

Name: SOLUTIONS

Midterm Exam
15-462 / 15-662 Computer Graphics, Spring 2014

60 points

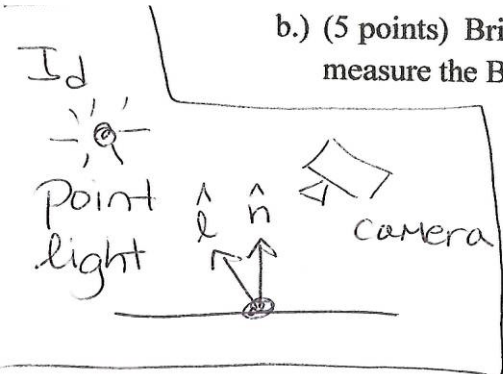
Closed book, closed notes, no calculators. Use the back of the sheets for extra space.
Write down your assumptions and steps so that I can give you partial credit.

1. (10 points) **BRDFs and Surface Reflectance.** Measuring a BRDF for an anisotropic surface may involve sampling inputs and outputs over 4 total dimensions: two dimensions may parameterize the incoming light source direction, and two dimensions may parameterize the outgoing light source direction. Suppose we are certain that the surface to be measured is an ideal diffuse (i.e., Lambertian) surface.

Perfect
diffuse
surface

- a.) (5 points) What is the minimum number of dimensions we must sample to fully capture the BRDF of this surface? Explain your answer.

- b.) (5 points) Briefly describe a simple hardware setup that would allow you to measure the BRDF of an ideal diffuse (Lambertian) surface.



Carefully measure \hat{l} . Take a single picture
Solve for k_d as above, for red, green, and blue channels separately.

Practically, taking multiple samples & averaging

2. (5 points) **OpenGL Depth Buffer.** True or false: Under perspective projection, the depth information stored in the OpenGL depth buffer is a linear scaling of the true distance of an object from the camera. Clearly and concisely explain your answer. ^{is} better.

Name: SOLUTIONS

3. (5 points) Shaders and GLSL. List one thing that you can do in a fragment shader that cannot be done in a vertex shader. Clearly and concisely explain your answer.

4. (10 points) 2D Transforms.

a triangle.

a.) (5 points) Give a 2x2 matrix that reflects (mirrors) any 2D point about the x-axis.

b.) (5 points) Is the 2x2 matrix which mirrors points about the x-axis a rotation matrix? Why or why not?

Name: SOLUTIONS

6. (5 points) **3D Transformations and Normal Vectors.** Suppose we are given a transformation matrix M that was created by combining a number of rigid body transformations (i.e., some sequence of translations and rotations). True or false: both vertex positions and surface normals can be accurately transformed by multiplying them by matrix M . Concisely explain your answer.

Name: SOLUTIONS

8. (20 points) **Implicit functions and distance.** Certain tasks in graphics benefit from an ability to quickly calculate the distance to the closest object. We are going to explore calculating the distance to a plane using implicit functions. For all of the questions below, assume you are given a plane defined by the implicit function

$$f(x,y,z) = 2x + y - 3z + 1 = 0$$

- a.) (5 points) Choose some specific point \mathbf{r} that lies on the plane. Test your point by ensuring that $f(r_x, r_y, r_z) = 0$.

- b.) (5 points) Give a vector \mathbf{n} that is normal to the plane. It does not have to be a unit vector.

- c.) (5 points) Using \mathbf{r} and \mathbf{n} from parts a.) and b.), write an expression for a point \mathbf{s} that lies at unit distance from the plane. In other words, the distance of point \mathbf{s} from the plane must be equal to 1.

- d.) (5 points) Use implicit function $f(x,y,z)$ defined above to create a distance function $D(x,y,z)$ that exactly computes the signed distance of a point $[x, y, z, 1]^T$ from the given plane.