Midterm Exam

Student Name:_____   **Class Account Username:**_____

Instructions: *Read them carefully!*

The exam begins at 3:10pm and ends at 4:00pm. You must turn your exam in when time is announced or risk not having it accepted.

*Make sure you fill in your **name and class account above**, and that you sign below. Anonymous tests will not be graded.*

***Write legibly**. If the person grading the test cannot read something, s/he will simply assume that you meant the illegible portion as a note to yourself and they will ignore it. If you lose points because part of your answer could not be read, you will not be given the opportunity to explain what it says.*

***Be clear and concise**. The answers to most questions should be short. If you find yourself writing an excessively long response, you may want to think more carefully about the question. Long rambling answers generally get fewer points that short ones do because there are more opportunities to mark something wrong.*

You may use one page of notes while taking the exam. You may not ask questions of other students, look at another student's exam, use a textbook, use a phone or calculator, or seek any other form of assistance. In summary: do not cheat. Persons caught cheating will be subject to disciplinary action.

***Do not ask questions during the exam.** Most questions are unnecessary and they disturb other students. Figuring out what the exam question is asking is part of the test. If you think you have to make some unusual assumption to answer a problem, note what that assumption is on the test.*

I have read these instructions, I understand them, and I will follow them.

Your Signature: _____

Date: _____

Student ID: _____

Total Points: 159 + 10 You Scored: _____ + _____

---

1. **Please fill in each of the blanks with an appropriate answer.**   *2 points each blank, 62 Total*

True or False: The dynamic range of intensities that can be displayed on your laptop monitor is larger than that what you'd find in most real-world scenes. _____

True or False: Humans are good at judging the relative brightness of two squares on a screen when the borders of the colors are touching. _____

Fill in the three missing colors in order: Red, _____, Yellow, Green, _____, _____, violet.

True or False: The light we see reflected off most objects consist of a continuos combination of many wavelengths of light. _____

The sensitivity curves for the _____ and _____ cones have the most amount of overlap with the sensitivity curves for the rods.

The letters BSP in the term BSP Tree stand for :

_____.

True or False: Any color humans can see can be reproduced using any **two** distinctly colored light sources. _____

_____ is the main phenomenon that makes the sky appear blue.

_____ is the main phenomenon that makes rainbow patterns in peacock feathers.

The BRDF is a function describes how much _____ coming in from one incoming direction goes out in another outgoing direction.

True of False: The exponent in the Flat shading model controls how rounded a material appears. _____

A _____ can be thought of as a light located "at infinity".

Midterm Exam

CS 184: Foundations of Computer Graphics page 3 of 10
Spring 2015
Prof. James O'Brien

True or False: Translation is a nonlinear transformation. _____

The real eigenvalue of an arbitrary rotation matrix is always _____.

True of False: Matrix multiplication is associative. _____

True of False: Pasteurized coordinates are needed to allow perspective to be expressed as matrix multiplication. _____

Of the various methods discussed in class for representing rotations, the method of _____ uses points in a 3-dimensional solid ball.

The implicit formula for a sphere with radius 5 is _____.

True or False: AABB Trees can be used to accelerate ray intersection tests for complex scenes. _____

Under *perspective* projection a set of parallel lines will converge to a vanishing point unless the lines are _____ to the image plane.

Under *perspective* projection spheres will generally appears as _____.

Which points in a linear perspective image are vanishing points for some set of parallel lines? _____

The _____ breaks a matrix C into C = (U S Transpose(V)) where U and V are orthonormal and S is diagonal.

True or False: An AABB tree can be used to quickly sort polygons in front-to-back order. _____

True or False: Systems like OpenGL typically convert everything to quadrilaterals before rendering. _____

Midterm Exam

CS 184: Foundations of Computer Graphics   page 4 of 10
Spring 2015
Prof. James O'Brien

True or False: BSP Trees will always be unbalanced. _____

Finding the interaction of a ray with a sphere requires solving a _____ equation.

True or False: AABB Trees will always be balanced. _____

2. **If you have three *orthogonal unit* vectors, A, B and C, then we can write the dot and cross products as A . B and A x B, respectively. Simplify the following expressions:**   *8 points*

    (B x A) . (B x A) =
    (B x A) + (A x B) =
    C x (A x B) =
    C x B x (B x (B x A)) =

3. **You have a sphere centered at [0,3,4] with radius 5, and a ray from [0,0,0] in the direction [0, 0.75, 1]. Write the implicit equation for the sphere, the parametric equation for the ray, and compute the *coordinates* of the intersection point[s].** _Be neat and clear!_   *9 points*
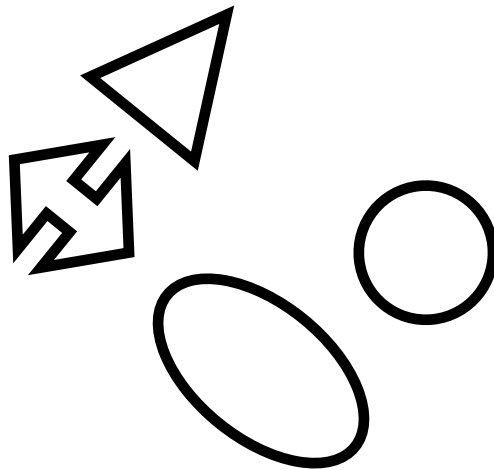
    Sphere equation:

    Ray equation:

    Intersection[s] at =

4. **Write out a 3x3 transformation matrix that will perform a 360 rotation degrees about the axis [3, 4, 2].**   *2 points*
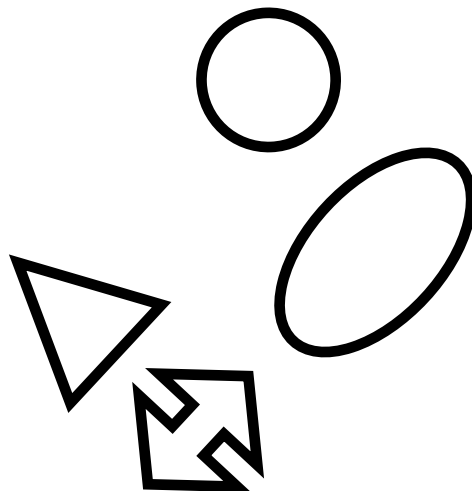
---

5. **Draw the single _convex hull_ that encloses all four shapes shown:**   *6 points*

6. **Draw the single _axis-aligned bounding box_ that encloses all four shapes shown:**   *4 points*

---

7. Given a rotation encoded as a quaternion, in general how is the rotation changed when the *both the real and imaginary parts are negated*?   *2 points*

8. Write down plausible RGB values for the following materials: *6 points*

    Glossy Metallic Magenta
    Kd =
    Ks =

    Glossy Plastic Cyan
   *Kd =*
    Ks =

    Flat Yellow
    Kd =
    Ks =

9. If shading a point at the origin with normal [0,0,1] and Kd=[0.1 ,0.2 , 0.2], where the light is located at [3,0,4] with intensity [10,10,20] and the eye located at [27,91,17], compute the RGB value of the <u>diffuse</u> lighting term.   *9 points*

10. Circle the 3D homogenized matrix that would *scale by 1/2*.   *3 points*

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix} \quad \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1/2 \end{bmatrix}$$

Midterm Exam

CS 184: Foundations of Computer Graphics   page 7 of 10
Spring 2015
Prof. James O'Brien

11. **The following line segments will be inserted into a BSP Tree in the order indicated. As discussed in class, the lines themselves will be used to define the split planes.** *The numbers are on the positive side of each line.* *The negative-side children should be on the left of your tree and the positive-side on the right.*

   Diagram the resulting tree below. If needed, show where line segments need to be split by marking on the above figure. Also, indicate the names of the split parts by writing labels on the figure above.   (For example, if there were a segment 11 and it was to be split, you would draw a mark showing where it would be split and label the resulting pieces 11a and 11b.)   9 *points*
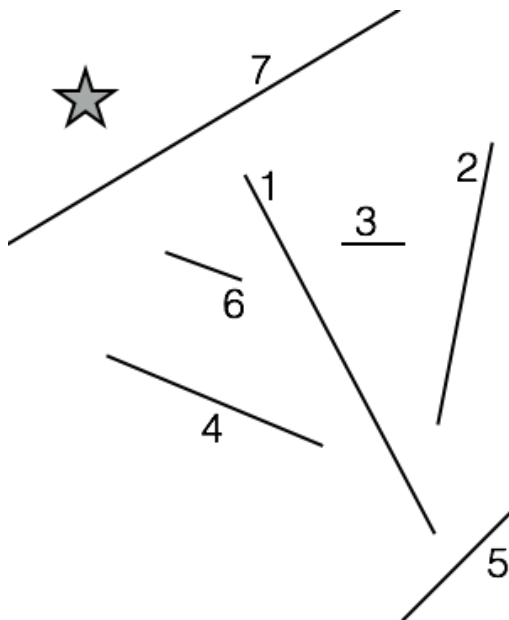
   List the *back-to-front* traversal order that would result for the location indicated by the viewer icon (the star).
                                                                                  9 points

Midterm Exam

CS 184: Foundations of Computer Graphics   page 8 of 10
Spring 2015
Prof. James O'Brien

12. **Imagine that you have a RGB monitor where the wires have been swapped so that the <u>red</u>, <u>green</u>, and <u>blue</u> outputs from the computer have been respectively attached to the <u>green</u>, <u>blue</u>, and <u>red</u> inputs on the monitor. When one attempts to display the following colors, what colors will actually appear on the screen?** *8 points*

Cyan   _____

Magenta   _____

Yellow   _____

Red   _____

Green   _____

Blue   _____

Black   _____

White   _____

13. **Write out a series of 4x4 matrices that would scale an object by 4x with the point [0,3,4] staying fixed in space.** *6 points*

Note that unclear or sloppy answers will not receive any credit.

Midterm Exam

CS 184: Foundations of Computer Graphics page 9 of 10
Spring 2015
Prof. James O'Brien

14. On the figure below write the appropriate letter in each of the blanks to label the diagram properly. Some of the letters are just there to confuse you. *16 points*
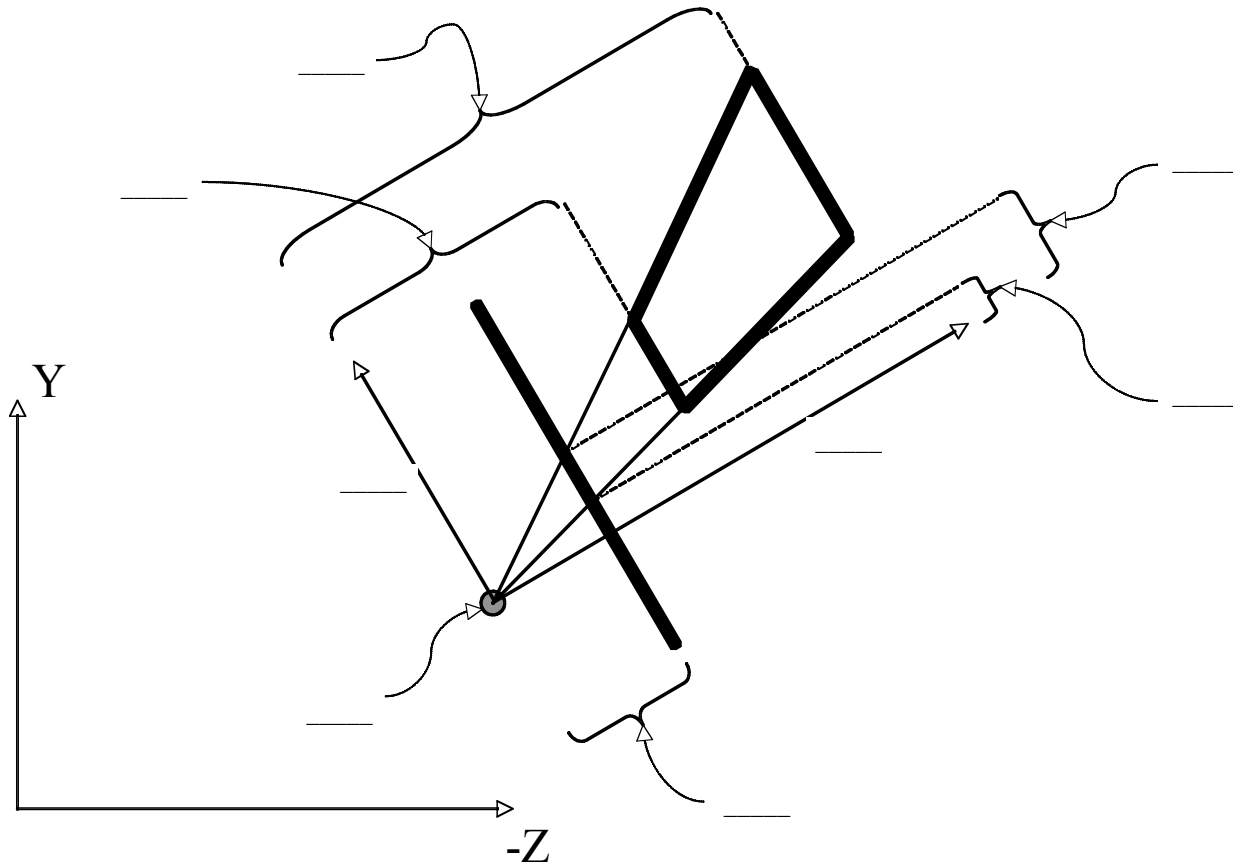
A	Distance to image plane	I	Center of focus
B	Scale factor	J	Focal distance
C	View up vector	K	Right clipping plane distance
D	Projection singularity distance	L	View plane normal
E	Top clipping plane distance	M	Bottom clipping plane distance
F	View direction	N	Far clipping plane distance
G	Near clipping plane distance	O	Aperture
H	Look-at direction	P	Center of projection

EXTRA CREDIT   **+10** *points*

Given:

A 3D shape defined implicitly by

$$(x - c_x)^2 + (y - c_y)^2 - r^2 = 0$$

and a ray defined by

$$\mathrm{ray}(t) = [p_x, p_y, p_z] + t\,[d_x, d_y, d_z]$$

What is the shape?

Write out the quadratic equation that should be solved to find the intersection.

Your answer must be neat and clear. No points will be awarded for imprecise answers. Do not attempt this question until you have completed the rest of the exam! Extra credit is all or nothing.