling rate resulting from a low resolution, the resolution is further decreased to 20.

As observed, the distinct points are obvious and straight lines are drawn between those points to form the "curve".

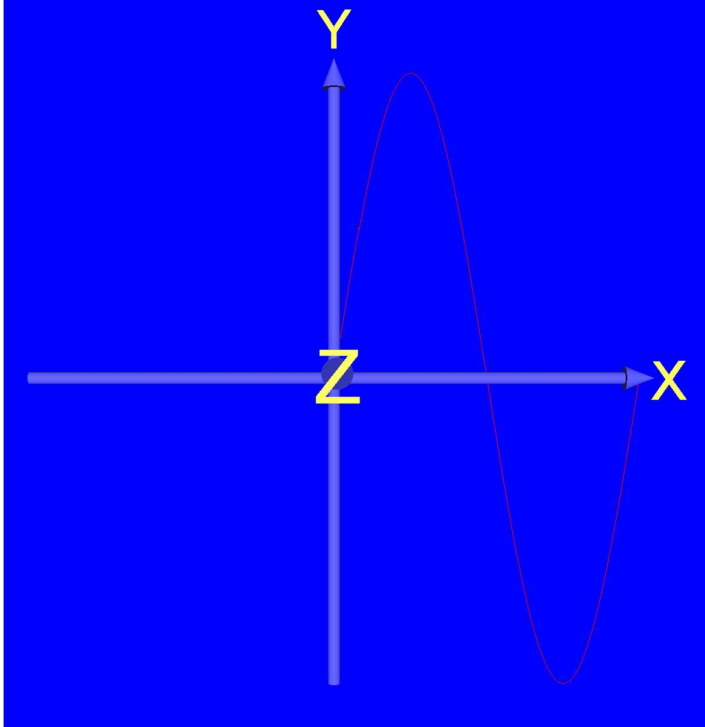
3D Helix	Remarks
 <p data-bbox="427 993 583 1020">3D_helix1.wrl</p>	<p data-bbox="933 226 1442 363">Straight line defined by parametric equations <math>[x= \cos(u*4*2*Pi), y= \sin(u*4*2*Pi), z= u]</math>, with domain <math>[0,1]</math>. Sampling resolution is 100.</p> <p data-bbox="933 409 1497 506"><b>Note:</b> By initializing the z parametric as u, the 2D circle is made into a 3D helix.</p>
 <p data-bbox="427 1797 583 1824">3D_helix2.wrl</p>	<p data-bbox="933 1031 1458 1167">Straight line defined by parametric equations <math>[x= u*\cos(u*4*2*Pi), y= u*\sin(u*4*2*Pi), z= u]</math>, with domain <math>[0,1]</math>. Sampling resolution is 100.</p> <p data-bbox="933 1213 1497 1350"><b>Note:</b> By multiplying the x and y parametric equations by u, a spiral which grows from origin (0,0) is created as domain u increases from 0 to 1.</p>



3D\_helix3.wrl

Straight line defined by parametric equations  
 $[x= u*\cos(u*4*2*\text{Pi}), y= u*\sin(u*4*2*\text{Pi}) + u, z= u]$ ,  
with domain  $[0,1]$ .  
Sampling resolution is 100.

## 2.2 Parametric Representation of $y=\sin(x)$



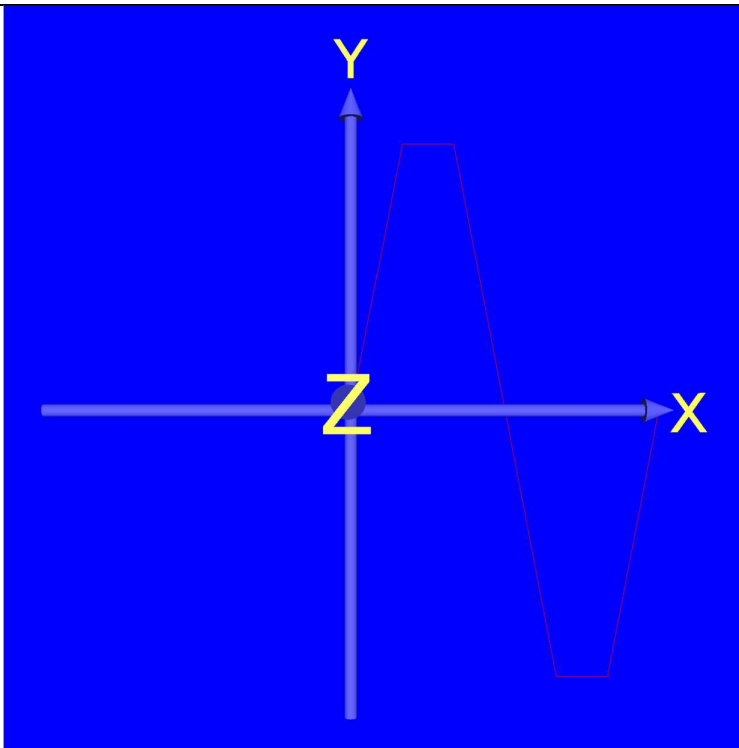
sin\_curve1\_parametric\_representation.wrl

Straight line defined by parametric equations  
 $[x= u, y= u*\sin(u*2*Pi), z= 0]$ ,  
with domain  $[0,1]$ .  
Sampling resolution is 100.

**Note:**

With a sampling resolution of 100, 100 other points  
are sampled besides the starting point at origin  
(0,0). Therefore, the curve looks smooth.

## 2.3 Changing the Sampling Resolution of sin curve



sin\_curve2\_parametric\_representation.wrl

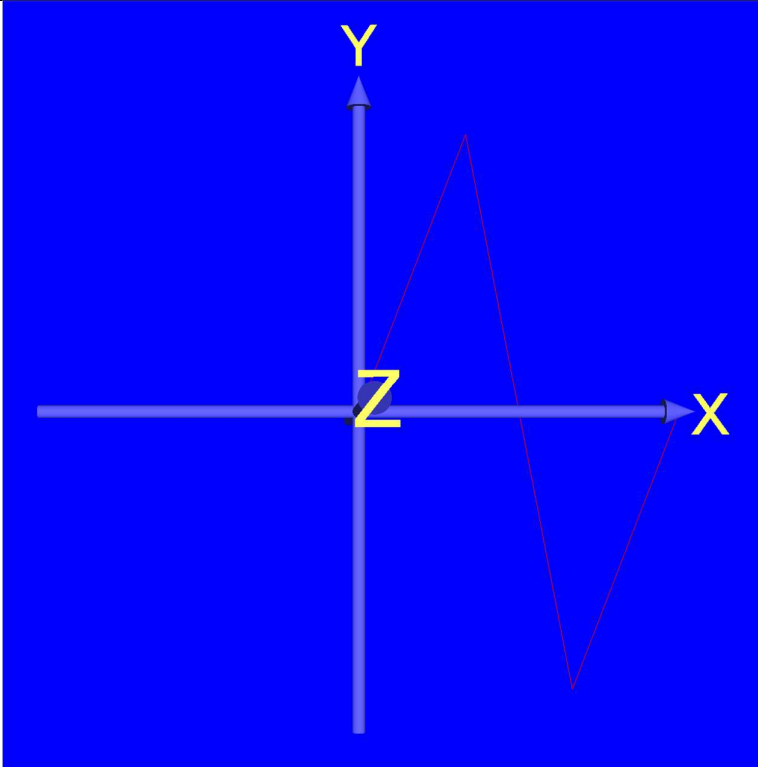
Straight line defined by parametric equations  
 $[x= u, y= u*\sin(u*2*Pi), z= 0]$ ,  
with domain  $[0,1]$ .

**Sampling resolution is 6.**

**Note:**

With a sampling resolution of 6, only 6 other points  
are sampled besides the starting point at origin  
(0,0). The “curve” does not look smooth at all.





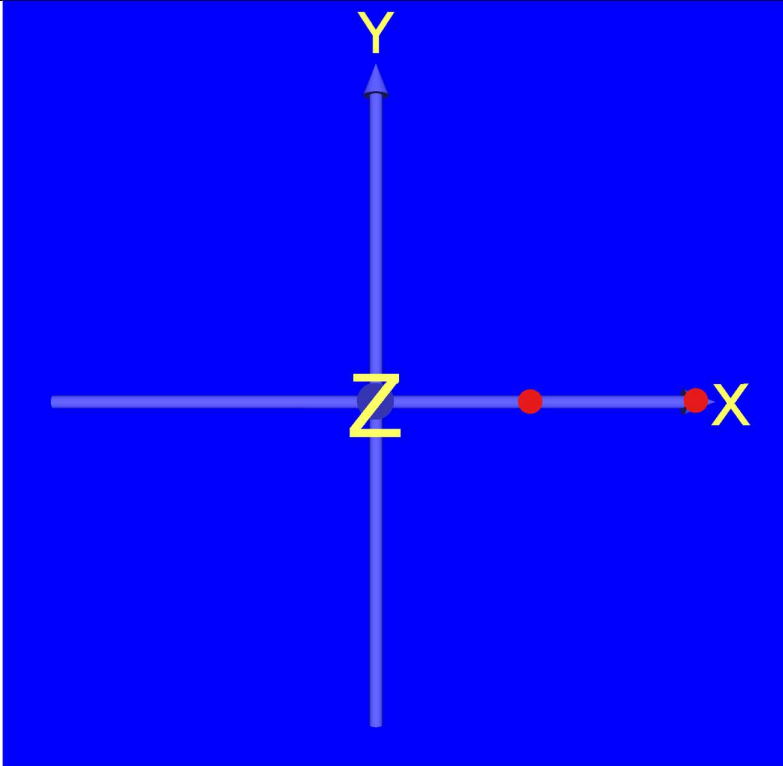
sin\_curve3\_parametric\_representation.wrl

Straight line defined by parametric equations  $[x= u, y= u*\sin(u*2*\text{Pi}), z= 0]$ , with domain  $[0,1]$ .

**Sampling resolution is 3.**

**Note:**

With a sampling resolution of 3, only 3 other points are sampled besides the starting point at origin (0,0). The “curve” looks pointy as straight lines are drawn to connect the 3 points.



sin\_curve4\_parametric\_representation.wrl

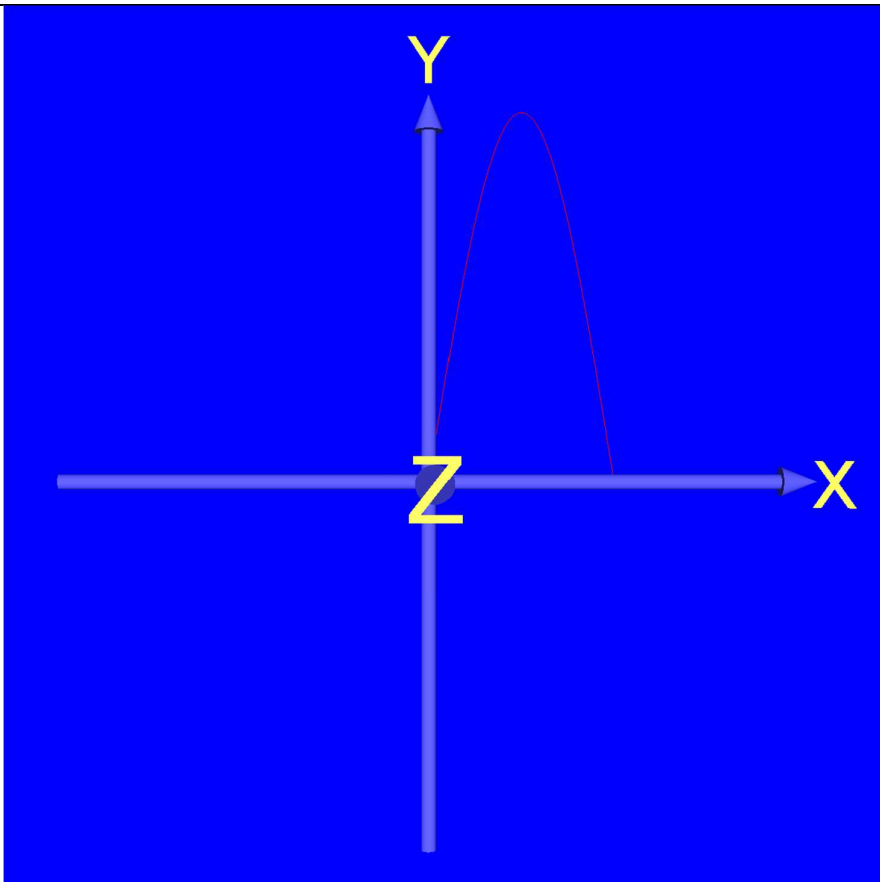
Straight line defined by parametric equations  $[x= u, y= u*\sin(u*2*\text{Pi}), z= 0]$ , with domain  $[0,1]$ .

**Sampling resolution is 2.**

**Note:**

When the sampling resolution is 2, no curve is observed. This is due to only 2 points being sampled (as illustrated on the left), which results in a straight-line  $y=0$ , along the x-axis. Therefore, it can be concluded that when drawing curves, a sampling resolution of 2 is strongly discouraged unless it is for a specific purpose.

## 2.4 Changing the Domain parameter of sin curve



sin\_curve5\_parametric\_representation.wrl

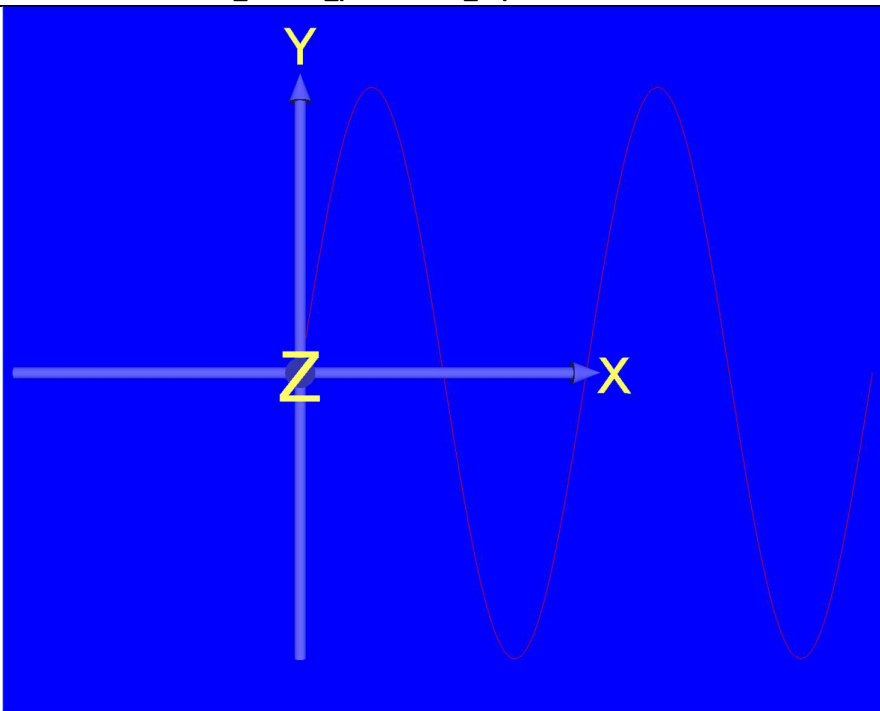
Straight line defined by parametric equations

$[x= u, y= u*\sin(u*2*\text{Pi}), z= 0]$ ,  
with **domain [0,0.5]**.

Sampling resolution is 1000.

**Note:**

By decreasing the domain from [0,1] to [0,0.5], the curve is shortened to half of the original curve.



sin\_curve6\_parametric\_representation.wrl

Straight line defined by parametric equations

$[x= u, y= u*\sin(u*2*\text{Pi}), z= 0]$ ,  
with **domain [0,2]**.

Sampling resolution is 1000.

**Note:**

By increasing the domain from [0,1] to [0,2], the curve is elongated and appears as 2 cycles of itself.