1. Define functions $f_1 : \langle x_1, x_2 \rangle \mapsto \langle -x_2, x_1 \rangle$, and $f_2 : \langle x_1, x_2 \rangle \mapsto \langle -2x_1, \frac{1}{2}x_2 \rangle$, and $f_3 : \langle x_1, x_2 \rangle \mapsto \langle x_1 - x_2, x_2 \rangle$, and $f_4 : \langle x_1, x_2 \rangle \mapsto \langle x_2, x_1 - x_2 \rangle$. Verify (but do not show your work) that each $f_i$ is linear.

   a. Draw (and show your answer below) how these four functions transform the “F”-shape. Your answers should be similar to the drawing on the right in Figure II.3 on page 22.

   b. Which of the $f_i$’s are rigid? Which of the $f_i$’s are orientation-preserving?

2. Do Exercise II.2, page 22 (using Figure II.4).

3. Let $f(x)$ denote the transformation of the previous problem (#II.2). Express $f^{-1}$, the inverse of $f$, as an affine map in the form $f^{-1}(x) = Nx + w$.


5. Do Exercise II.8, page 27 (using Figure II.9)

6. Do Exercise II.9, page 28 (again using Figure II.9)


8. Let $T_u$ and $R_{\theta,u}$ be the translation and rotation operators in $\mathbb{R}^3$. Give the $4 \times 4$ matrix representations of $T_{i+j} \circ R_{\pi/2,k}$ and of $R_{\pi/2,k} \circ T_{i+j}$. (You can do this either by multiplying matrices or by visualizing. If you do it with matrices, you are recommended to try visualizing afterwards.)