Name:

Student ID:

CS 130 Midterm

You may not ask any questions during the test. If you believe that there is something wrong with a question, write down what you think the question is trying to ask and answer that.

1 Multiple Choice (2pts each)

______1. LCD monitors use A) additive color B) subtractive color C) CMYK D) any of the above E) none of the above

______2. The midpoint (or Bresenham) algorithm for rasterizing lines is optimized relative to the DDA algorithm in that it A) avoids a round operation B) is incremental C) uses only integer arithmetic D) all of the above E) A and B only

______3. The z-buffer approach to rendering A) selects which fragment to draw based on its depth B) orders triangles from back to front C) orders triangles based on the average z-values of their vertices D) selects which vertices to clip based on their z-values E) B and C only

______4. A point with barycentric coordinates $(-1, 1, 1)$ is A) inside the triangle B) outside the triangle C) either inside or outside the triangle but there isn't enough information to tell D) none of the above

2 True/False (1pt each)

You get 1 point for answering a question correctly. You get -0.25 points for answering the question incorrectly and 0.5 points for leaving it blank. (It is statistically to your advantage to answer only if you are at least 60 percent confident that your answer is correct)

______1. (T/F) Rasterization occurs before vertex transformations in the graphics pipeline.

______2. (T/F) Clipping is performed after perspective division in the graphics pipeline.

______3. (T/F) Given any matrices M_1, M_2, and M_3, $(M_1M_2)M_3 = M_1(M_2M_3)$.

______4. (T/F) Given any matrices M_1, M_2, and M_3, $M_3M_2M_1 = M_1M_2M_3$.

______5. (T/F) If monitor gamma is increased, the image will have higher average intensity.

______6. (T/F) Using an alpha channel allows you to represent more unique colors.

______7. (T/F) The rasterizer can generate multiple fragments per pixel.

______8. (T/F) The OpenGL pipeline is primarily designed to implement global illumination.

______9. (T/F) OpenGL supports z-buffering.

______10. (T/F) Translation affects vectors the same as points.

______11. (T/F) All rotations in 3D space can be specified with 2 real numbers.

______12. (T/F) The perspective transformation is nonlinear in z.

______13.(T/F) The perspective transformation is nonlinear in x.

______14.(T/F) The viewport transformation maps from normalized device coordinates to screen space.

______15.(T/F) This matrix is a rigid body transformation

______16.(T/F) This matrix reflects about the x-axis.

$$\begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

______17.(T/F) We can translate the vector

$$\begin{pmatrix} 3 \\ 2 \\ 1 \\ 0 \end{pmatrix}$$

by multiplying it by the matrix

$$\begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

3 Written Response (15pts total)

1. (5 pts) What is the effect of applying the following matrix to a point? Be explicit: what do a, b, c, d, e, f do to the point?

$$\begin{pmatrix} a & 0 & 0 & d \\ 0 & b & 0 & e \\ 0 & 0 & c & f \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

2. (5 pts) Consider a triangle with points $(0, 0, 0)$, $(2, 0, 0)$, and $(0, 2, 0)$, and a point $(1.0, 0.5, 0)$. Convert that point to barycentric coordinates.

3. (5 pts) Consider a ray with endpoint $\mathbf{a}$ and a normalized direction $\mathbf{u}$,

$$\mathbf{P}(t) = \mathbf{a} + t\mathbf{u}, \quad t \geq 0,$$

and a sphere of radius r, centered at the origin. The implicit equation is given as follows:

$$\mathbf{p} \cdot \mathbf{p} - r^2 = 0$$

Describe geometrically in what ways can the ray intersect/not intersect with the sphere(when is there exactly one intersection, when is there two intersections, and when are there no intersections), and what does each of those cases says about the value of t. Come up with an algorithm that finds all of the intersection points of the ray and sphere, if any.

hint: Solve for t
hint: Dot product is distributive $a \cdot (b + c) = a \cdot b + a \cdot c$
hint: The solution to: $ax^2 + bx + c = 0$ *is* $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$