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 \( T_{1} \circ R_{\pi/2,k} \) and of \( R_{\pi/2} \circ T_{1+j} \). (You can do this either by multiplying matrices or by visualizing. If you do it with matrices, you are recommended to try visualizing afterwards.)