

CS 130
Exam I

Fall 2017

Name	
Student ID	
Signature	

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.

Question	Points	Score
True/False		
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
Multiple Choice		
13	2	
14	2	
15	2	
16	2	
17	2	
Written Response		
18	6	
19	6	
20	6	
Total	40	

1 True/False

For each question, indicate whether the statement is true or false by circling T or F, respectively. 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% confident that your answer is correct).

1. (T/F) Shaders are programs that run on the GPU.
2. (T/F) The fragment shader determines the position of the vertexes.
3. (T/F) For nonzero vectors \mathbf{u} and \mathbf{v} , $\mathbf{u} \cdot \mathbf{v} = 0$ if and only if \mathbf{u} and \mathbf{v} are parallel.
4. (T/F) For nonzero vectors \mathbf{u} and \mathbf{v} , $\mathbf{u} \times \mathbf{v} = \mathbf{0}$, if and only if \mathbf{u} and \mathbf{v} are parallel.
5. (T/F) The product of a matrix with a vector is a vector.
6. (T/F) Barycentric coordinates cannot be negative.
7. (T/F) For any point \mathbf{p} inside a triangle T , the sum of barycentric coordinates of \mathbf{p} with respect to T is always equal to 1.
8. (T/F) Orthographic projections preserve parallel lines.
9. (T/F) If the rotation matrix R rotates a point by the angle θ , then R^T rotates the point by $-\theta$.
10. (T/F) Scaling preserves the area of polygons.
11. (T/F) DDA provides antialiasing effects when rasterizing lines.
12. (T/F) For any vector \mathbf{v} , $\mathbf{v} \cdot \mathbf{v} = \|\mathbf{v}\|$.

2 Multiple Choice

For each question, circle exactly one of (a)-(e), unless otherwise stated.

13. Which statement about OpenGL is true?
 - (a) The `glPushMatrix` function restores to the top of the stack the matrix that was returned by the most recent `glPopMatrix` operation.
 - (b) `glColor` sets the color of the most recently drawn primitive or object.
 - (c) After modifying only the vertex shader, the C++ application code must be recompiled in order to see the effects of changes.
 - (d) A program can utilize the OpenGL programmable shader pipeline, by providing only a vertex shader.
 - (e) None of the above

14. Match the type of transformation in the left column with the example transformation matrix in the right by drawing lines between the matching boxes.

translation

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

rotation

$$\begin{pmatrix} \cos \theta & 0 & \sin \theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

perspective

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

identity

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

15. OpenGL perspective projection

- (a) preserves parallel lines.
- (b) is a linear transformations in z .
- (c) is an affine transformations.
- (d) preserves the z ordering between the near and far planes, but not necessarily everywhere else.
- (e) preserves the z ordering everywhere.

16. Which statement about transformation matrices is true?

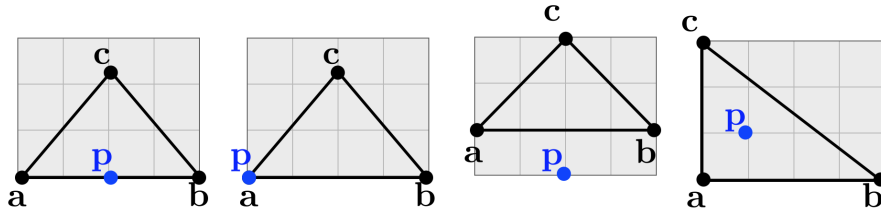
- (a) A uniform scaling transformation, S , can be represented as $S = \alpha I$, where α is a scalar and I is the identity matrix.
- (b) Two translation matrices, T_1 and T_2 can be combined into another translation matrix T by adding them, i.e. $T = T_1 + T_2$.
- (c) The inverse of a scaling matrix is always equal to its transpose.
- (d) For a rotation matrix R and a translation matrix T , $RT = TR$, even though matrix multiplication is not generally commutative.
- (e) None of the above

17. Which sentence completion is false? The Phong reflectance model

- (a) calculates the red, green, and blue color channels independently.
- (b) captures ambient, diffuse, and specular components.
- (c) does not consider the shadow of an object on itself in its calculations.
- (d) does not consider the geometry of the object being shaded.
- (e) requires the normal of the object at the point being shaded.

3 Written Response

18. For each of the four triangles and points \mathbf{p} shown below, give the barycentric coordinates of the point \mathbf{p} with respect to the triangle.



19. Come up with a series of transformation matrices as well as an order of multiplication (you don't need to actually perform the multiplication) to transform the rectangle with vertices

$$\mathbf{a} = (1, 0), \quad \mathbf{b} = (3, 0), \quad \mathbf{c} = (3, 1), \quad \mathbf{d} = (1, 1)$$

into the rectangle with vertices

$$\mathbf{a}' = (-1, 0), \quad \mathbf{b}' = (-1, 1), \quad \mathbf{c}' = (-2, 1), \quad \mathbf{d}' = (-2, 0)$$

(specifically, $\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}$ map to $\mathbf{a}', \mathbf{b}', \mathbf{c}', \mathbf{d}'$, respectively). Sketch the rectangle at every step of the transformation.

20. Consider a ray with endpoint \mathbf{a} and a normalized direction \mathbf{u} , and a plane with normal \mathbf{n} and point \mathbf{q} . The parametric equation for the ray is

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

The implicit equation for the plane is

$$f(\mathbf{p}) = \mathbf{n} \cdot (\mathbf{p} - \mathbf{q}) = 0.$$

Determine if the ray intersects the plane, and find any intersection points.

Show your work.

