EECS 487 F14 HW 1

7 problems totaling 75 points plus points from Pop Quizzes.
Due: 9:40AM Wednesday 15 October 2014, in class (at the *start* of lecture)

Please review the grading policy page on the course web site.

Sources. You are allowed to consult both online and offline sources, including humans, to help solve the problems; but if you do consult any outside sources, you **MUST** cite them. You do not need to cite the teaching staff, the textbooks, nor the lecture notes; these are the only exceptions. Your submission must be your individual work. Classmates can give an idea on how to approach a problem, but cannot give any solution, even in part, to these problems. If you find an online solution to any of these problems, you are allowed to consult it, but not to use it verbatim. You must phrase your solution in such a way that shows you have understood the problem and its solution. Failure to comply with any part of the above policy is a *strict violation* of the Honor Code.

Notation. Please follow the notation specified in the first day's lecture.

Write legibly. If you turn in a handwritten solution, please write legibly; **illegible scribble will earn zero points**. If the grader cannot read what you've written, it will be immediately marked wrong. If you lose points because part of your answer could not be read, you will *not* have the opportunity to explain what it says. It is best to write a *rough draft* where you can scribble and make a mess, and then submit a clean, carefully-written version.

Partial Credit. Even if your solution to a problem is far from correct, you may still earn up to half of the total credit on any given part if the effort is substantial and direction is correct. Do not leave any question blank! However, notice that the true/false questions deduct points for incorrect answers, so those are the only ones that you may want to leave without solution if you are unsure of your answer.

A Quick Note on State. For the entire homework, assume that all OpenGL state is at its default value unless specifically stated. This is equivalent to creating a context and then only changing that state involved or mentioned.

1.) **True/False with Justification** (10 pts).
(2) points for a correct answer with justification, (0) points for no answer or a correct answer with incorrect/poor justification, and (-1) points for a wrong answer.

i.) _____ **Cross Product.** Cross product distributes over a sum.

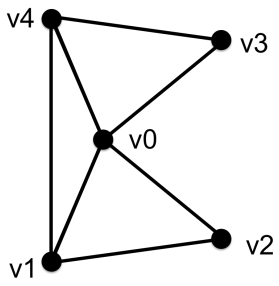
ii.) _____ **Triangles.** A point in a triangle after a shear transformation would have the same color as the point before the transformation when color is linearly interpolated for both triangles.

iii.) _____ **Linearity.** Rotation about an arbitrary point in 2D space is a linear transformation.

iv.) _____ **Perspective Projection.** Parallel lines in world coordinates cannot be parallel in normalized device coordinate after viewing transform and *perspective* projection transform (both lines are within the view volume).

v.) _____ **Orthographic Projection.** The area ratio of two triangles in world coordinates is preserved in normalized device coordinate after viewing transform and *orthographic* projection transform (both triangles are within the view volume).

2.) **OpenGL Geometric Primitive.** (9 pts). Specify three vertex index arrays to draw the polygon below using `GL_TRIANGLES`, `GL_TRIANGLE_STRIP`, and `GL_TRIANGLE_FAN`, respectively given it will be drawn by one `glDrawElements()` call. (Assume `glPolygonMode(GL_FRONT, GL_LINE)` is set.)



3.) **Triangles** (13 pts). Consider a triangle defined by the points (1,1,0), (0,2,0), and (2,1,1). The color of each vertex are red, green and white respectively.

i.) (3 points). What is the area of the triangle?

ii.) (5 points). Evaluate if the point $P = (5, -1, 2)$ is on the plane that contains the triangle. Evaluate if P is linear, affine, and/or convex combination of three points of the triangle.

iii.) (5 points). The color of the triangle is linearly interpolated. Find the coordinate of a point whose color is $C =< \frac{3}{4}, \frac{1}{2}, \frac{1}{4} >$.

4.) **Clipping Window** (13 pts). Consider a diamond-shaped clipping window defined by

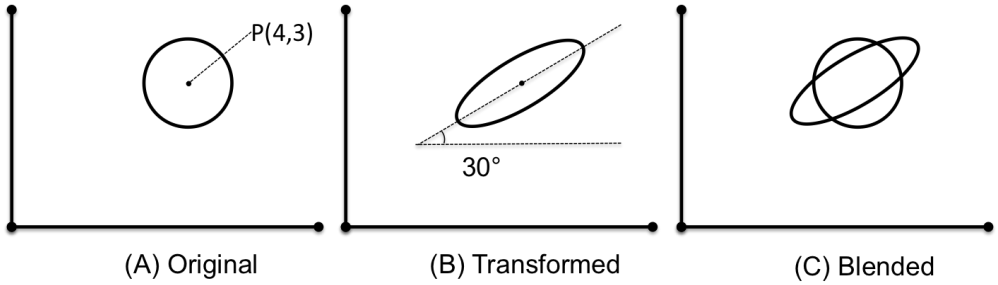
$$|x| + \frac{|y|}{2} \leq 1.$$

Using an algorithm discussed in class, clip the line segment determined by $P(0, 1)$ and $Q(4, 5)$. Show your work.

5.) **Transformations** (10 pts). Jason wants to transform a circle (A) into a slanted ellipse (B) so that he can draw a Saturn-like object when A is blended with B. The center of the circle A is at point P with coordinates $(4, 3)$, the radius of the circle is 1; the major axis of the ellipse is 2 and the minor axis is $\frac{1}{2}$.

i.) **Transformation Matrix** (7 pts). Determine the set of transformations needed to create the ellipse (B) centered at P, and construct the matrix corresponding to these transformations, executed in the required order.

ii.) **Final Point** (3 pts). To what coordinates does the north pole ($N = (4, 4)$) in the circle (A) get transformed after the transformation from (A) to (B)?



6.) **Eye Coordinates.** (10 pts). Joel wants to take a selfie with a new SelfieStick 7++ that he bought. The camera is at world coordinates $(3, 5, 4)$ and his head is at world coordinates $(0, 5, 0)$. The camera is directly facing the head in the upright landscape position.

i.) (6 points). Find the basis of the camera coordinate frame (u, v, w).

ii.) (4 points). Find the camera coordinates for Joel's left shoulder at world coordinates $(-1, 4, -1)$.

7.) **Blinn-Phong Lighting** (10 pts). For this question you *must* use the Blinn-Phong method to compute specular reflection. Consider a material with the following characteristics:

Material:
ambient reflection coefficient m_a = (0.5, 0.5, 0.5)

diffuse reflection coefficient m_d = (0.2, 0.2, 0.2)

specular reflection coefficient m_s = (0.8, 0.8, 0.8)

shininess $m_{shi} = 4$

Light:
emmisive intensity I_e = (1, 1, 1)

ambient intensity I_a = (4, 4, 4)

incident intensity I_i = (5, 5, 5)

A vertex at location $(1, 0, 1)$ with normal $(\frac{3}{2}, 0, 0)$ has this material and the light is positioned at $(4, 0, 5)$. What is the intensity of the light when viewed from $(1, 0, 3)$? Also find the reflection vector.