

Q1. The rotation axis is Y axis
it rotates counterclockwise, and rotates 60°

Q2. the line passes through $(1, 0, 0)$ and $(0, 0, 2)$
one of the direction of the line is $(-1, 0, 2)$

① move point $(1, 0, 0)$ to the origin

$$T_1 = \begin{bmatrix} 1 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$a = -1 \quad b = 0 \quad c = 2$$

$$d = 2 \quad L = \sqrt{5}$$

② aligning a vector to z-axis

$$R_x(\alpha) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_y(-\beta) = \begin{bmatrix} \frac{2}{\sqrt{5}} & 0 & \frac{1}{\sqrt{5}} & 0 \\ 0 & 1 & 0 & 0 \\ \frac{-1}{\sqrt{5}} & 0 & \frac{2}{\sqrt{5}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

③ reflection

$$R_f = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

④ Reverse Steps

$$R_y(\beta) = \begin{bmatrix} \frac{2}{\sqrt{5}} & 0 & \frac{1}{\sqrt{5}} & 0 \\ 0 & 1 & 0 & 0 \\ \frac{-1}{\sqrt{5}} & 0 & \frac{2}{\sqrt{5}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_x(-\alpha) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

⑤ Move Back

$$T_2 = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Thus, the whole matrix is

$$T = T_2 \cdot R_x(-\alpha) \cdot R_y(\beta) \cdot R_f \cdot R_y(-\beta) \cdot R_x(-\alpha) \cdot T_1$$

$$Q3. \begin{bmatrix} 2 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} 2x+y \\ y+1 \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix}$$

$$\Rightarrow x = \frac{1}{2}(x' - y' + 1)$$

$$y = y' - 1$$

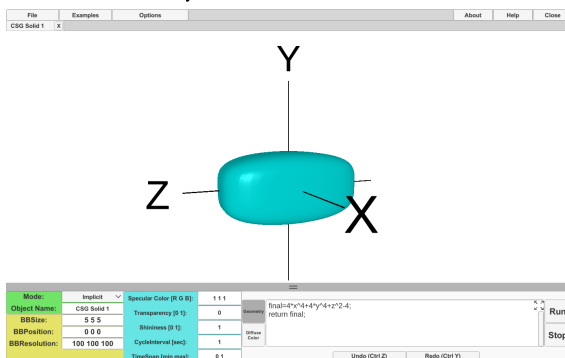
$$z = z'$$

$$\text{satisfy: } 4x\left(\frac{1}{2}(x' - y' + 1)\right)^4 + 4(y' - 1)^4 + z'^2 - 4 = 0$$

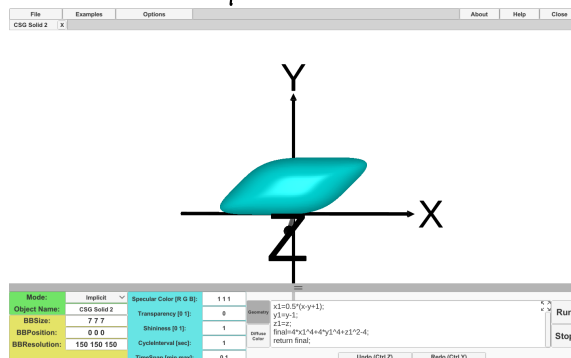
the implicit function of the new object is

$$4 \cdot \left(\frac{1}{2}(x - y + 1)\right)^4 + 4(y - 1)^4 + z^2 - 4 = 0$$

origin



transformed



Q4. original curve =
$$\begin{cases} X = \sin(\pi u) & u \in [0, 1] \\ y = 0 \\ z = \cos(\pi u) + 1 \end{cases}$$

$R_y(\theta) = \begin{bmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \begin{matrix} \theta \in [0, 2\pi] \\ \theta = 2\pi v \\ v \in [0, 1] \end{matrix}$

$T = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 2v \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad v \in [0, 1]$

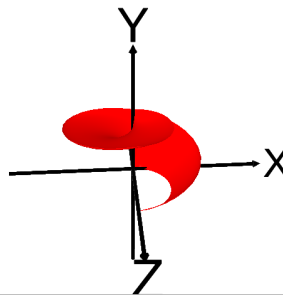
$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} \cos \theta & 0 & \sin \theta & 0 \\ 0 & 1 & 0 & 2v \\ -\sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} \cos \theta x + \sin \theta z \\ 2v \\ -\sin \theta x + \cos \theta z \\ 1 \end{bmatrix}$$

thus, the parametric representation of the surface is

$$\begin{cases} X = \sin(\pi u) \cdot \cos(2\pi v) + (\cos(\pi u) + 1) \cdot \sin(2\pi v) & u \in [0, 1] \\ y = 2v & v \in [0, 1] \\ z = \sin(\pi u) \cdot (-\sin(2\pi v)) + (\cos(\pi u) + 1) \cdot \cos(2\pi v) \end{cases}$$

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Parametric	X				



Mode:	Parametric	Specular Color [R G B]:	1 1 1	Geometry	x1=sin(pi*u); z1=cos(pi*u)+1; x=x1*cos(2*pi*v)+z1*sin(2*pi*v); y=2*v; z=-sin(2*pi*v)*x1+z1*cos(2*pi*v);	Run
Object Name:	Parametric Solid 1	Transparency [0 1]:	0	Diffuse Color		Stop
Domain:	0 1 0 1 0 1	Shininess [0 1]:	1			
Resolution:	30 30 30	CycleInterval [sec]:	1			
		TimeSpan [min max]:	0 1		Undo (Ctrl Z) Redo (Ctrl Y)	