CS3388B, Winter 2023

Problem Set 3

Due: January 27, 2023

Exercise 1.

Consider a window with width 1000px and height 800px with a viewport whose opposite corners, in pixels, are $(200, 100)$ and $(800, 700)$.

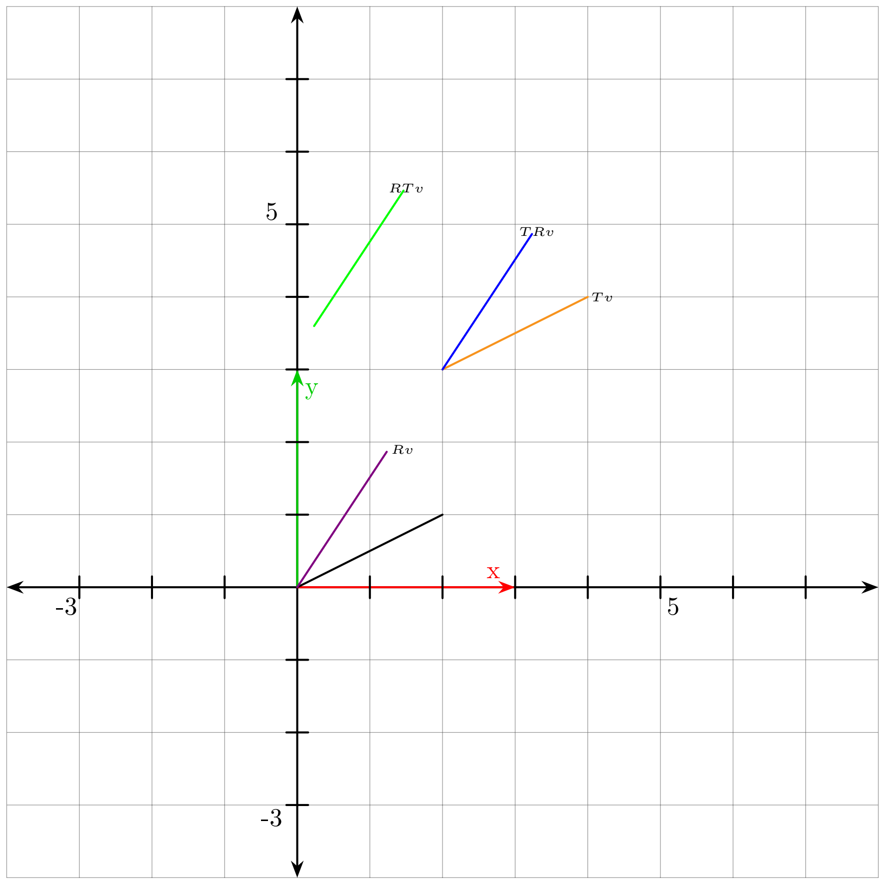
Give the viewport matrix which transforms normalized device coordinates to this viewport.

```
[w/2      0      x0 + w/2]
[                        ]
[0       h/2     y0 + h/2]
[                        ]
[0        0         1    ]
```

Exercise 2. Consider the following affine transforms:

$$T = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix} \qquad R = \begin{bmatrix} \cos(30) & -\sin(30) & 0 \\ \sin(30) & \cos(30) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Let $M_1 = TR$ and $M_2 = RT$ be two transformation matrices. Consider the line segment defined by $v_1 = (0, 0)$ and $v_2 = (2, 1)$. Draw the line segment when transformed by M_1 and when transformed by M_2. Describe, in words, what is the difference between the affine transforms M_1 and M_2? Why is the result different?



Exercise 3.

Consider the shear matrix

$$S = \begin{bmatrix} 1 & m \\ 0 & 1 \end{bmatrix}.$$

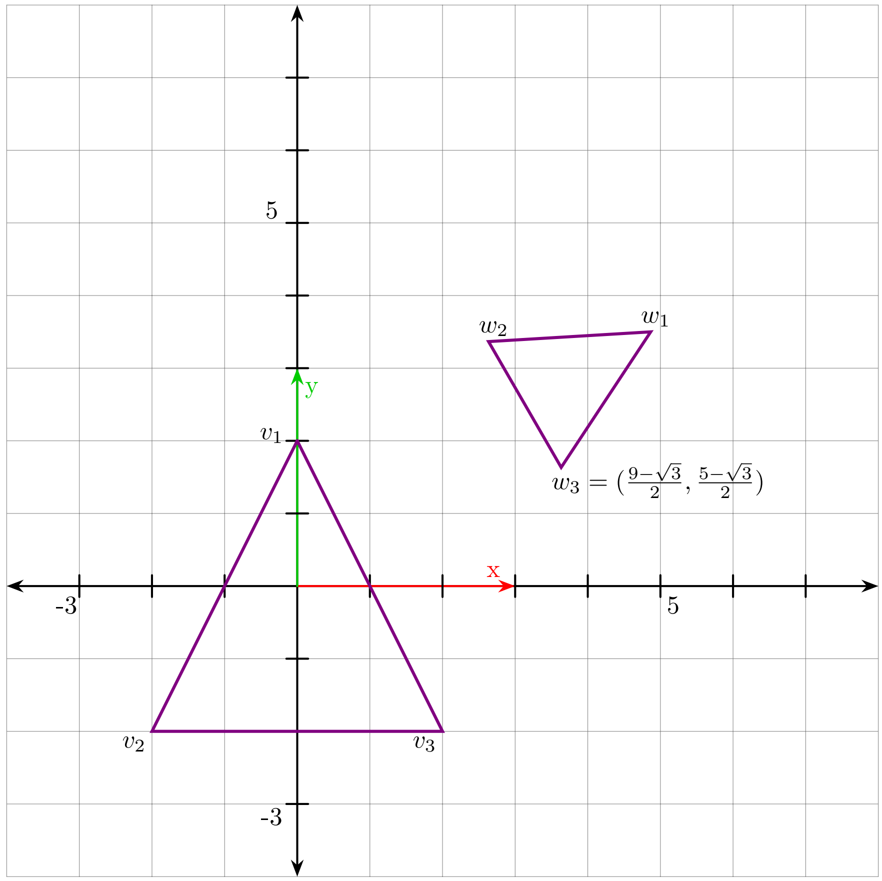
Find the inverse of S in homogeneous coordinates and show that $SS^{-1} = I_3$, the 3x3 identity matrix.

```
[1     m     0]
[            ]
[0     1     0]
[            ]
[0     0     1]

[1     -m     0]
[             ]
[0     1      0]
[             ]
[0     0      1]
```

Exercise 4.

The below triangle (v_1, v_2, v_3) has been affinely transformed to (w_1, w_2, w_3) by a combination of a scaling, a translation, and a rotation. Let those individual transformations be described by the matrices S, T, R, respectively.



Using homogeneous coordinates, find the matrices S, T, R. Then find (through matrix-matrix and matrix-vector multiplication) the coordinates of w_1 and w_2. What is the correct order of matrix multiplications to get the correct result?

$TSRv$ is one correct order (of many). $T, S, R :=$

```
[1     0     4]
[             ]
[0     1     3]
[             ]
[0     0     1]

[0.5      0      0]
[                 ]
[ 0      0.5     0]
[                 ]
[ 0       0      1]
```

```
[               1/2      ]
[             3          ]
[ 1/2         ----      0]
[              2         ]
[                        ]
[    1/2                 ]
[  3                     ]
[- ----       1/2       0]
[    2                   ]
[                        ]
[  0           0        1]
```