Homework #1
Matrices, Vectors, and Transforms
Due Thursday, September 13 by the end of class

Question #1: (20 points)
For each of the following homogeneous coordinates,
(a) (6 pts) state whether it is a point or a vector.
(b) (6 pts) state whether it is normalized or not.
(c) (8 pts) if it is not normalized, please normalize it; if it is already normalized, do nothing.

| 1  | 11 | 5 |
| 5  | 8  | 7 |
| 9  | 6  | 2 |
| 1  | 4  | 0 |
| 7  | 1/√2 | 14 |
| 7  | 0  | 7 |
| 7  | 1/√2 | 21 |
| 0  | 0  | 1 |

Question #2: (15 points)

(a) (5 pts) Solve the following dot product:

\[
\begin{bmatrix}
2 \\
-1 \\
5
\end{bmatrix}
\cdot
\begin{bmatrix}
3 \\
8 \\
10
\end{bmatrix}
\]

(b) (5pts) Solve the following cross product:

\[
\begin{bmatrix}
4 \\
1 \\
9
\end{bmatrix}
\times
\begin{bmatrix}
2 \\
8 \\
1
\end{bmatrix}
\]

(c) (5pts) State the equation for the plane defined by the vector \([1, 2, 3, 0]^T\) and the point \([3, 2, 1, 1]^T\). Your answer should be in the form \(ax + by + cz + d = 0\).

Question #3: (35 points)

Part I:
Write out the following 4x4 matrices and label each with the following names:

- (4 pts) \(\mathbf{T0}\): Translate in x by 4 and in y by 3
- (4 pts) \(\mathbf{R}\): Rotate about the z axis by \(\pi/4\) (45 degrees)
- (4 pts) \(\mathbf{T1}\): Translate in x by -4 and in y by -3
- (4 pts) \(\mathbf{S}\): Scale in x by a factor of 2, and y by a factor of 4 (z is unchanged)
Part II: (5 pts)
Assume you have an object you want to rotate by $\pi/4$ around a z-axis centered at (4,3,0). Using the symbols $T_0$, $R$, and $T_1$, please show the correct order of composition of those matrices to perform the desired rotation.

Part III: (10 pts)
Multiply out your answer from part II.

Part III: (8 pts)
Apply the transform $R$ to the 3D coordinate (7, 5, 7) and multiply out.