Make sure that your writing is legible, or else, please type your answers using your favorite text formatter. Your solutions are to be on the due date in class at the beginning of the class and no later. No late assignments (please read the policies on the class web site).

1. Show that reflection about the line $y = x \in \mathbb{R}^2$ can be achieved by a composition of rotations about the origin and a reflection about the x-axis. Also write down the precise order of the composition and the entries in the individual matrices in this composition.

2. Show that parallel lines remain parallel under an affine transformation i.e., the property of being parallel is an invariant of the class of affine transformations.

3. Prove that ratio of areas is invariant to planar affine transforms. Is this ratio invariant for orientation reversing affinities (affine transforms) as well?

4. Show that a line at infinity $l_{\infty}$ remains a line at infinity under the projectivity $H$ if and only if $H$ is an affinity. Note that you have to prove both sides of the implication.

5. Prove that an image line $l$ defines a plane through the camera center with normal direction $n = K^t l$ measured in the camera’s Euclidean (inhomogeneous) coordinate frame, where $K$ is the camera matrix (internal parameters).

6. Given a projective transformation that takes points $x \rightarrow x'$ via $x' = Hx$, prove that $Cross(x_1', x_2', x_3', x_4') = Cross(x_1, x_2, x_3, x_4)$ i.e., the cross ratio is a projective invariant. You may do this for the 1-dimensional case which implies, the points are represented in homogeneous coordinates by a two-vector $(x_1, x_2)^t$ and the $H$ matrix is a $(2,2)$ matrix.