CS 543 – FALL 2013 – Final Exam

Name:

Instructions: Read questions carefully before answering. Do not hesitate to ask for clarifications. Show all work. Partial credits are given, so do not leave anything blank! Ask for extra paper if you need it! Good luck!

Bonus Question (1 point) What was your favorite topic in this class?

Question 1: (20 points) Basic Definitions

(4 points each) Define the following terms

a. Why are explicit representation of curves hardly used in computer graphics?

b. Distinguish between the umbra and penumbra of a shadow

c. What is tone mapping?

d. What is a billboard? How are they used to speed up computer games while preserving realism?

e. What is the luminance of an image?
Question 2 (18 points): Shading and antialiasing

(18 points) Given a polygon edge passing through a pixel as shown in Figure 1, compute the color of the pixel for each of the antialiasing methods listed below.

1) Prefiltering

2) Supersampling

3) Postfiltering
Question 3: (10 points) Ray Tracing

a) (5 points) How can many small objects in a scene slow down a ray tracer? What can you do to improve the ray tracer’s performance?

b) (5 points) On a small cell phone screen, we render the same scene separately using OpenGL and then with ray tracing and measured their running times. We then calculate the ratio (OpenGL running time/ray tracing running time) as $x$. We then try an experiment. On the same screen size, we add more objects into the scene such that the total number of polygons is increased ten fold. Would you expect the ratio $x$ to increase or decrease? Explain.
Question 4: (18 points) Raster Graphics

We would like to use the Bresenham midpoint algorithm to draw a line from (4,1) to (16,4) on the screen

a. (4 points) Derive an equation for this line that can be used for testing whether a point (x,y) is above or below the actual line?

b. (3 points) Using your equation, in the following sequence what are the (x,y) values of the next midpoint?
   X: 4 5 6 7 A
   Y: 1 1 2 2 B

c. (7 points) Using your expression in part (a), determine the (x,y) value of the next pixel that should be shaded (i.e. fill in the values A and B) in the sequence in part b (Show your work!!)

d. (4 points) Why is the recursive flood fill algorithm inefficient? How can you improve its efficiency?
Question 5 (14 points): Texture Mapping

a. (10 points) During cube mapping, the reflected vector \( \mathbf{R} \) is calculated as \((x,y,z) = (7,8,4)\). Using \( \mathbf{R} \) to look up the cube map, what face of the cube is looked up? What are the values of \( s \) and \( t \) used to perform this look up?

b. (4 points) Explain briefly how normal mapping can be used to preserve realism while reducing computational demands
**Question 6: (12 points) Clipping**

a. (4 points) What sorts of polygons should be tessellated before clipping? How does tessellation make clipping these polygons easier?

b. (8 points) The Liang-Barsky clipping algorithm continuously calculates and updates the values of \( t_{in} \) and \( t_{out} \) and exits if ever \( t_{out} < t_{in} \). Using a 2D square instead of the actual 3D Canonical View Volume (CVV), show a straight line that goes from Point A to Point C, which will trigger this condition. Make sure you label clearly points A, C and also the hit points corresponding to \( t_{in} \) and \( t_{out} \) in your diagram.

**Questions 7: (8 points) Hidden Surface Removal**

(4 points) What is cyclic overlap? Why is it hard to use the Painters HSR algorithm when polygons exhibit cyclic overlap?

(4 points) What is depth compression?