CMSC 23700	**Introduction to Computer Graphics**	**Homework 3**
Fall 2004		**Due November 4**

1. Let $R(t) = \langle 1, 1, 1\rangle + t\langle -1, -1, -1\rangle$ and let S be the unit sphere at the origin. For what values of t does $R(t)$ intersect S?

2. An *axis-aligned bounding box* (AABB) in 2D is defined by four scalar values:

$$\langle minX, maxX, minY, maxY\rangle$$

We use $\langle 1, -1, 1, -1\rangle$ to denote the empty AABB. Let

$$bb_1 = \langle minX_1, maxX_1, minY_1, maxY_1\rangle$$

and

$$bb_2 = \langle minX_2, maxX_2, minY_2, maxY_2\rangle$$

be two *non-empty* AABBs.

   (a) What is the minimum AABB that contains the union of bb_1 and bb_2?

   (b) What is the minimum AABB that contains the intersection of bb_1 and bb_2?

   (c) What is the minimum AABB that contains the difference of bb_1 and bb_2 (*i.e.,* $bb_1 \setminus bb_2$).?

3. Let $\mathbf{M} = \begin{bmatrix} & \mathbf{N} & & \\ 0 & 0 & 0 & 1 \end{bmatrix}$ be a 4×4 matrix. Show that $\mathbf{M}\langle x, y, z, 1\rangle^{\mathrm{T}}$ is the same as $\mathbf{M}\langle hx, hy, hz, h\rangle^{\mathrm{T}}$ after homogenization.

4. Suppose you have an application with a near plan of 10 meters, a far plane of 100 kilometers (10^5 meters), and a minimum feature size of 1 meter. How many bits of Z-buffer do you need to avoid Z-fighting? What if the near plane is at 1 meter?