#Math 2270
#Final Project

with(*LinearAlgebra*) :
#Basic transformation matrix
v0 := ⟨*a·x*, *b·y*, *c·z*, 1⟩;

$$\begin{bmatrix} a\,x \\ b\,y \\ c\,z \\ 1 \end{bmatrix}$$

(1)

 # Matrix result for scale
Scale := ⟨⟨2, 0, 0, 0⟩|⟨0, 2, 0, 0⟩|⟨0, 0, 2, 0⟩|⟨0, 0, 0, 1⟩⟩;

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(2)

#Scale Transmormation matrix for 2x, 2y, 2z
v := ⟨*x*, *y*, *z*, 1⟩;

$$\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

(3)

vprimeS := ⟨2 *x*, 2 *y*, 2 *z*, 1⟩;

$$\begin{bmatrix} 2\,x \\ 2\,y \\ 2\,z \\ 1 \end{bmatrix}$$

(4)

Scale.v

$$\begin{bmatrix} 2\,x \\ 2\,y \\ 2\,z \\ 1 \end{bmatrix}$$

(5)

#Translation
t1 := ⟨*x* + *dx*, *y* + *dy*, *z* + *dz*, 1⟩;

$$\begin{bmatrix} x+dx \\ y+dy \\ z+dz \\ 1 \end{bmatrix}$$

$$(6)$$

$Translation1 := \langle\langle 1, 0, 0, 0\rangle | \langle 0, 1, 0, 0\rangle | \langle 0, 0, 1, 0\rangle | \langle dx, dy, dz, 1\rangle\rangle;$

$$\begin{bmatrix} 1 & 0 & 0 & dx \\ 0 & 1 & 0 & dy \\ 0 & 0 & 1 & dz \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$(7)$$

$Translation2 := \langle\langle 1, 0, 0, 0\rangle | \langle 0, 1, 0, 0\rangle | \langle 0, 0, 1, 0\rangle | \langle 5, 2, 1, 1\rangle\rangle;$

$$\begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$(8)$$

$\langle x+5, y+2, z+1, 1\rangle;$

$$\begin{bmatrix} x+5 \\ y+2 \\ z+1 \\ 1 \end{bmatrix}$$

$$(9)$$

$\langle 5, 2, 1, 1\rangle;$

$$\begin{bmatrix} 5 \\ 2 \\ 1 \\ 1 \end{bmatrix}$$

$$(10)$$

#Rotation
$Rx := \langle\langle 1, 0, 0, 0\rangle | \langle 0, \cos(theta), \sin(theta), 0\rangle | \langle 0, -\sin(theta), \cos(theta), 0\rangle | \langle 0, 0, 0, 1\rangle\rangle;$

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

$$(11)$$

$Ry = \langle\langle \cos(theta), 0, \sin(theta), 0\rangle | \langle 0, 1, 0, 0\rangle | \langle -\sin(theta), 0, \cos(theta), 0\rangle | \langle 0, 0, 0, 1\rangle\rangle;$

$$Ry = \begin{bmatrix} \cos(\theta) & 0 & -\sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{12}$$

$Rx1 := \left\langle \langle 1, 0, 0, 0 \rangle \middle| \left\langle 0, \cos\left(\frac{pi}{2}\right), \sin\left(\frac{pi}{2}\right), 0 \right\rangle \middle| \left\langle 0, -\sin\left(\frac{pi}{2}\right), \cos\left(\frac{pi}{2}\right), 0 \right\rangle \middle| \langle 0, 0, 0, 1 \rangle \right\rangle;$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\left(\frac{1}{2}\pi\right) & -\sin\left(\frac{1}{2}\pi\right) & 0 \\ 0 & \sin\left(\frac{1}{2}\pi\right) & \cos\left(\frac{1}{2}\pi\right) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{13}$$

$Rx2 := \langle \langle 1, 0, 0, 0 \rangle | \langle 0, 0, 1, 0 \rangle | \langle 0, -1, 0, 0 \rangle | \langle 0, 0, 0, 1 \rangle \rangle;$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{14}$$

$Ry1 := \left\langle \left\langle \cos\left(\frac{pi}{4}\right), 0, \sin\left(\frac{pi}{4}\right), 0 \right\rangle \middle| \langle 0, 1, 0, 0 \rangle \middle| \left\langle -\sin\left(\frac{pi}{4}\right), 0, \cos\left(\frac{pi}{4}\right), 0 \right\rangle \middle| \langle 0, 0, 0, 1 \rangle \right\rangle;$

$$\begin{bmatrix} \cos\left(\frac{1}{4}\pi\right) & 0 & -\sin\left(\frac{1}{4}\pi\right) & 0 \\ 0 & 1 & 0 & 0 \\ \sin\left(\frac{1}{4}\pi\right) & 0 & \cos\left(\frac{1}{4}\pi\right) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{15}$$

$Ry2 := \left\langle \left\langle \frac{1}{\text{sqrt}(2)}, 0, \frac{1}{\text{sqrt}(2)}, 0 \right\rangle \middle| \langle 0, 1, 0, 0 \rangle \middle| \left\langle -\frac{1}{\text{sqrt}(2)}, 0, \frac{1}{\text{sqrt}(2)}, 0 \right\rangle \middle| \langle 0, 0, 0, 1 \rangle \right\rangle;$

$$\begin{bmatrix} \frac{1}{2}\sqrt{2} & 0 & -\frac{1}{2}\sqrt{2} & 0 \\ 0 & 1 & 0 & 0 \\ \frac{1}{2}\sqrt{2} & 0 & \frac{1}{2}\sqrt{2} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{16}$$

$Rx2.Ry2;$

$$\begin{bmatrix} \dfrac{1}{2}\sqrt{2} & 0 & -\dfrac{1}{2}\sqrt{2} & 0 \\[2mm] -\dfrac{1}{2}\sqrt{2} & 0 & -\dfrac{1}{2}\sqrt{2} & 0 \\[2mm] 0 & 1 & 0 & 0 \\[1mm] 0 & 0 & 0 & 1 \end{bmatrix} \tag{17}$$

$Rotate := \langle\langle .707, -.707, 0, 0\rangle | \langle 0, 0, 1, 0\rangle | \langle -.707, -.707, 0, 0\rangle | \langle 0, 0, 0, 1\rangle\rangle;$

$$\begin{bmatrix} 0.707 & 0 & -0.707 & 0 \\ -0.707 & 0 & -0.707 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{18}$$