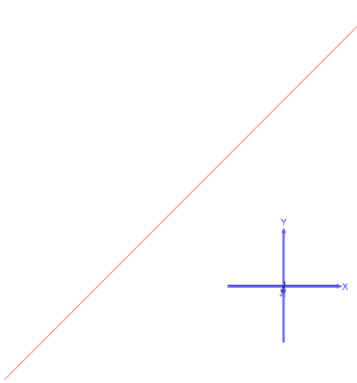
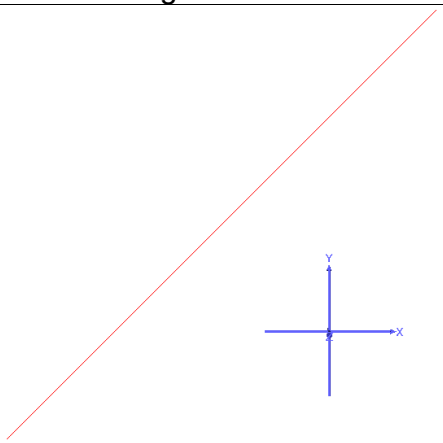
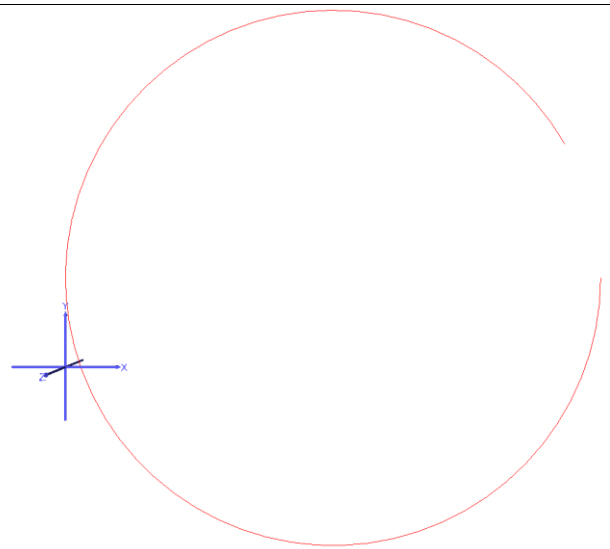
1a) Straight line segment

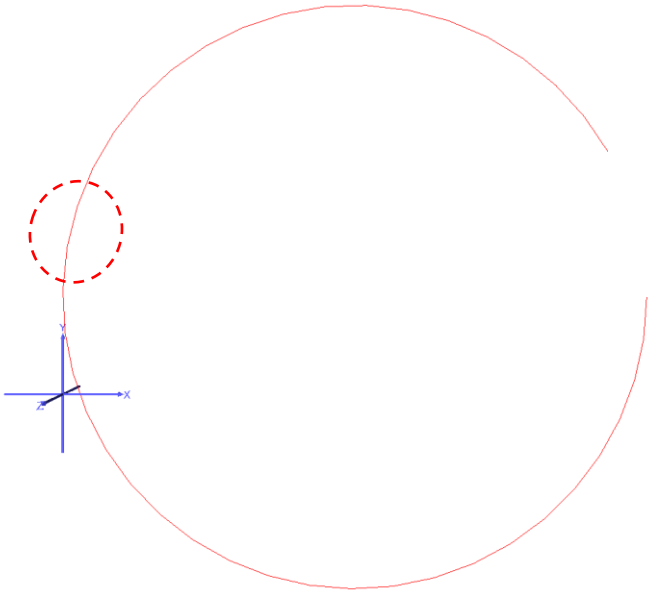
Straight line 1	Description
	The screenshot as shown is using “1a Resolution10.wrl”. The equation is defined as: x=(-6)+u*(2+6) y=(-2)+u*(6+2) z=0 with u as the parameter domain [0, 1] and sampling resolution set to 10.

Straight line 2	Description
	The screenshot as shown is using “1a Resolution1.wrl” with the same equation as above and sampling resolution set to 1.

Note
Since it is a straight line, changing the sampling resolution will not have any effect on the graph. The minimum sampling resolution to create a straight line is 1.

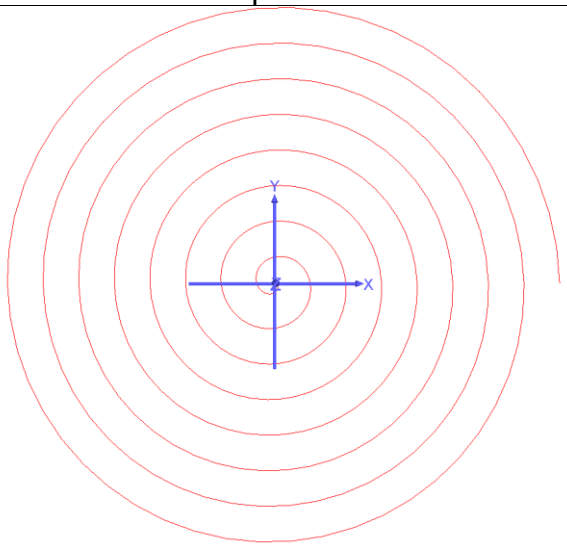
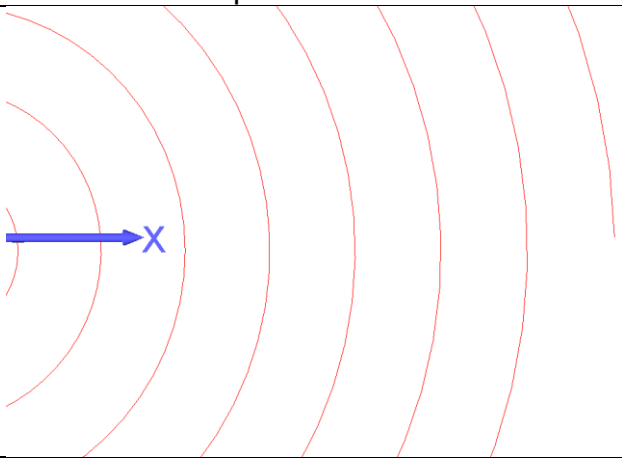
1b) Circular arc

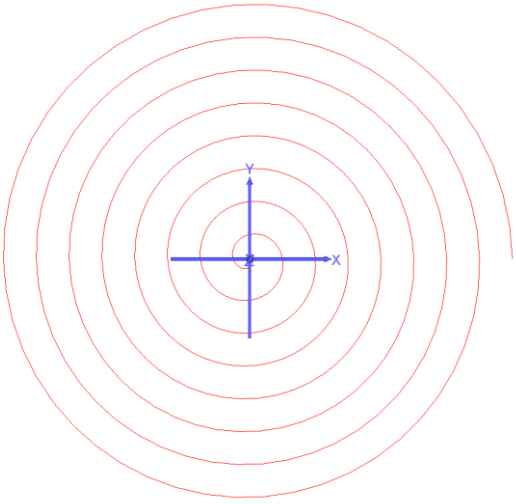
Circular arc 1	Description
	The screenshot as shown is using “1b Resolution50.wrl”. The equation is defined as: x=(6*(cos(2*pi*u+((pi/6)*(1-u)))))+6 y=(6*(sin(2*pi*u+((pi/6)*(1-u)))))+2 z=0 with u as the parameter domain [0, 1] and sampling resolution set to 50.

Circular arc 2	Description
	The screenshot as shown is using “1b Resolution40.wrl” with the same equation as above and sampling resolution set to 40.

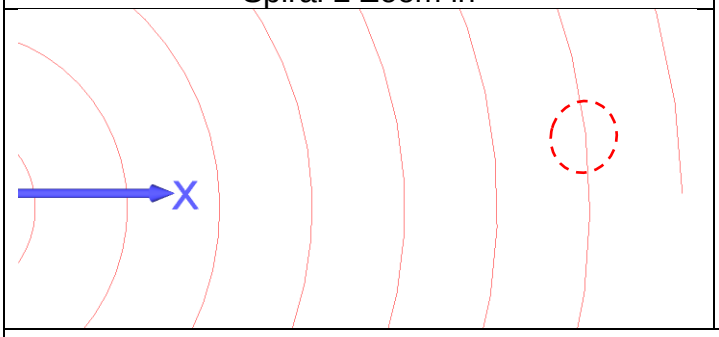
Note
As shown in circular arc 2, notice the sharp shape started to appear when you zoom in towards the arc that is drawn, this occur when the sampling resolution is set to 40. When the sampling resolution is reduced, the curve will start to change. This shows that when the sampling resolution is reduced, the connection in-between points of the curve is much further away from each other. Therefore, the minimum sampling resolution for circular arc is 50.

1c) Origin-centered 2D spiral curve

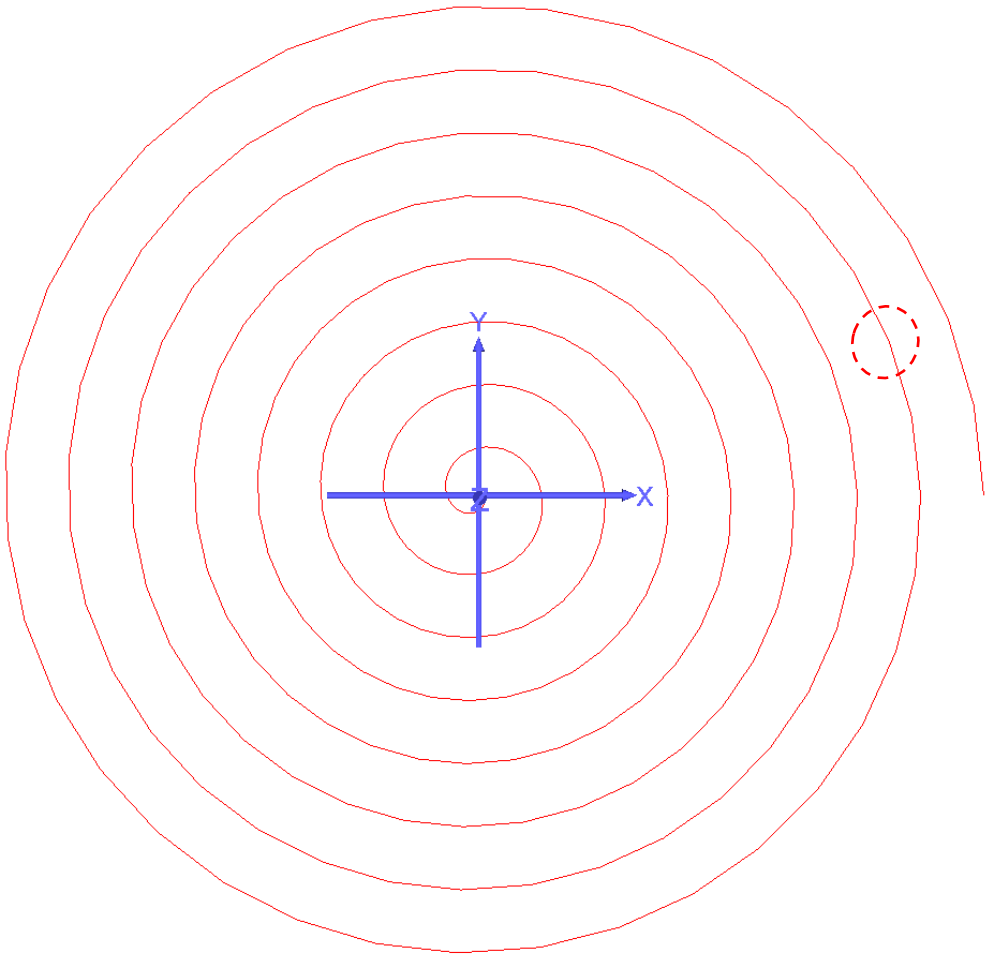
Spiral 1	Description
	The screenshot as shown is using “1c Resolution500.wrl”. The equation is defined as: x=4*u*(cos(16*pi*u*(-1))) y=4*u*(sin(16*pi*u*(-1))) z=0 with u as the parameter domain [0, 1] and sampling resolution set to 500.
Spiral 1 Zoom in	
	

Spiral 2	Description
	The screenshot as shown is using “1c Resolution410.wrl” with the same equation as above and sampling resolution set to 410.

Spiral 2 Zoom in



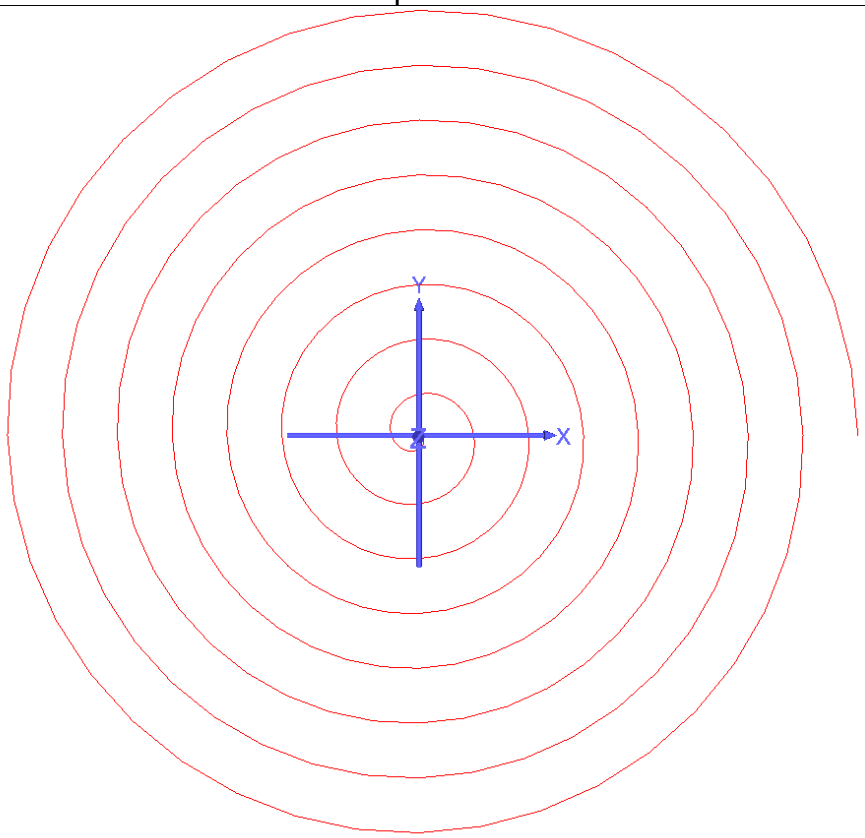
Spiral 3



Description

The screenshot as shown is using “1c Resolution280.wrl” with the same equation as above and sampling resolution set to 280.

Spiral 4



Description

The screenshot as shown is using “1c Resolution320.wrl” with the same equation as above and sampling resolution set to 320.

Note

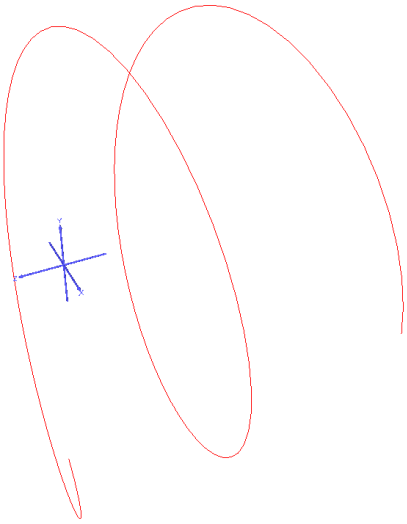
In this curve, using 500 sampling resolution shows the minimum sampling resolution for a smooth curve. This is shown in the Spiral 1 screenshot.

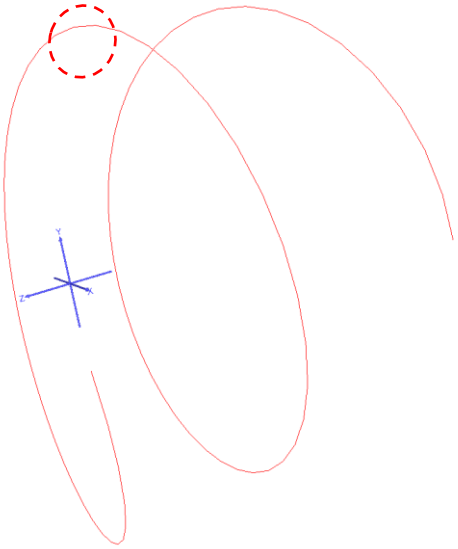
Unlike the circular arc, spiral curve required more sampling resolution to provide a smooth curve. This is due to the number of revolutions of the spiral, the greater the number of revolutions the more sampling resolution is required. As shown in Spiral 2, you will be able to notice the slight changes when the sampling resolution is reduced to 410 when you zoom in closer to the curve.

To provide a full shape of the spiral curve without zooming in, the minimum sampling resolution for the smooth curve as shown in Spiral 4 is 320. As the sampling solution is reduced to 280 and you will be able to notice the curve line is form as show in Spiral 3.

Notice the equation required (-1) to provide clockwise rotation. Without the (-1), the domain of the parameter u [0, 1] is define as counterclockwise rotation for the equation.

1d) 3D cylindrical helix

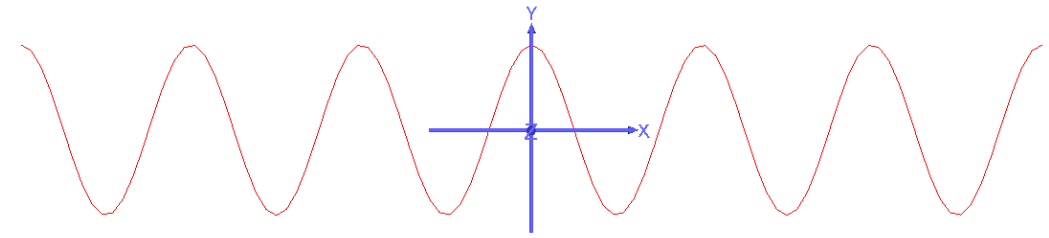
Cylindrical helix 1	Description
	The screenshot as shown is using “1d Resolution90.wrl”. The equation is defined as: x=6*(cos(4*pi*u)) y=6*(sin(4*pi*u)) z=(-6)+(8*u) with u as the parameter domain [0, 1] and sampling resolution set to 90.

Cylindrical helix 2	Description
	The screenshot as shown is using “1d Resolution80.wrl” with the same equation as above and sampling resolution set to 80.

Note
The cylindrical helix has similarity to the circular arc. As shown above, with higher sampling resolution, it will provide a smooth curve. In Cylindrical helix 1 the minimum sampling solution to provide a smooth curve is 90. As shown in Cylindrical helix 2, once the sampling solution is reduced to 80, notice the curve line changes.

2) Defined curve number M = 2

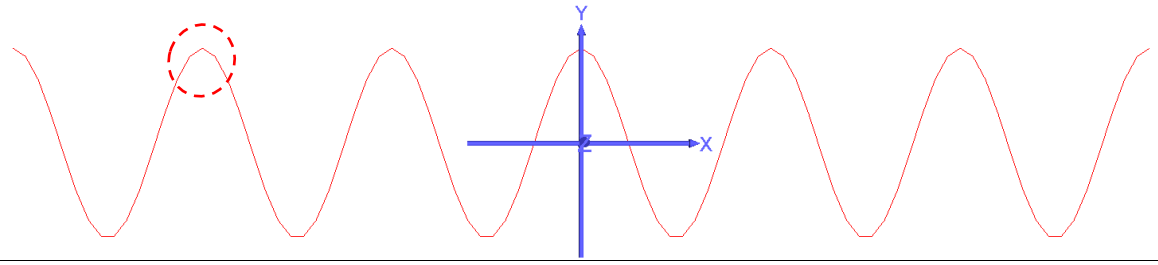
Cosine curve 1



Description

The screenshot as shown is using “2 Resolution100.wrl”. The equation is defined as:
x=(-6)+u*(6-(-6))
y=cos(u*12*pi)
z=0
with u as the parameter domain [0, 1] and sampling resolution set to 100.

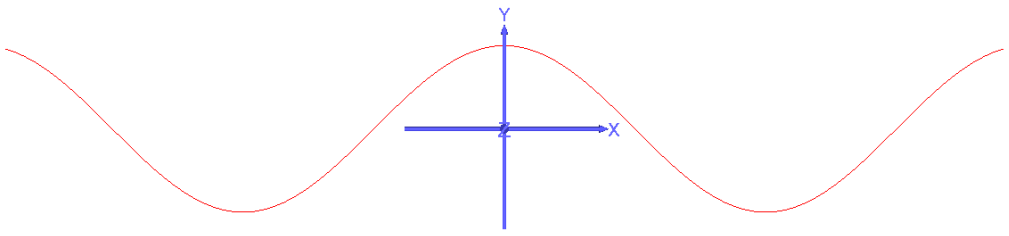
Cosine curve 2



Description

The screenshot as shown is using “2 Resolution90.wrl” with the same equation as above and sampling resolution set to 90.

Cosine curve 3

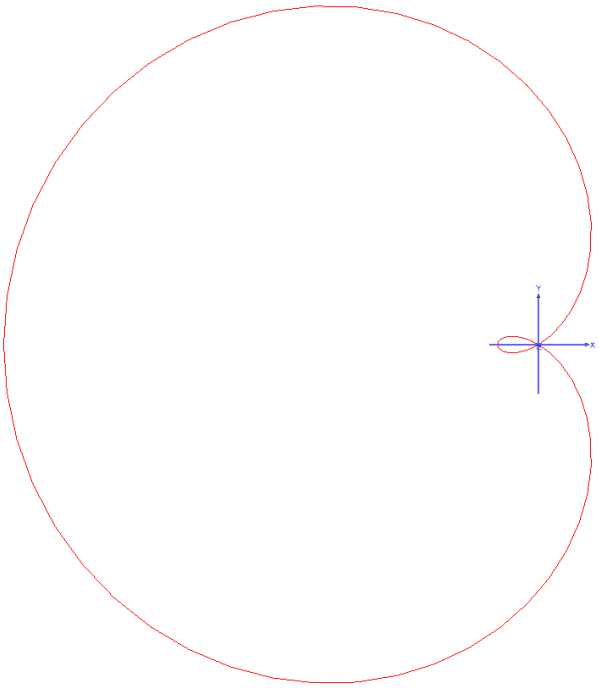


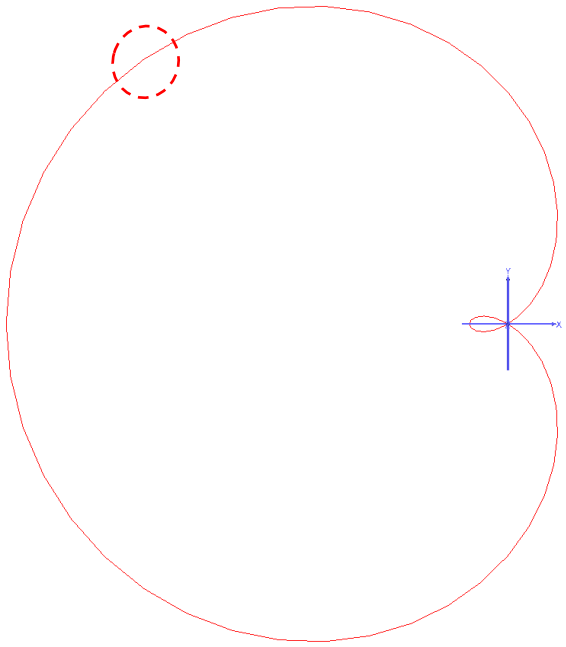
Description

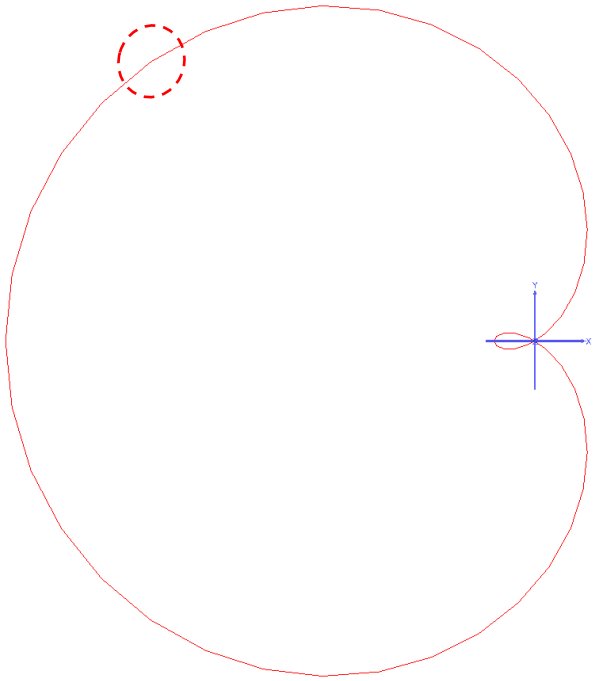
The screenshot as shown is using “2 CosineWithValueOf x.wrl”. The equation is defined as:
x=(-6)+u*(6-(-6))
y=cos((-6)+u*(6-(-6)))
z=0
with u as the parameter domain [0, 1] and sampling resolution set to 100.

Note
As shown in cosine curve 2, when the sampling solution is reduced to 90, the line can be seen in the cosine curve. Therefore, the minimum sampling resolution for cosine curve is 100. Notice the additional equation of the cosine curve 3 image, where y = cos(x) is used. The equation y provides 2 oscillations of the cosine curve within the domain x [-6, 6]. Therefore, it is required to modify the cosine curve angle to satisfy total of 6 oscillations. Since 2*pi is equal to 1 oscillation, 12*pi is used to provide 6 oscillations. This is shown in cosine curve 1, where equation y = cos(u*12*pi) is used for 6 oscillations of cosine curve with the domain x [-6, 6]. In conclusion, “2 Resolution100.wrl” file, equation defined as: x=(-6)+u*(6-(-6)) y=cos(u*12*pi) z=0 with u as the parameter domain [0, 1] and sampling resolution set to 100 is the solution to this question.

3) Limaçon

Limaçon 1	Description
	The screenshot as shown is using “3 Resolution70.wrl”. The equation is defined as: x=(6-1*(7*(cos(u*2*pi))))*(cos(u*2*pi)) y=(6-1*(7*(cos(u*2*pi))))*(sin(u*2*pi)) z=0 with u as the parameter domain [0, 1] and sampling resolution set to 70.

Limaçon 2	Description
	The screenshot as shown is using “3 Resolution60.wrl” with the same equation as above and sampling resolution set to 60.

Limaçon 3	Description
	The screenshot as shown is using “3 Resolution50.wrl” with the same equation as above and sampling resolution set to 50.
Note	
For Limaçon curve, the minimum sampling resolution to provide a smooth curve is 70 as shown in Limaçon 1. As shown in Limaçon 2 and Limaçon3, you will be able to notice line is form when the sampling resolution is reduced to 60 or 50.	