

Name:

PID:

1. For each of the four transformations (a)-(d) of  $\mathbb{R}^3$ , give a  $4 \times 4$  matrix that represents it over homogeneous coordinates.

(a) The translation  $T_{\langle 1,0,2 \rangle}$ .

$$\begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

(b) The non-uniform scaling  $S_{\langle 3,2,1 \rangle}$ .

$$\begin{pmatrix} 3 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

(c) The rotation  $R_{\pi, \mathbf{k}}$ .

$$\begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

(d) The rotation  $R_{\pi, \langle 1,0,1 \rangle}$ .

$$\begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$