CS 559: Computer Graphics - Final Exam

May 14, 2004

Name: _____

ID: _____

Login: _____

- You have 2 hours to complete the exam.
- Before beginning, write your name, ID number and login on the front page, and your login on every page.
- On your desk you may have something to write with, one double-sided piece of paper with anything on it, an optional ruler, and nothing else.
- Do all your work on the pages provided, going to the back side if necessary. If you do use the back, indicate on the front side that there is something on the back.
- If you need to make assumptions in order to answer a question, say what they are.

Question 1: ____/10

Question 2: ____/6

Question 3: ____/6

Question 4: ____/4

Question 5: ____/3

Question 6: ____/6

Question 7: ____/4

Question 8: ____/5

Question 9: ____/6

Question 10: ____/6

Question 11: ____/4

Total: ____/60

Question 1: (10 points)

Provide short (at most two sentence) answers to the following questions.

a. What must you do to correctly render a set of partially transparent objects using a z-buffer in OpenGL?

b. The full moon typically looks to us more like a flat disk than like a sphere. Is this what you would expect from a very distant spherical diffuse object lit by a distant light source? Explain your answer.

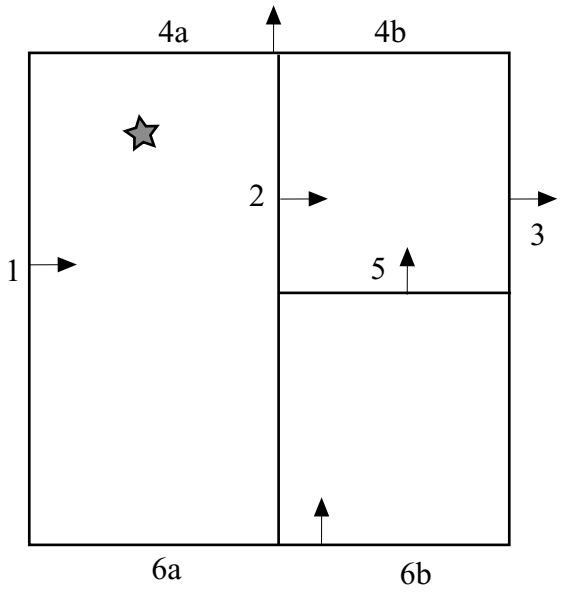
c. Under what circumstances should mipmaps be used?

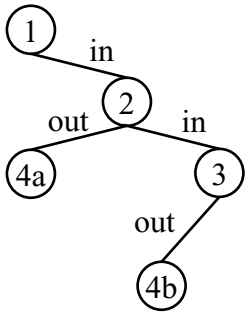
d. Give one reason why rational splines (e.g. NURBS) would be preferable over regular splines.

e. What is an extraordinary vertex in the butterfly subdivision scheme?

Question 2: (6 points)

Consider the partially built BSP tree for the 2D scene below. Arrows on the edges point to the "inside."



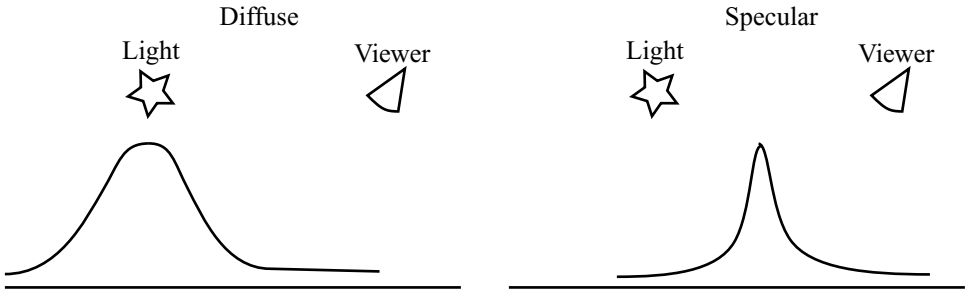


a. Complete the tree by adding nodes for 5, 6a and 6b.

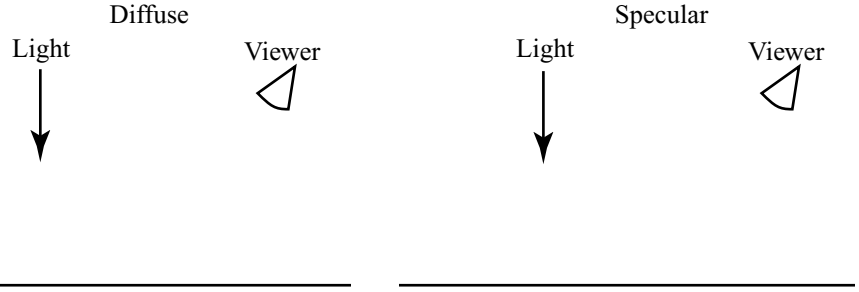
b. Give the rendering order for back-to-front rendering, derived from the BSP tree, if the viewer is located at the star on the image.

Question 3: (6 points)

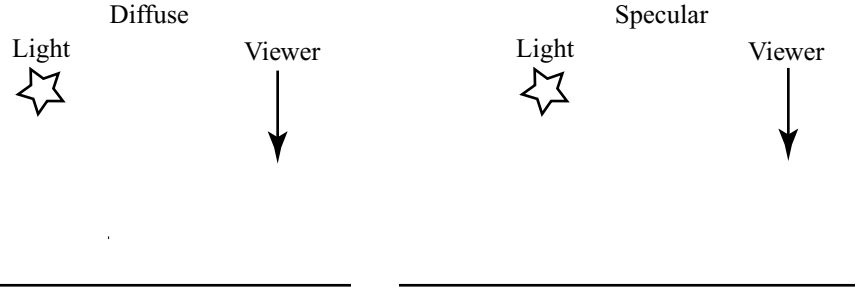
Below are shown the illumination graphs for the diffuse and specular components of a flat surface lit by a light as shown with a viewer in the position indicated.



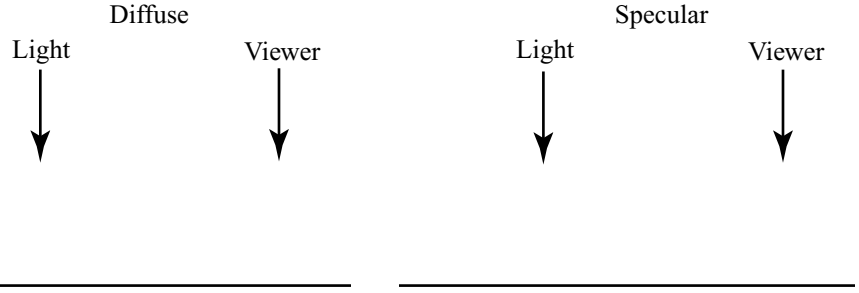
a. Draw two more graphs, one for the diffuse and one for the specular component of the same flat surface. However, now make the distant light assumption, using a directional light source coming from vertically above.



b. Draw two more graphs, but now make the distant viewer assumption, assuming that the viewer is looking from a constant direction vertically down to the surface. Use the point light from the original example, NOT a directional light.



c. Draw two more graphs, showing the effect of **both** a directional light coming from above and a distant viewer looking from above.



Question 4: (4 points)

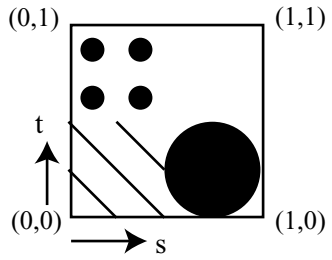
Consider a situation in which you are shown an image generated using OpenGL. The scene was lit with a single light, and a consistent set of shading options was used in generating the image. It contains a variety of curved and flat surfaces.

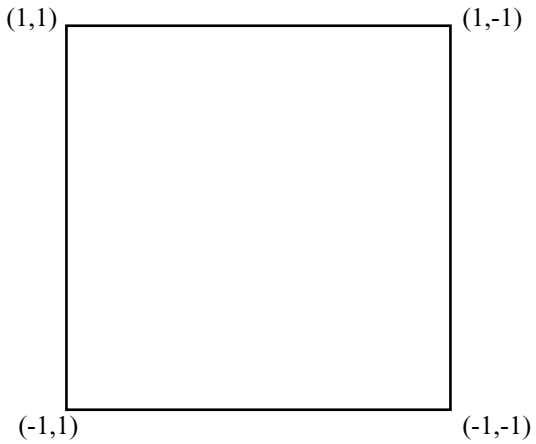
a. How would you determine which shading interpolation scheme, *flat* or *Gouraud* (smooth), was used to create the scene?

b. How would you determine what kind of light source, *point* or *directional* was used in the scene?

Question 5: (3 points)

Apply the texture image on the left to the polygon on the right. The texture coordinates, (s, t) are shown for each polygon vertex. The texture should be **repeated** in s and **clamped** in t.





Question 6: (6 points)

A student is planning a polygon mesh data structure in which vertices are stored in a vertex array, and then the triangular faces in the mesh each store the indices of the vertices and the triangle's face plane normal vector. The face data structure is given below.

```
class Triangle {
        int     vertices[3]; // The vertex indices.
        float   nx, ny, nz; // The face-plane normal.
};
```

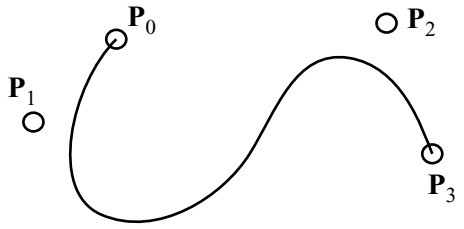
a. Is this a convenient way to represent a mesh if used with flat shading? Explain your reasoning.

b. Suggest an object for which this is a good mesh format when used with Gouraud shading. Explain.

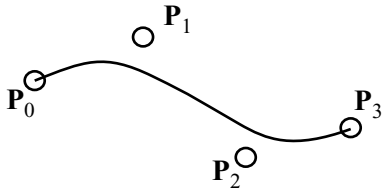
c. Suggest an object for which this is a bad mesh format when used with Gouraud shading? Explain.

Question 7: (4 points)

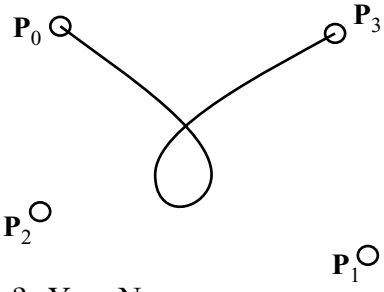
For each of the curves below, circle Yes or No to indicate whether or not it could be a Bezier segment for the four control points shown. If not a Bezier curve, state why.



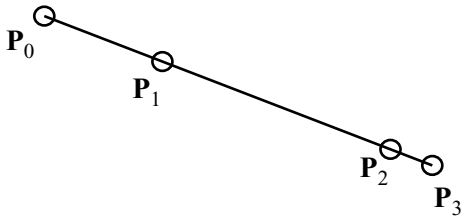
Bezier? Yes No
If not, reason:



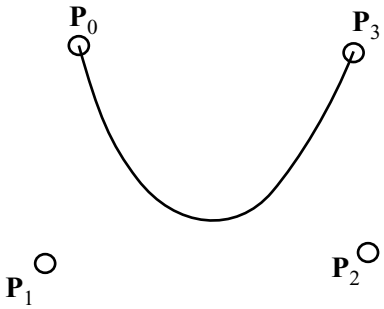
Bezier? Yes No
If not, reason:



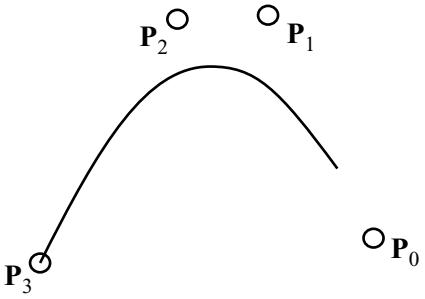
Bezier? Yes No
If not, reason:



Bezier? Yes No
If not, reason:



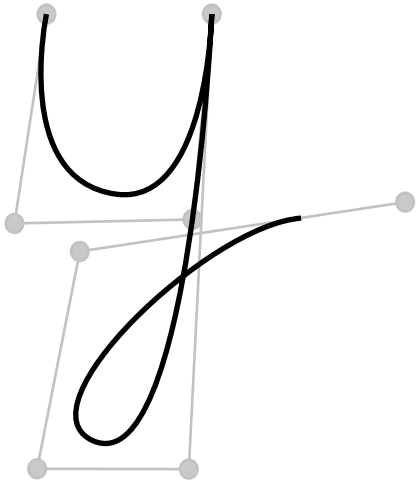
Bezier? Yes No
If not, reason:



Bezier? Yes No
If not, reason:

Question 8: (5 points)

The uniform cubic B-spline curve below has some repeated control points.

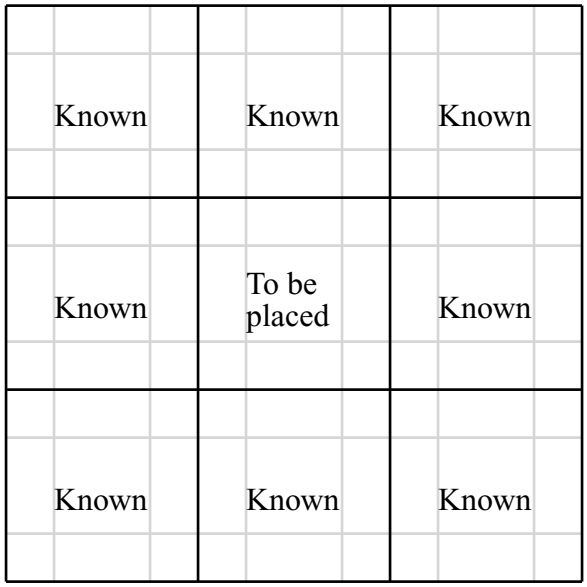


a. Label each gray circle (each control point) above with the number of times it must be repeated. Do not overlook the point in the center.

b. What is the valid parameter range for points on this curve?

Question 9: (6 points)

Consider the situation shown below, where you have must fill a hole between several Bezier patches with another Bezier patch. The eight surface patches around the hole have already been specified by the user. All of the existing patches join with C^1 continuity across all their edges. The questions below all concern the control point placement for the patch to fill the hole.



a. The hole is to be filled to achieve C^0 continuity with all its neighbors. How many control points of the hole-filling patch will be *free* (not constrained)?

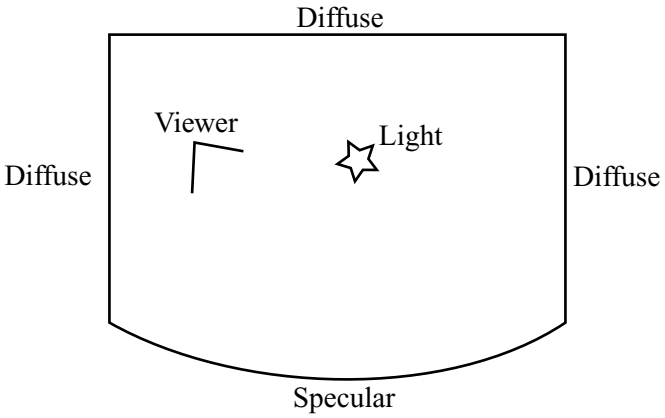
b. Can the hole be filled to achieve C^1 continuity with its neighbors? If so, how many control points of the hole-filling patch will be free?

c. Can the hole be filled to achieve C^2 continuity with its neighbors? If so, how many control points of the hole-filling patch will be free?

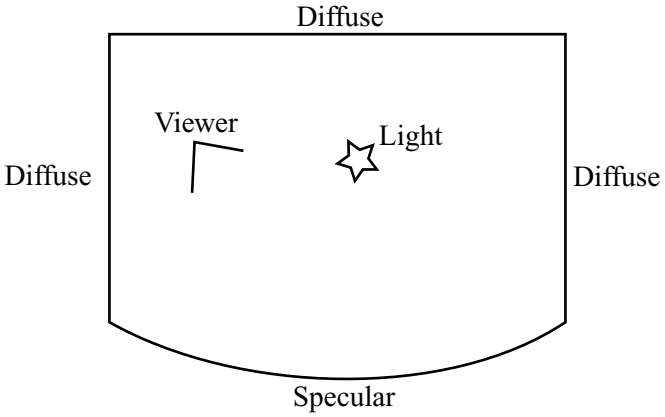
Question 10: (6 points)

The scenes below contain a range of surfaces, a light, and a viewer. The surfaces are each marked as specular or diffuse. Recall that light paths start at the light and end at the eye.

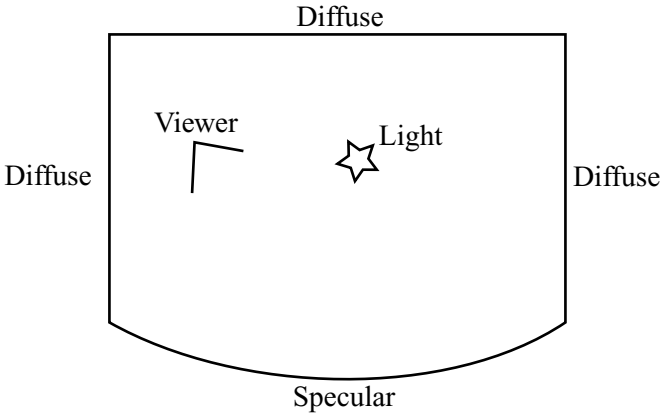
a. On the figure below draw a light path of the type captured by a raytracer, but not the standard OpenGL lighting model.



b. On the figure below draw a light path of the type captured by a radiosity algorithm, but not a raytracer or a light caching algorithm.



c. On the figure below draw a light path of the type captured by a light caching algorithm, but not a regular raytracer or radiosity solver.



Question 11: (4 points)

Describe a situation in which you might combine motion capture animation with procedural animation. Be specific about the objects/features involved and the kind of motion you aim to create.