

CS 184: FOUNDATIONS OF COMPUTER GRAPHICS

SPRING 2004

PROF. JAMES O'BRIEN

FINAL EXAM

Your Name: _____ Your Class Computer Account: cs184-_____

Room: _____ Row: _____ Seat: _____ Your Student ID#: _____

Instructions: *Read them carefully!*

The exam begins at 5:10pm and ends at 8:00pm. You must turn your exam in when time is announced or risk not having it accepted.

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

Write legibly. If the person grading the test cannot read something, he/she 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.

You may use four pages 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. 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.

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.

Total Points: XX You Scored: _____ Extra Credit Points: X You Scored: _____

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

Your Signature: _____

1. Answer the following with true (T) or False(F)

1 point each

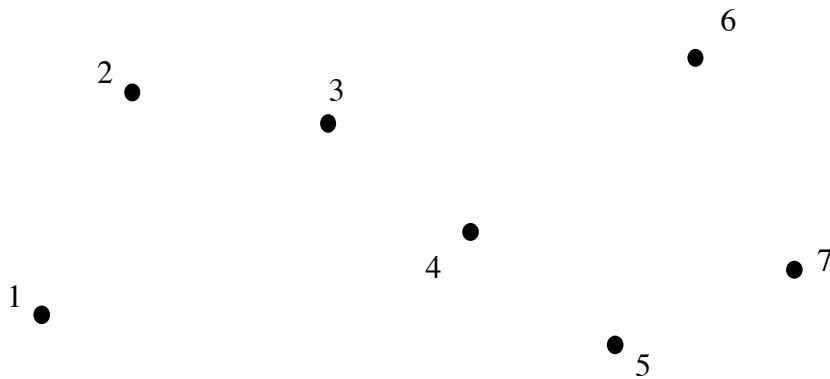
- _____ The term “distributed ray tracing” refers to a method for parallel computation of images.
- _____ One of the things that anti-aliasing helps prevent is the stair-step appearance of rasterized lines.
- _____ The Z-buffer hidden surface algorithm can be modified to account for transparency by simply adding an α -buffer.
- _____ B-spline curves have both the convex hull property and they interpolate control points.
- _____ Catmull-Clark subdivision is a generalization of B-spline surfaces.
- _____ Hermite and Bezier bases functions can be used to describe different classes of curves.
- _____ The Bresenham line drawing algorithm only became practical once fast floating point hardware was commonly available.
- _____ Rotation about an arbitrary axis can be expressed as a series of axis-aligned rotations.
- _____ The Phong reflectance model can be used to describe any real surface’s reflectance properties.
- _____ Motion capture is often used for animating smoke, water, and other fluid phenomena.
- _____ Ray tracing can be used to compute global illumination phenomena.
- _____ In a perspective projection, a sphere can have an outline shaped like an ellipse

2. Imagine that you have a CRT monitor where the lines for red and blue have been swapped. If you tried to display the following colors what would you actually see on the screen?

3 points

- Red _____
- Green _____
- Blue _____
- Magenta _____
- Cyan _____
- Yellow _____
- Black _____
- White _____

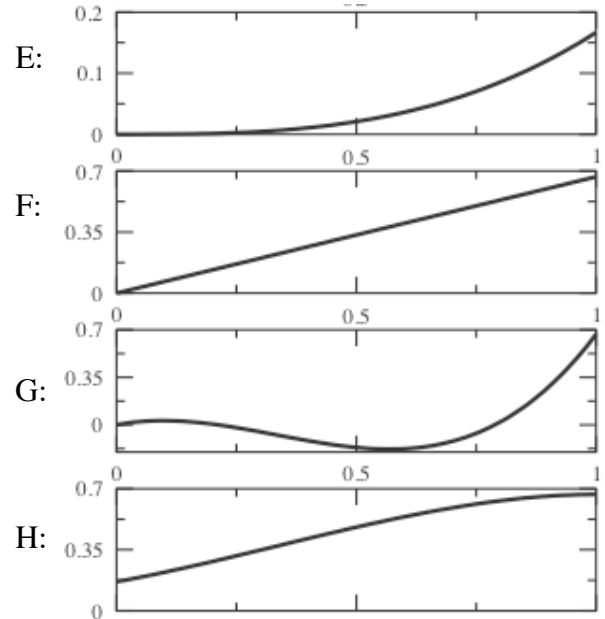
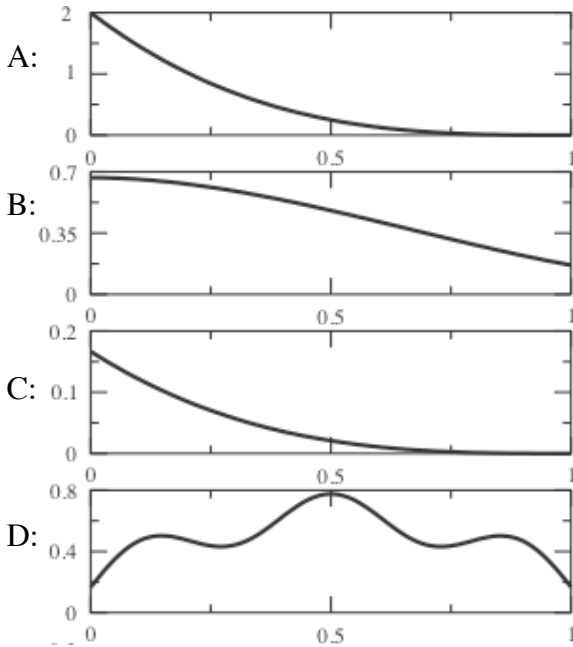
3. The diagram below shows the control points for a curve made from two joined cubic Bezier segments. Draw the curve as accurately (and neatly) as you can. *5 points*



4. Give two examples of phenomena that require a global illumination model for them to be rendered properly. *5 points*

5. *In general*, how many vanishing points would a perspective view of a pyramid (four sided base) have? Draw a little sketch to justify your answer. *5 points*

6. There are 8 functions plotted below. Neatly cross out the ones that are not part of the cubic B-spline basis set. Number the remaining functions to show the order that they go together to form the B-spline “hump” function. 6 points



For those that are NOT B-spline basis functions write a single short sentence that explains why they could not be. Your reason should be simple. Note: “It isn’t what I have in my notes,” “it won’t fit,” “it doesn’t solve the equations,” or other generic answers will not be accepted. 4 points

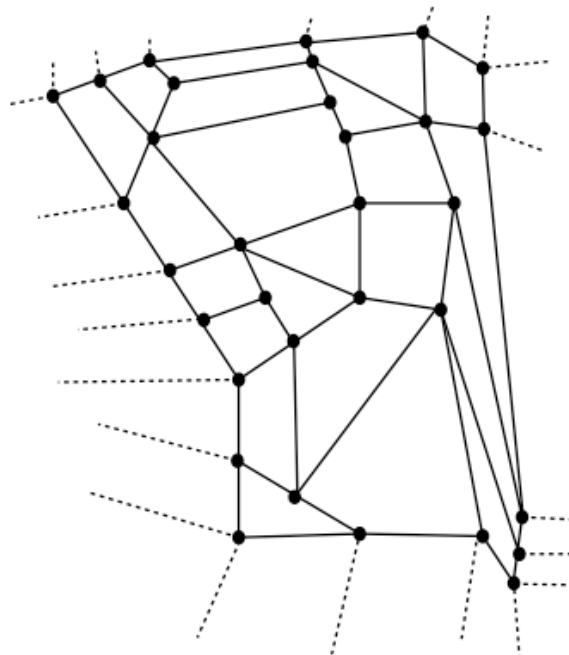
Letter	Reason
_____	_____
_____	_____
_____	_____
_____	_____

7. The “Painter’s algorithm” sorts polygons by the depth of their center of gravity, and draws the furthest polygon first. Sketch one example where this algorithm fails.

3 points

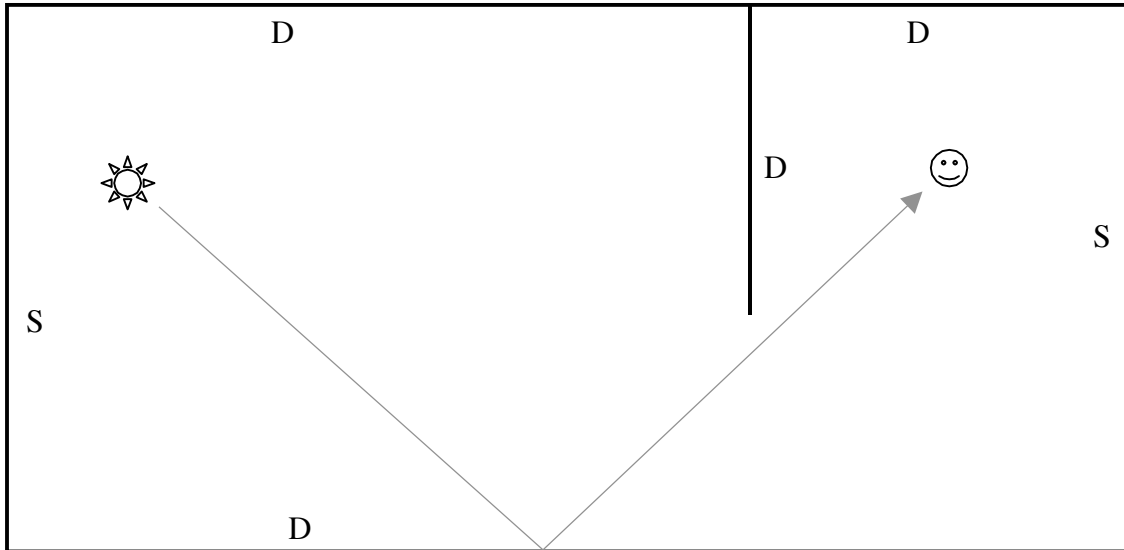
8. Some questions on Catmull-Clark subdivision:

6 points



The above diagram shows a mesh. Circle any vertex that is extraordinary and place an X in any polygon that will produce an additional extraordinary vertex after subdividing (points on the boundary do not count.). Note: Make your circles and X’s clear. You may want to mark each vertex and face as you examine them to make sure you do not skip one.

9. Consider the diagram below. “S” denotes a specular surface, “D” a diffuse one. Show a light path that would not be captured by first computing a radiosity solution and then rendering with ray tracing. Explain why this path would not be captured. (An simple example path is shown. The direction the viewer is looking in does not matter.) *5 points*



Write the path expression for the path you drew. (For example the one shown is LDE.)

10. A friend of yours tells you that they have a method for computing an analytical inverse to any kinematics equation. Give two succinct reasons why this claim is very unlikely to be true. (Claiming you have no smart friends is not a valid answer.) *4 points*

11. Some surface is defined parametrically by $\mathbf{x} = \mathbf{x}(\mathbf{u})$. Write the formula for the surface normal at a given point, \mathbf{u}_0 . (Does not need to be of unit length.) *5 points*

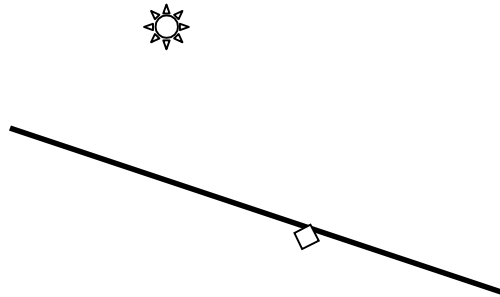
12. Some surface is defined implicitly by $f(\mathbf{x}) = 0$. Write the formula for the surface normal at a given point, \mathbf{x}_0 . (Does not need to be of unit length.) *5 points*

13. When rendering a scene with photon mapping, what part of the calculation must be recomputed when the viewpoint moves? Why? (Overly long, verbose answers will not be appreciated.) *5 points*

14. If you render a scene containing a infinite receding ground plane with a checkerboard pattern on it using a basic ray tracing algorithm, describe what the resulting image will look like? *3 points*

If you send multiple (*e.g.* 16) rays into the scene for each pixel, how will the resulting image change? *3 points*

15. Consider the diagram below. A location has been marked on the surface. Indicate a viewer position such that a viewer looking at the surface from that position would see a specular highlight on the surface at the marked location. *3 points*



16. Consider the two diagrams below. All four surfaces are identical ideal diffuse reflectors. In each diagram circle the surface that will appear brighter to the observer. *4 points*



17. When clipping two arbitrarily oriented squares against each other to find their intersection (in 2D), what is the maximum number of sides that the resulting shape may have? *2 points*

18. .

4 points

Extra Credit

Do not work on this until AFTER you have finished the rest of the exam. You can earn AT MOST 10 extra credit points for this. Most answers will earn SUBSTANTIALLY less than the full 10 points. You may only use the front of this page for your answer. Confusing, sloppy, or otherwise irritating answers will not be scored.

Imagine you work at a special effects studio and you have been asked to animate a scene where a dragon flies into a small town at night, knocks down several buildings, breathes fire on some things, and then eats a few individuals from a large crowd of people who are running about. Discuss the *interesting* issues that would arise in trying to do this whole scene using CG and how you would address those issues.

MAX 10 points

This portion of the test should only be completed after you have finished the rest of the exam. If you wish, you may remove this sheet and later submit it anonymously by sliding it under Prof. O'Brien's office door.

Did you enjoy this class?

Do you have any suggestions for future offerings of the course?

Do you have any comments specifically about Prof. O'Brien?

Do you have any comments specifically about either of the TA's or the graders?