CS 112: Introduction to Computer Graphics (Winter 2016)
Written Assignment 3 (Total Points = 163)
Due: Monday, 22 Feb, 1:30pm

Instructions: All answers must be typed other than small figures or matrices, which can be handwritten. Written assignment will be returned without grading if the work is not neat. Hard copies of written assignment must be submitted in class to Professor Majumder.

1. Consider three vertices A, B and C. Choose the normal vector of face ABC? [2]
    a. |AB| * |AC|
    b. (B - A) × (C - A)
    c. (B - A) · (C - A)
    d. ((B - A) + (C - B) + (A - C)) / 3

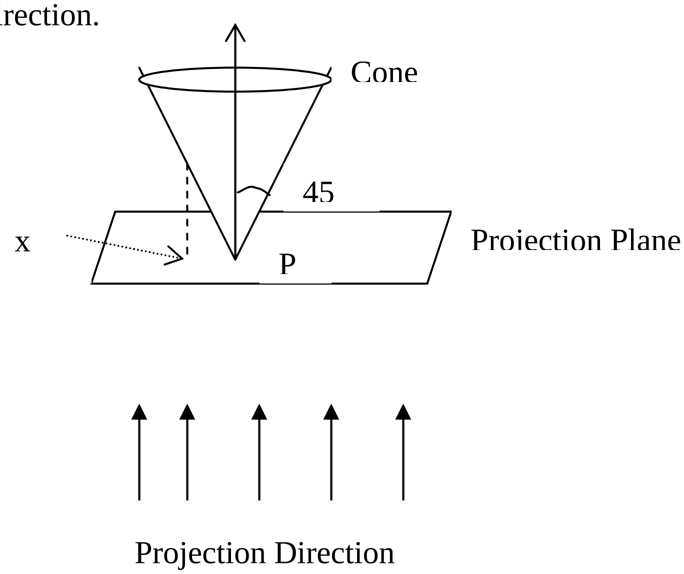
2. When is the vertex illumination computed in the OpenGL pipeline? ____ (a) Between the model-view and the projection transformations, or (b) After the projection transformation, before clipping. [2]

3. OpenGL can be instructed to cull (avoid rendering) triangles that are facing away from the viewer. Given viewing direction V and a triangle ABC both in world coordinates, assuming orthographic projection, how can you tell whether ABC is facing the viewer or not? What additional information do you need to compute the orientation of the triangle if we use perspective projection? [4+3=7]

4. 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 might change? ____[2]
    a. Ambient
    b. Diffuse
    c. Specular

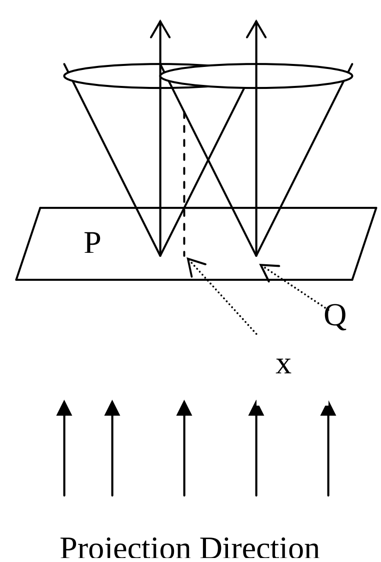
5. Definition: Silhouette edges are the edges in the manifold that have one back-facing polygon AND one front facing polygon incident on it. (1) How do you compute the silhouette edges of a manifold? (2) In OpenGL you can draw only back-facing polygons, or only front facing polygons. If you render the 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? (3) 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 (2), 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? [5+2+3=10]

6. 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 distance(x, P), which is the distance between point x and P. [5]

7. 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 12 and show that for each pixel which color should be assigned to it. [5]



8. 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 13. What will be the shape of the curve of this boundary (straight line, circle, ellipse, etc.)? [5]

9. 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]

10. 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]