CS 543 – Spring 2018 – Exam 3

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. What is the problem with using interpolating polynomials to represent curves in computer graphics?

b. Distinguish between the umbra and penumbra of a shadow

c. What issues may arise if tone mapping is done using a single scaling factor for all pixels in an image?

d. A tessellation shader can add/remove __________________________ while a geometry shader can add/remove __________________

e. What does it mean to filter 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.

**Figure 1: Polygon edge intersecting a pixel**

1) Prefiltering

2) Supersampling

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

a. (5 points) Bounding volumes can be used to speed up ray tracers. If you want to ray trace some small objects in a very large room, would bounding volumes perform worse than expected in this situation? Why?

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 stay the same, increase or decrease? Explain.
**Question 4: (22 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. (5 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? Don’t forget to insert ALL known values into your equation.

b. (5 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. (8 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 (6 points): Normal Mapping

a. (6 points) When rendering a mesh using a normal map, three vectors need to be computed at each vertex in object space. What are these 3 vectors? List them.

Question 6: (24 points) Clipping

b. (4 points) What sorts of polygons should be tessellated before clipping? How does tessellation make clipping these polygons easier?
c. (10 points) The Liang-Barsky clipping algorithm continuously calculates and updates the values of $t_{\text{in}}$ and $t_{\text{out}}$ and exits if ever $t_{\text{out}} < t_{\text{in}}$. Using a 2D square instead of the actual 3D Canonical View Volume (CVV), draw 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 $t_{\text{in}}$ and $t_{\text{out}}$ in your diagram.

d. (10 points) Given a rectangular clipping window bounded by points (4, 2) and (12, 8), what is the result of clipping the edge from (-1, 3) to (8, 6) using Cohen-Sutherland clipping?