**CS 559: Computer Graphics**

Homework 6

This homework must be done individually. Submission date is Tuesday, April 20, 2004, in class.
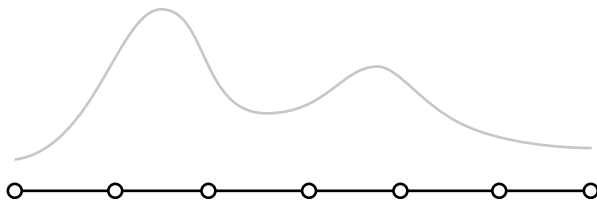
Question 1:

The figure below plots the accurately computed brightness of each point on a flat polygonal surface, as might be computed using the standard lighting model. The vertices of the polygonal surface are shown as small circles, indicating that there are six faces involving seven vertices. The brightness at each point is due to some light sources and a particular viewer position, none of which are shown.
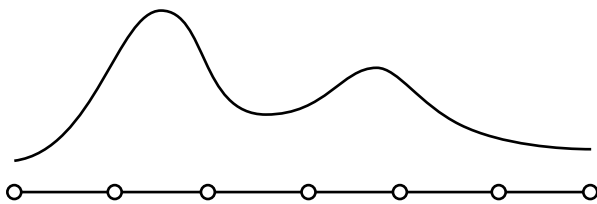

a. Plot the intensity that the viewer would see at each point if a flat shading model was used. Assume that the reference point for the flat shading is the leftmost vertex of each face. The accurate values are lightly shown on the figure below to help you. Feel free to draw on this sheet and hand it in as part of your homework.
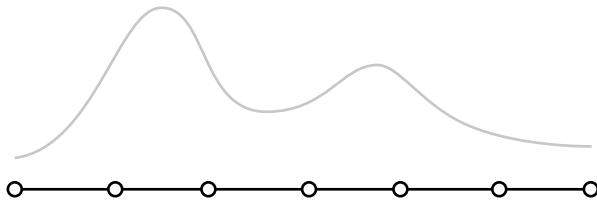
b. Plot the intensity that the viewer would see if Gouraud shading interpolation was used.

c. Plot the intensity that the viewer would see if Phong shading interpolation was used.
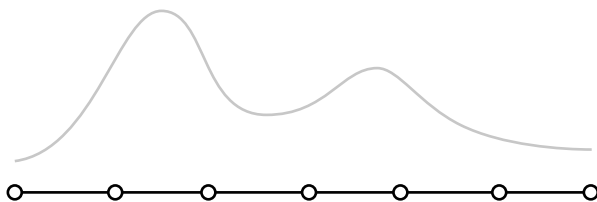
Question 2:

Consider the texture shown below on the right and the textured triangles on the left. The texture is to be **repeated** in both s and t. Give a set of texture coordinates that could be used for the vertices of the triangle mesh. Each vertex should have only one set of texture coordinates, because the mesh is going to be drawn as a fan.
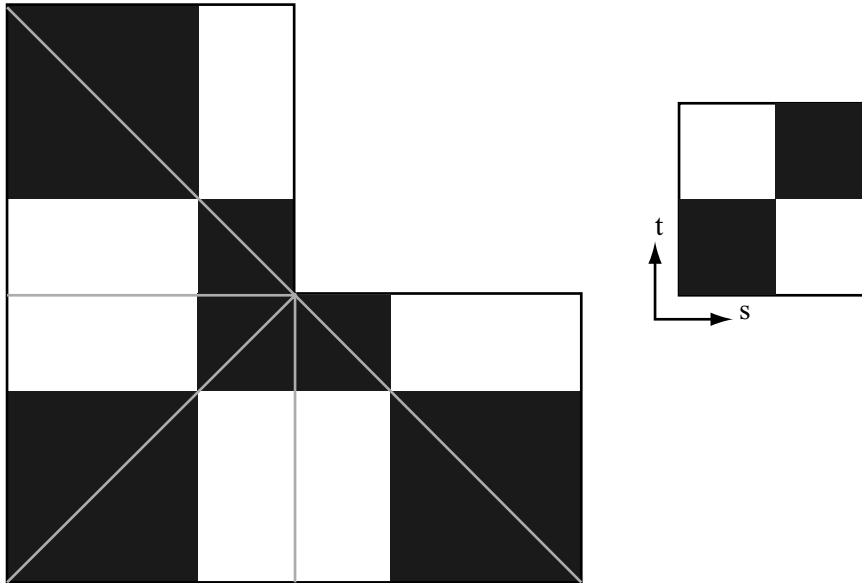
Question 3:

On the left is a polygon with both its world coordinates and texture coordinates marked. On the right is a 16×16 texture map that will be used with the polygon.

(0.0, 1.5, 0.0)   (3.0, 1.5, 0.0)
(0.0, 1.0)   (1.0, 1.0)

(0.0, 0.0, 0.0)   (3.0, 0.0, 0.0)
(0.0, 0.0)   (1.0, 0.0)
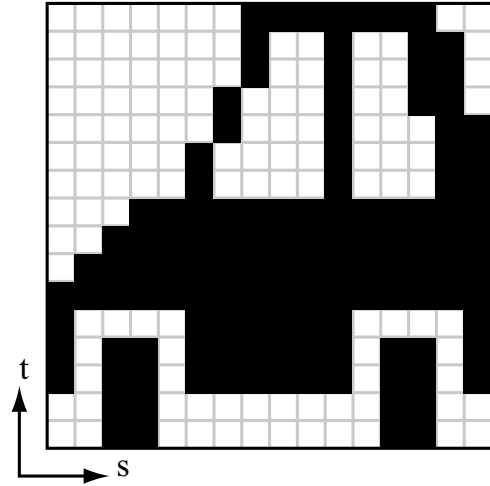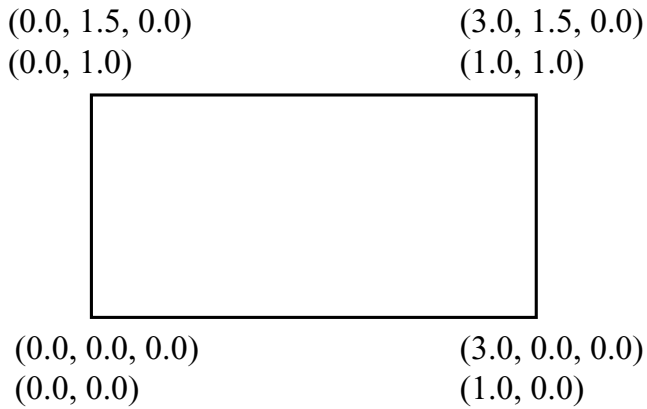
a. Draw the next mipmap level for the texture. Indicate the intensity of each pixel in each mipmap, and assume the mipmaps are generated by averaging pixels.

b. The polygon is rendered with a perspective view looking toward the negative z axis with the positive y axis pointing up. The viewing and window parameters are such that, for the polygon, each unit of distance in world space appears as 5 pixel lengths on the screen. Which mipmap should be used for texturing the polygon? Show your working, and assume nearest_mipmap_nearest as the texture interpolation mode.

Question 4:

This question explores the quality of a polygonal approximation to a cylinder. The figure below shows, on the left, a circle with an eight sided polygon that will be used to approximate it. On the right is a close up of one facet of the polygon and the neighboring circular region.
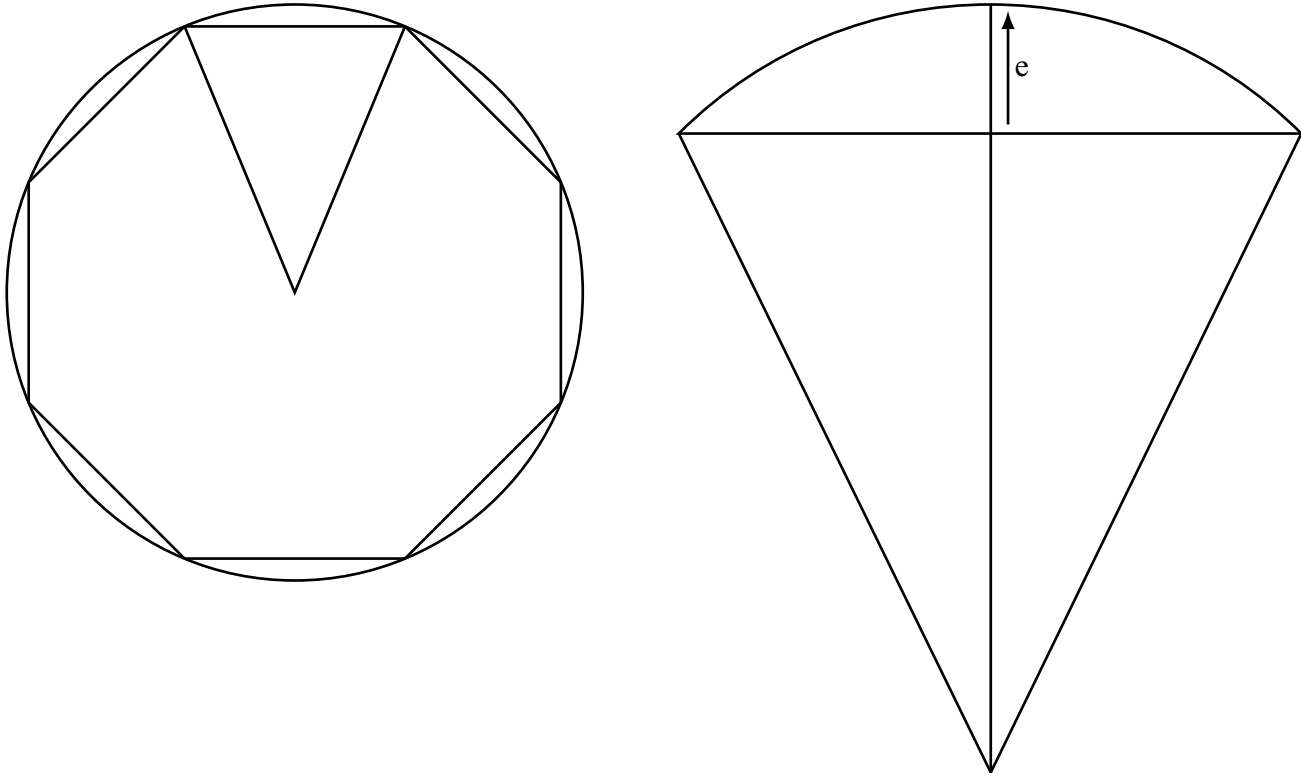
a. Let e be the error in the approximation, as indicated on the figure. Assuming that the radius of the circle is 1, what is the value for e for the 8-sided approximation shown?

b. What is a general formula for e in terms of the number of sides in the polygon, assuming it is regular and the radius of the circle is 1?

c. How many sides are needed to half the error of an 8-sided polygon?

d. How many are needed to give an error of $e = 0.001$?

e. How does the error change as the radius changes?