CMSC 23700	Introduction to Computer Graphics	Homework 2
Winter 2014		Due January 30

1. Let $L_1(t) = \mathbf{p}_1 + t\mathbf{d}_1$ and $L_2(t) = \mathbf{p}_2 + t\mathbf{d}_2$ be parametric descriptions of two lines (with $|\mathbf{d}_1| = |\mathbf{d}_2| = 1$. The main text describes an approach to computing the distance between two lines that is based on differential equations (pp. 94-96). There is another way to solve this problem based on geometric reasoning.

   Let $\mathbf{q}_1 = L_1(t_1)$ and $\mathbf{q}_2 = L_2(t_2)$ be the closest points on the two lines. Then the vector $\mathbf{u} = \mathbf{q}_2 - \mathbf{q}_1$ will be perpendicular to the two lines.

   Based on this observation, derive a formula for determining t_1 and t_2.

2. Consider a cylinder with radius 1 and height 2 that is centered at the origin with its axis being the Z axis.

   (a) Give an *implicit* representation of the cylinder.

   (b) Given a ray $R(t) = \mathbf{o} + t\mathbf{d}$, with $|\mathbf{d}| = 1$, derive an intersection test for the ray and cylinder.

3. An *oriented bounding box* (OBB) can be represented by a center point $\mathbf{p}$, a 3x3 rotation matrix $\mathbf{R}$ (the columns of this matrix define the axes of the OBB), and a vector $\mathbf{r}$ of extents (the distances from the center to the sides along each of the OBB's axes).

   (a) Define an affine transformation that takes the axis-aligned $2 \times 2 \times 2$ cube centered at the origin to the OBB.

   (b) Given a sphere $\langle \mathbf{c}, r \rangle$, outline a test to determine if the sphere intersects the OBB.