1. (a) Construct the $4 \times 4$ matrix that corresponds to a 135 degree counter-clockwise rotation around the $X$ axis followed by a translation by $\langle 1, 0, 0 \rangle$.

(b) Given a unit cube with corners $\langle 0, 0, 0 \rangle$ and $\langle 1, 1, 1 \rangle$, what are its corners after transformation by the above matrix (give all eight coordinates)?

2. Affine transformations can be represented by $4 \times 4$ homogeneous matrices with the following shape:

$$\begin{bmatrix} M & t \\ 0 & 1 \end{bmatrix}$$

where $M$ is a $3 \times 3$ matrix and $t$ is a vector. We can use $\langle M \mid t \rangle$ as a more compact notation for this class of matrices. The product of two homogeneous matrices is

$$\langle M_1 \mid t_1 \rangle \langle M_2 \mid t_2 \rangle = \langle M_1 M_2 \mid M_1 t_2 + t_1 \rangle$$

and applying the transformation to a homogeneous point is

$$\langle M \mid t \rangle \begin{bmatrix} v \\ 1 \end{bmatrix} = M_1 v + t$$

If we restrict ourselves to isotropic (uniform) scaling, rotation, and translation, then these matrices are called SRT transforms and have the form $\langle sR \mid t \rangle$, where $s$ is a scalar and $R$ is a rotation matrix. Given this notation, solve the following equations:

(a) $\langle s_1 R_1 \mid t_1 \rangle \langle s_2 R_2 \mid t_2 \rangle$

(b) $\langle sR \mid t \rangle \begin{bmatrix} v \\ 1 \end{bmatrix}$

(c) $\langle sR \mid t \rangle^{-1}$

3. Given a ray $R(t) = o + t d$, and a cone whose radius is $r$ and height is $h$ with its base centered at the origin of the $X - Y$ plane and its apex at $\langle 0, 0, h \rangle$, what is the polynomial whose roots determine the intersection points of $R(t)$ with the cone?