

CS 112: Introduction to Computer Graphics (Winter 2011)

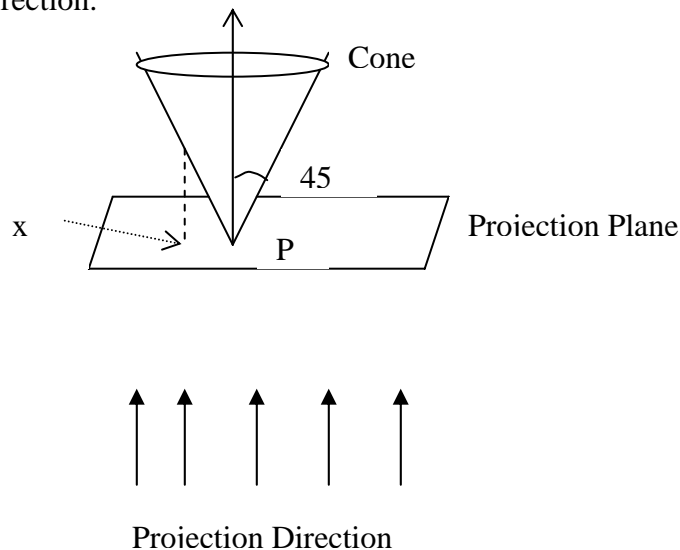
Written Assignment 4 (Total Points = 155)

Due: Wednesday, Mar 2, 2011, 11am PST

Estimated Time: 14-18 hrs

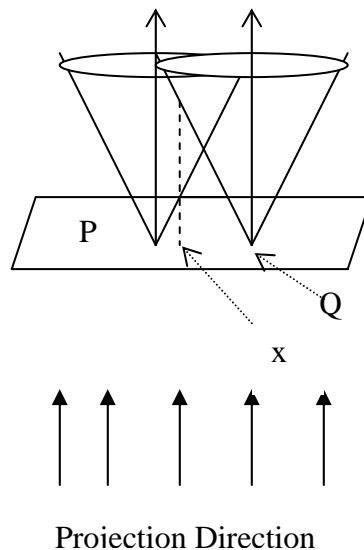
1. You change the normal vectors of an OpenGL triangle, but don't change the position of the vertices. Which components of the color seen by the viewer (ambient, diffuse, and specular) might change? Why? [5]
2. You are in an empty room (just 4 walls, floor and ceiling), with a single light bulb. You carefully measure the dimensions of the room, the color of the paint on each wall, and the radiant intensity of the light bulb. You use these measurements to construct an OpenGL model of the room, and render the scene. Nevertheless, the rendering will not look like a photograph of the room. Why not? [5]
3. Rasterize the line  $(P1,P2)$  where  $P1=(2,5)$ , and  $P2=(8,15)$ . Find the coordinates and the color of each pixel rasterized by this line segment, given the color of  $P1$  is 0.8 and that of  $P2$  is 0.1. Also show that the center of the pixel that is rasterized by this line is at most at a distance 0.5 from the actual line. [15+10+5 = 30]
4. Draw the results of clipping of a triangle  $ABC$  defined by  $A=(500,100)$ ,  $B=(800,460)$  and  $C=(400,500)$  against a window whose  $x_{\min} = 300$ ,  $x_{\max}=700$ ,  $y_{\min}=200$  and  $y_{\max}=500$ , using Sutherland Hodgeman's method. Show the vertices remained in the window (including the ones newly created by clipping) for all the steps of the pipeline clearly. It does not matter if you do it clock-wisely or counter clock-wisely. [20]
5. How do you find back facing triangles (which cannot be seen from the current eye position, and should not be rendered after back-face culling)? [5]
6. Definition: Silhouette edges are the edges in the manifold that have one back-facing polygon AND one front facing polygon incident on it. How do you compute the silhouette edges of a manifold? [10]
7. In OpenGL you can draw only back-facing polygons, or only front facing polygons. If you render the manifold(front facing polygons), then clear the frame-buffer but not the depth buffer, then again render only the back facing polygons. What do expect to see? [10]
8. Assume that the "thickness" of a line is an attribute of a line. Thickness of three means that the line would be drawn three pixels "thick". In question 7, if the thickness of the line was one and now is increased to three only for the second rendering (rendering of back faces), what do you expect to see? Compare your results with Question 6. [5]

9. You are rendering a black and white checkered tiled floor using a single texture mapped polygon. The view is simulating a person standing on the floor and looking at a point far away from him on the floor. Do you expect to see any artifacts at the distant end of the floor and why? If so, how would you remove these artifacts? [5+5=10]
10. What is the common OpenGL approach to avoid aliasing while texture mapping? How can you explain this method using sampling theorem? [7+3=10]
11. One artifact of gouraud shading is that it can miss specular highlights in the interior of the triangles. Can this be explained by the sampling theorem? Justify your answer by analyzing the sampling algorithm of gouraud shading. [5]
12. You are given a display which has spatial resolution of 1000x1000 and a gray intensity resolution of 8. You would like to increase your intensity resolution to 50. How would you achieve this by giving up some of the spatial resolution? What is the minimum factor (i.e. no. of pixels for each unit) by which you have to trade off the spatial resolution to do so? [2+3=5]
13. Can quantization be explained as an artifact of insufficient sampling? Why or why not? We know that increasing the number of bits reduces quantization. Can that be explained in the context of insufficient sampling? Justify your answer. [5+5=10]
14. The image of your TV looks washed out. The technician says that the intensity response curve of the TV is linear and hence the problem. To correct the problem, he has to make it non-linear. Why? What kind of non-linear response do you think he will put in? [4+6=10]
15. Consider orthographic projection. The projection plane is perpendicular to the projection direction.



The surface of the cone makes an angle 45 degrees with the axis of the cone. The axis is parallel to the projection direction, and the apex (P) is on the projection plane. Assume that you are drawing the cone (and not the projection plane). What will be the depth value at any arbitrary point  $x$  on the plane? Express it in terms of  $\text{distance}(x, P)$ , which is the distance between point  $x$  and P. [5]

16. Choose another point Q on the plane, and construct a similar cone as the one resting on P. The cone resting on P is colored red, and the one resting on Q is colored green. After projecting these two cones, the pixels on the projection plane would get the color of the point on the cone that is closer to the projection plane. For example, the vertical line at point  $x$  intersects the cone at P first and hence point  $x$  would get the red color. Use your answer to Question 15 and show that for each pixel which color should be assigned to it. [5]



17. Certain region of pixels in the projection plane would get red color and certain region of pixels would get the green color. Interpret the boundary of the regions with red color and green color using your answer to Question 16. What will be the shape of the curve of this boundary (straight line, circle, ellipse, etc.)? [5]