Homework #2: Lighting, Shading, Object Modeling, 2D/3D Transforms
Due Friday, October 12th

1.
   a. Show that the following sequences commute:
      i. A rotation and a uniform scaling
      ii. Two rotations about the same axis
      iii. Two translations
   b. Show that the following does not commute:
      i. A rotation and a translation

2. Suppose we have a line extending from (0, 0, 0) to (1, 0, 0). We apply a single rotation to move one endpoint of the line to (0, 0, 1). Which vector was used as the axis of rotation?

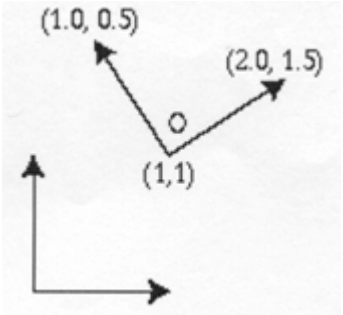
3. Write down the lighting equation that expresses lighting at a point in terms of ambient, diffuse, and specular components. Explain what the terms mean.

4. Given a polygonal mesh as (x, y, z) vertices connected by edges and faces, how would you calculate each face's normal and the normal at each vertex?

5.
$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} 6 \\ 4 \\ 1 \\ 1 \end{bmatrix}$$

   a. What is the homogenous 4-vector defined by the above multiplication?
   b. What is the real coordinate 3D space that the 4-vector represents?

6.
   a. Drawn below are two 2D coordinate systems shown as a set of axes. The coordinates of the origin and the tips of the *x* and *y* axes of the coordinate system **O** (the object coordinate system) are given. These coordinates are with respect to the world coordinate system.



Derive a transformation matrix that transforms the object coordinate system to the world coordinate system. You may write this matrix as a product of other matrices if you wish. You must fill in the entries for each matrix that you give (i.e. it is not enough to just give an answer that says rotate by 10 degrees); however, each entry may be a number or a mathematical expression.

b. Derive the transformation from the world coordinate system to the object coordinate system **O**.