CS4451 TEST 1 / SPRING 2004

1. Write the matrix (in homogenous coordinates) of the planar transformation that rotates by 45 degrees around the point $(1, 2)$.

2. Take a sphere centered at c with radius R. Let the viewpoint be at e and the light source at b. You know that the distance between the viewpoint and the center of the sphere is the same as the distance between the light source and the center of the sphere and that $\angle ecb < 90°$

1. Assuming that only ambient and *diffuse* terms are used for illumination, which point on the sphere appears brightest? Give a formula for that point.

2. Assuming that only ambinet and *specular* terms are used for illumination, which point on the sphere appears brightest? Give a formula for that point.

3. Describe how you would extend the ray tracer you wrote for the first project to include objects that are perfect mirrors, maybe a few triangles and spheres. Be concise and specific: concentrate on how to compute a color for some pixel.

4. You are rendering a horizontal equilateral triangle using OpenGL, using the 'true' normals at all vertices (thus, the normals of all vertices are equal to the normal vector of the triangle's plane). The light source is directly above the center of the triangle. Let's say that the triangle's material combines ambient and diffuse terms. Compare the brightness of the center of the triangle under the three shading models:

1. Flat

2. Gouraud

3. Phong

5. A scene consists of several spheres, all disjoint and no one contained in another. All spheres are nicely triangulated in a way suitable for back face culling and rendered in OpenGL, with back face culling on and with the z-buffer working. Things look fine when the viewpoint is outside all of the spheres. Describe what happens when it moves to the inside of one of the spheres. Which of the spheres will you see, if any at all? Explain why.

6. If vertices of a triangle project to pixels $(0, 0)$, $(5, 5)$ and $(0, 5)$ and their depths are (respectively) 0.1, 0.35 and 0.6, what is the depth of the pixel $(1, 2)$?