1. Prove that if two lines are parallel, they will continue to be parallel if we apply any arbitrary 2D affine transformation to them.

2. Affine Transformations
   a. Create a single matrix that will rotate 3D points by 45 degrees around the y axis and then translate them 3 units in the z direction.
   
   b. Consider the following matrix:

   \[
   \begin{pmatrix}
   1 & 1 & 3 \\
   -1 & 1 & 3 \\
   0 & 0 & 1
   \end{pmatrix}
   \]

   This matrix transforms 2D points. Express the effect of this matrix as a combination of scaling, rotation and translation. For example, an (incorrect) answer might be: This matrix translates points by (7,3), then scales them by a factor of 2, then rotates them counterclockwise by 60 degrees.

3. Perspective
   a. Suppose you have a camera with a focal point at (0,0,0) and an image plane at z = 1. There is a world point located at (16, 8, 4). Where does this point appear in the image?
   
   b. Suppose the camera’s focal length changes to be z = 2, with the focal point still at (0,0,0). Where does the point appear in the image now?
   
   c. Suppose we have the camera from problem a, and we are looking at a line on the floor that passes through the points (3, -2, 6) and (4, -2, 9). What is the vanishing point of this line?
   
   d. Suppose there is a camera with a focal point at (7,6,13) and an image plane that can be described by the equation \( x + y = 14 \). There is a point in the world located at (17,11,8). If a ray of light goes from this point towards the focal point, where will it intersect the image plane?
4. Orthographic projection

a. Suppose that I have two line segments in 3D that have the same length. Give an example to show that after these are projected orthographically into an image, they do not necessarily have to have the same length.

b. Show that if the line segments are parallel and have the same length, they will still have the same length after being projected into the image. Hint: Two line segments are parallel if they point in the same direction. This means that the vector from one end of the line segment to the other is the same for both line segments.

5. QT

Follow the instruction on Prof. Khan’s web course web page (https://www.cs.umd.edu/class/fall2014/cmsc427/) to download Qt onto your machine (if this is not possible, you can use a machine in a computer lab, as explained on that web page). Run the HelloWorld2D program provided on that web page. Take a screen shot showing the working program, and hand it in.