

## 6.837 Introduction to Computer Graphics

### Quiz 1

Tuesday October 26, 2003 2:40-4pm

One page of notes allowed

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### 1 Light and shading [ /15]

#### 1.1 Phong [ /2]

What is the visual effect of the Phong exponent? Write one or two sentences.

#### 1.2 Lambertian materials [ /4]

For a diffuse material, the BRDF is constant, yet the intensity varies across a rounded surface. Why? Write one or two sentences.

#### 1.3 Falloff[ /2]

In the real world, how fast does light intensity decrease with respect to distance from a point light source?

### 1.4 Shadows [ /3]

Which algorithm produced the shadows in the following image: ray-casting, shadow maps or shadow volumes? How can you tell?



### 1.5 Recursive ray tracing [ /4]

If the objects in your scene have reflective and transmissive color no “brighter” than  $(0.5, 0.5, 0.5)$  and the recursive ray weight cutoff is 0.05, what is the maximum depth of the ray tree in *your* ray tracer? Explain briefly.

## **2 Linear algebra [ /12]**

### **2.1 Linearity [ /3]**

What formal property defines linearity? Write one or two equations that characterize a linear operator.

### **2.2 Translation [ /2]**

Show that translation is not linear in Euclidean space.

### **2.3 Translation in homogeneous coordinates [ /2]**

Give the 4x4 matrix  $M$  for translation by a vector  $(t_x, t_y, t_z)$  in homogeneous coordinates.

## 2.4 Sum in homogeneous coordinates [ /5]

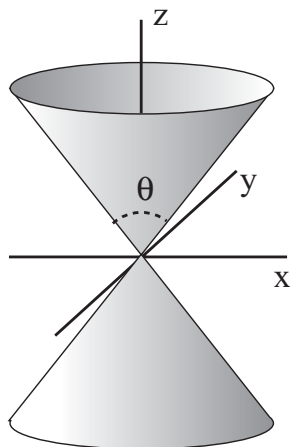
Consider the coordinate-by-coordinate sum of two homogeneous vectors (four components each). What's the 3D geometric interpretation of this sum? First treat the case where both vectors have  $w = 1$ , then the more general case where  $w \neq 0$ .

Now show that translation is a linear operation in homogeneous coordinates.

## 3 Ray-cone intersection [ /15]

### 3.1 Cone equation [ /4]

Give the implicit equation for a double-cone of angle  $\theta$  centered on the origin and oriented along the  $z$  direction.



### 3.2 Ray equation [ /2]

Give the parametric equation of a ray with origin  $O$  and direction  $\vec{d}$ .

### 3.3 Intersection [ /6]

Give the equation for the parameter  $t$  at the ray-cone intersection. Solve for  $t$ . Do you always find a solution? Why or why not?

### 3.4 Finite cone [ /3]

How do you need to change the equation or the code to handle half-infinite cones (only the half in the positive  $z$  half space)?

## 4 Rasterization [ /8]

### 4.1 Efficiency [ /4]

Here is pseudo-code for triangle rasterization.

```
For each triangle
  Set up coefficients ai, bi, ci for the 3 edge equations
  For each screen pixel
    For each edge fi = ai x + bi y + ci
      If all fi are positive
        display pixel
```

Give two possible optimizations.

### 4.2 Line rasterization [ /4]

How are line rasterization and ray-intersection acceleration related?

How do they differ?