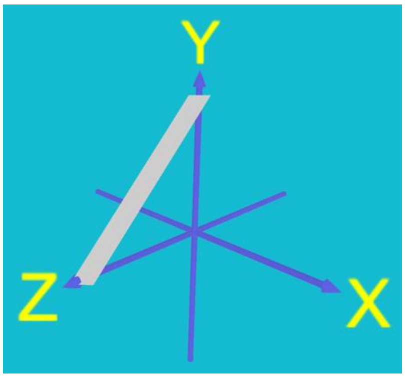
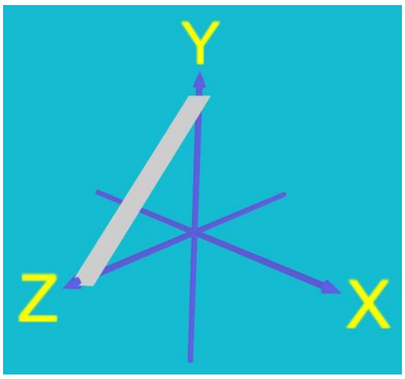
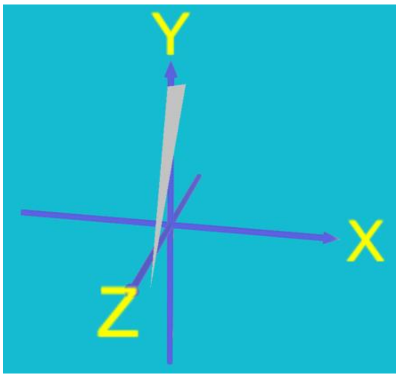
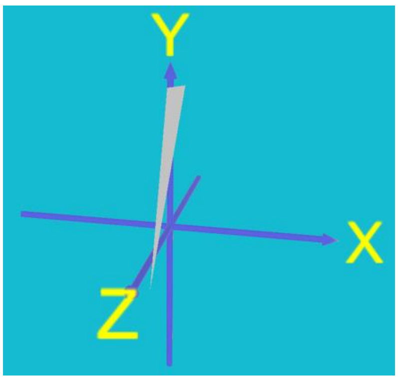
Nanyang Technological University

Lab 2 Report: Parametric Surfaces

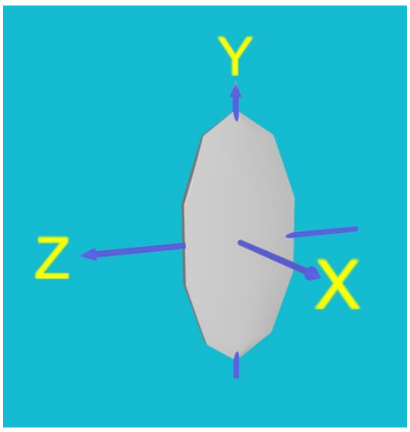
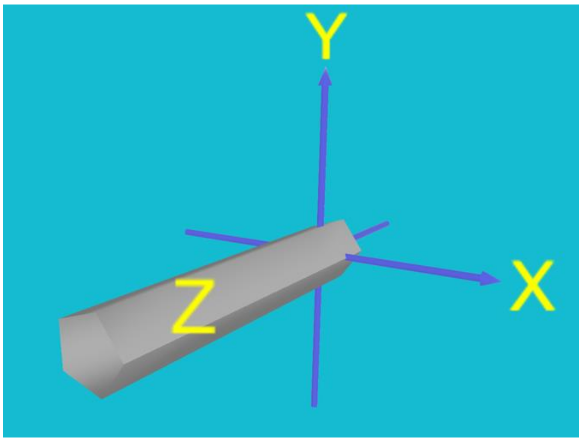
CZ2003 Computer Graphics and Visualization

Name: Ernest Ang Cheng Han
Tutorial Group: SSR1
Matric Number: U1921310H
N, M values: [N: 1, M: 10]

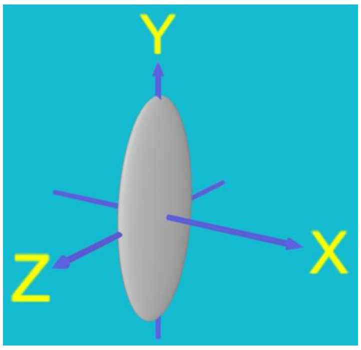
1. In 4 separate files, define parametrically using functions $x(u, v)$, $y(u, v)$, $z(u, v)$, $u, v \in [0,1]$ and display:

1a. A plane passing through the points with coordinates (***N***, ***M***, 0), (0, ***M***, ***N***), (***N***, 0, ***M***).	1b. A triangular polygon with the vertices at the points with coordinates (***N***, ***M***, 0), (0, ***M***, ***N***), (***N***, 0, ***M***).
Point 1 Coordinates: [1, 10, 0] Point 2 Coordinates: [0, 10, 1] Point 3 Coordinates: [1, 0, 10] Parametric Definition: $x(u, v)$ = 1 - u $y(u, v)$ = 10 - 10v z(u, v) = u + 10v $u \in [0,1]$ $v \in [0,1]$ File: 1a(Resolution 1).Func Resolution: 1 Screenshot:  File: 1a(Resolution 30).Func Resolution: 30 Screenshot:  	Point 1 Coordinates: [1, 10, 0] Point 2 Coordinates: [0, 10, 1] Point 3 Coordinates: [1, 0, 10] Point 4 Coordinates: [1, 0, 10] Parametric Definition: $x(u, v)$ = 1 - u + uv $y(u, v)$ = 10 - 10v z(u, v) = u + 10v - uv $u \in [0,1]$ $v \in [0,1]$ File: 1b(Resolution 1).Func Resolution: 1 Screenshot:  File: 1b(Resolution 30).Func Resolution: 30 Screenshot: 

Observations: As long as the sampling resolution is at least 1, the plane can be plotted since it basically requires only one line and have that same line translated linearly to create the plane Point 1, Point 2, Point 3, and Point 4 (0, 0, 11) are the vertices of the plane, where Point 1’s [u, v] values are: u = 0 and v = 0 Point 2’s [u, v] values are: u = 1 and v = 0 Point 3’s [u, v] values are: u = 0 and v = 1 Point 4’s [u, v] values are: u = 1 and v = 1	Observations: As long as the sampling resolution is at least 1, the plane can be plotted since it basically requires only one line and have that same line translated to create the plane Point 1, Point 2, and Point 3 are the vertices of the triangular polygon, where Point 1’s [u, v] values are: u = 0 and v = 0 Point 2’s [u, v] values are: u = 1 and v = 0 Point 3’s [u, v] values are: u = 0 and v = 1 Point 4’s [u, v] values are: u = 1 and v = 1

1c. An origin-centred ellipsoid with the semi-axes ***N***, ***M***, (***N***+***M***)/2	1d. A cylindrical surface with radius *N* which is aligned with axis Z, and spans from z1 $=-\boldsymbol{N}$ to $z2 = \boldsymbol{M}$.
X-axis: 1 Y-axis: 10 Z-axis: $\frac{1+10}{2}$ = 5.5 Parametric Definition: $x(u,v) = \cos(\pi v - \frac{\pi}{2})\sin(2\pi u - \pi)$ $y(u,v) = 10\sin(\pi v - \frac{\pi}{2})$ $z(u,v) = 5.5\cos(\pi v - \frac{\pi}{2})\cos(2\pi u - \pi)$ $u \in [0,1]$ $v \in [0,1]$ File: 1c(Resolution 5).Func Resolution: 5 Screenshot:  	Radius = 1 Spanning: -1 to 10 Parametric Definition: $x(u,v) = \cos(2\pi u)$ $y(u,v) = \sin(2\pi u)$ $z(u,v) = -1 + 11v$ $u \in [0,1]$ $v \in [0,1]$ File: 1d(Resolution 5).Func Resolution: 5 Screenshot: 

File: 1c(Resolution 30).Func
Resolution: 30
Screenshot:



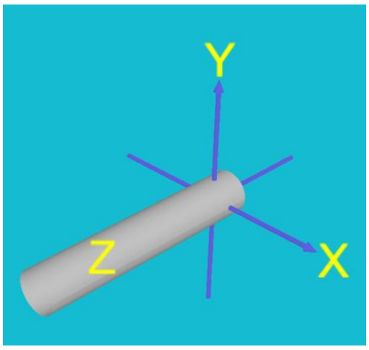
Observations:
The more sampling points used, the smoother the ellipsoid, since the ellipsoid is created by joining multiple straight line together between points defined in formula. As seen above, the ellipsoid plotted with resolution 5 is very pixilated compared to when it is plotted with resolution 30 where it is much smoother

The coefficient XX in XXcos(πv - $\frac{\pi}{2}$)sin(2πu - π) controls the length of the X semi-axis;

The coefficient YY in YYsin(πv - $\frac{\pi}{2}$) controls the length of the Y semi-axis;

The coefficient ZZ in ZZcos(πv - $\frac{\pi}{2}$)cos(2πu - π) controls the length of the Z semi-axis

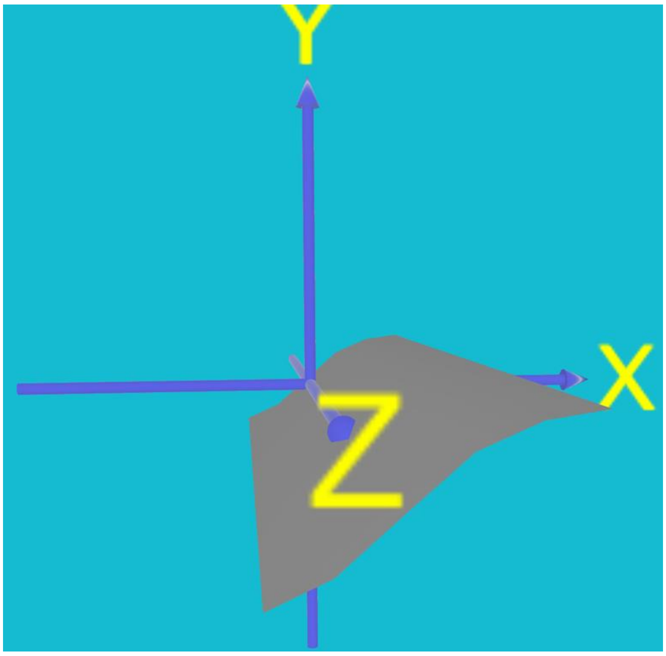
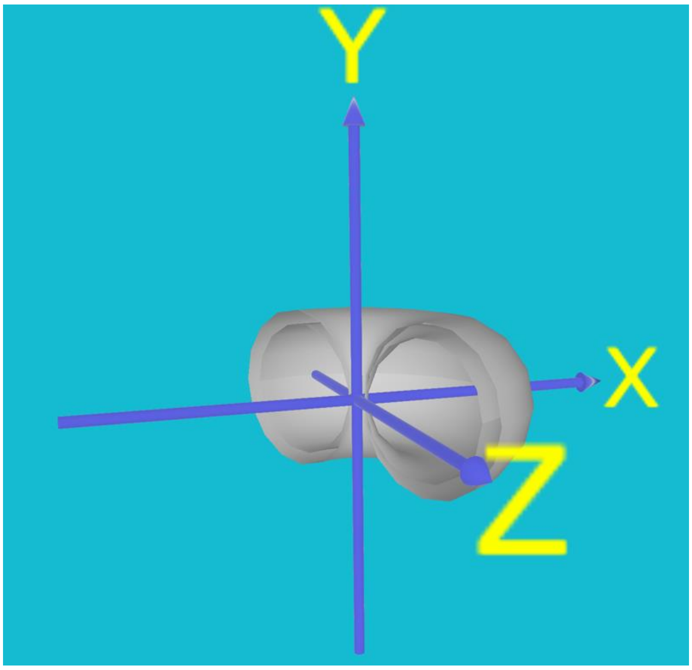
File: 1d(Resolution 30).Func
Resolution: 30
Screenshot:



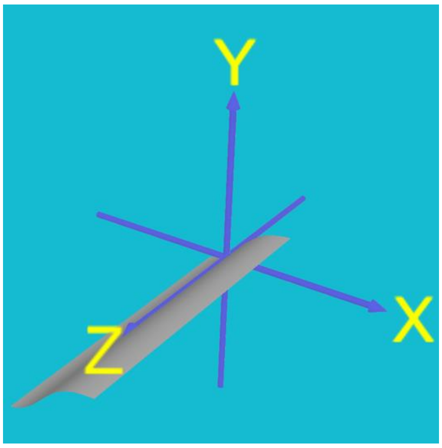
Observations:
The more sampling points used, the smoother the cylinder, since the cylinder is created by joining multiple straight line together between points defined in formula. As seen above, the cylinder plotted with resolution 5 looks more like a pentagon-like cylinder compared to when it is plotted with resolution 30 where it is much smoother and looks like a circular cylinder

The equation -1 + 11v controls how wide the cylinder will span parallel to the Z axis. Changing the limits in $v \in [0,1]$ will also likewise change how wide the cylinder will span parallel to the Z-axis

The coefficient XX in XXcos(2πu) and XXsin(2πu) controls radius N of cylindrical surface

2. Define parametrically using functions $x(u, v)$, $y(u, v)$, $z(u, v)$, $u, v \in [0,1]$ a surface obtained by translational sweeping of the curve number ***M*** (Table 1) along axis Z so that it will span from $z1 = -\boldsymbol{N}$ to $z2 = \boldsymbol{M}$.	3. Define parametrically using functions (u, v), $y(u, v)$, $z(u, v)$, $u, v \in [0,1]$ a surface created by rotational sweeping of the curve defined in Fig. 5. The curve has to be first translated by (-***N***, 0, 0) and then subjected to rotational sweeping about axis Y clockwise by angle $\frac{\pi}{N}$ starting the rotation at the angle $+\frac{3\pi}{2M}$ away from the coordinate plane *YZ*.
Number: 10 $y = \tanh x$ $x \in [-1.3, 2]$ Spanning: -1 to 10 Parametric Definition: $x(u)$ = 3.3u – 1.3 $y(u)$ = tanh(3.3u – 1.3) z(u) = -1 + 11v $u \in [0,1]$ $v \in [0,1]$ File: 2(Resolution 5).Func Resolution: 5 Screenshot:  	Polar Coordinates: r = **1** – (**10** + 5)cosα, $\alpha \in [0,2\pi]$ r = 1 – 15cosα Translation: (-1, 0, 0) Clockwise Rotation Sweeping Angle about axis Y: π Angle from YZ plane: $+\frac{3\pi}{20}$ (anti-clockwise) Parametric Definition: $x(u)$ = ((1 - 15cos(2πu))(cos(2πu)) – 1)(sin(-πv $+\frac{3\pi}{20}$)) $y(u)$ = (1 - 15cos(2πu))sin(2πu) z(u) = ((1 - 15cos(2πu))(cos(2πu)) – 1)(cos(-πv $+\frac{3\pi}{20}$)) $u \in [0,1]$ $v \in [0,1]$ File: 3(Resolution 30).Func Resolution: 30 Screenshot: 

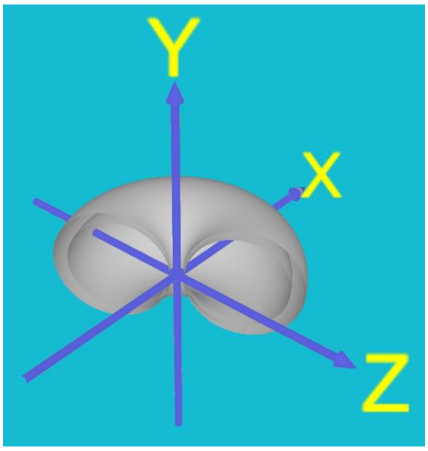
File: 2(Resolution 30).Func
Resolution: 30
Screenshot:



Observations:
The more sampling points used, the smoother the curve, since the circle is created by joining multiple straight line together between points defined in formula. As seen above, the curve plotted with resolution 5 is a spanned tanh curve made up of 5 lines which is much rougher and pixilated compared to when it is plotted with resolution 30, where the tanh curve is much smoother

The equation -1 + 11v controls how wide the cylinder will span parallel to the Z axis. Changing the limits in $v \in [0,1]$ will also likewise change how wide the cylinder will span parallel to the Z-axis

File: 3(Resolution 300).Func
Resolution: 300
Screenshot:



Observations:
The more sampling points used, the smoother the solid will be, since the solid is created by joining multiple straight line together between points defined in formula. As seen above, the solid plotted with resolution 30 is highly pixilated as not enough sampling points are used compared to plotting the solid with resolution 300, where the entire solid is much smoother

For parametric equations:
$x(u)$ = ((c - bcos(2πu))(cos(2πu)) – XX)(sin(ZZπv + YYπ))
$y(u)$ = (c - bcos(2πu))sin(2πu)
z(u) = ((c - bcos(2πu))(cos(2πu)) – XX)(cos(ZZπv + YYπ))

If c < b, c + b will determine the diameter of the outer oval shape from origin while b – c will control the diameter of the inner oval shape from origin.

If c = b, the distance between the 2 x-intercepts of the oval shape will be 2 * c from origin, where one of the x-intercepts is at origin

If c > b, c + b is the distance of the negative x-intercept from origin while c - b is the distance of the positive x-intercept from origin

XX will control the translation of the solid along the X-axis; YY will control the rotational sweeping of the solid as well as the direction; ZZ will control how rotated the curve is from YZ plane as well as the direction.