3. Transformations

a. You are given a coordinate system that has been transformed with respect to the world coordinate system. The transformation matrix is

$$M = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 0.8 & -0.6 & 1 \\ 0 & 0.6 & 0.8 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

What are the coordinates of the point (1 1 1) in the transformed coordinate system?

b. Rotation transformations are not commutative. Demonstrate this by computing 1) the transformation matrix for a rotation by 90° about x followed by a rotation by 90° about y and 2) the transformation matrix for a 90° rotation about y followed by a 90° rotation about x. 3) Apply the two composite transformation matrices to the point (1 1 1) to demonstrate that rotations are not commutative.

5. Hidden Surface Removal:
a. Write pseudo-code implementing a z-buffer algorithm for hidden surface removal.

b. What are the costs of this approach to hidden surface removal?

6. Projections:
a. List the sequence of operations (and purpose of each) in the transformation from world coordinates to screen coordinates using a parallel projection. You don't need to give the matrices, just the operations (e.g. shear) and a brief description of why they are needed (e.g. to align DOP with z axis).

b. What is the difference between parallel and perspective projections? Describe an application where each type of projection would be preferable.

2. Transformations

a. In Silicon Graphics's GL language the camera position can be specified with *lookat (fx, fy, fz, ax, ay, az);* where *fx, fy, fz* are the position of the camera in world coordinates and *ax, ay, az* are the location that the camera

is looking at. If you had a view of a unit square with its center at $(0, 0, 0)$ and parameters of $fx = 5$, $fy = 5$, $fz = 0.5$, and $ax = 0$, $ay = 0$, and $az = 0.5$ what would the final image look like? Show the axes for the world coordinate system and a bird's eye view of the ground plane to explain how you arrived at the three-dimensional view.

This specification does not allow the user complete control over the camera position and orientation. What assumptions are inherent in the lookat command?

3. Shadows

a. Explain why visible surface determination and shadow generation algorithms address a similar problem.

4. Illumination and Interpolation

a. Give the Phong illumination model including ambient, diffuse and specular components. Draw a picture to show the direction of the vectors in the equation.

b. What effects are lost in Phong illumination by putting the light source and the viewer infinitely far away from the scene?