Pre-Exam Questions:

Below are 6 potential exam questions. At least 2 (and probably 3) of them will appear on the actual exam. You can do these questions for practice, or ignore them. The final exam will be designed to be shorter than the midterm, so you should have plenty of time even if you don’t look at these questions.

On the actual exam, you may be given reference material and hints that are not given here, and the questions may be better explained.

You may write the answers to these questions on your 1 page of notes if you like, but you may not use anything in the exam besides your 1 sheet of notes.

**Question 1:**

A scene is lit by a single directional light source coming down vertically (like the sun at high noon). Your eye is on the Y axis, looking downward (the light can shine through you). You are looking at the square floor, which is a single, large square polygon centered at the origin.

Describe the lighting on the polygon for each of the following material properties. You might want to draw a sketch of the lighting on the square, or describe it in words. Notice that we’ve answered one part for you.

A. The floor is completely diffuse (no specularities), and shaded with Gouraud Shading:
   The entire floor would appear the same color.
B. The floor is completely specular (no diffuse), and is shaded with Gouraud Shading
C. The floor is completely diffuse (no specularities), and shaded with Phong Shading
D. The floor is completely specular (no diffuse), and is shaded with Phong Shading
E. If the angle of the light is changed, and the brightness of the light is adjusted such that the average brightness of the square is the same, which of the above 4 answers would be different?

**Question 2:**

A Bezier curve segment (7th degree) has the following 8 control points:

(0,0) (4,0) (4,4) (4,8) (8,8) (8,4) (12,4) (12,0)

The curve is divided into two curves at \( u = 0.5 \).

What are the **first three** control points for the first part of the curve?
**Question 3:**
A: Describe a situation where motion capture would be a good method for animating a human character
B: Describe a situation where it would be better to use keyframing than motion capture.

**Question 4:**
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.

```cpp
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 5:**
This question is actually too hard and will not be on the exam. It is a good way to review the properties of Bezier curves.

Consider a cubic Bezier curve with its control points at (0,0), (a,a), (1-a, a), (1,0). For a sufficiently large value of a, the curve will form a self-intersecting loop. What is the smallest value of a that the curve will self-intersect?

**Question 6:**
Environment mapping makes some assumptions that allow for the creation of shiny surfaces using standard graphics hardware.

A: Explain what the assumptions are and describe a situation in which Environment mapping works well.

B: Describe a situation where the assumptions of Environment mapping are violated, and it would be a poor approximation of a shiny object.
Question 7:

A planar mirror shows the same image that would be seen through the mirror if the eye point was placed on the opposite side of the mirror. (equivalently, you could imagine moving the object to the other side of the mirror). We use the term “reflection point” to mean the location on the mirror’s surface where a point on an object appears to be.

Use the convention that the Y axis points upwards, so the Y=0 plane is the floor.

Imagine that we have a mirrored floor (the Y=0 plane), and the eye point is at the position (10,5,0).

A: Where would the reflection point of point 0,2,2 be? (this would be the position of a point on the mirror’s surface where the point would appear to a viewer at (10,5,0)?

B: Give a 4x4 homogeneous transformation matrix that would transform any point with Y>0 to the place where its reflection point (the point on the mirror’s surface where the object would appear to the viewer at (10,5,0).
Question 8: B-Splines

Each of the following curves is shown with its control points. No control points are repeated. For each one, either give a reason why it could not possibly be a cubic B-Spline or say that it could be a cubic B-Spline. If a curve cannot be a B-Spline, there will be some obvious violation of a property of B-Spline curves – state what that property is.

Example:

Not a B-Spline since B-Spline would be C(2) and this curve has a kink (e.g. is only C(0)).

A)

B)

C)
**Question 9**

A sphere at the origin is approximated by a very small number of polygons. The camera is placed at (0,20,0) and faces the sphere. A directional light source sends light downward from infinity along the Y-axis, as shown here: 

Light is DIRECTIONAL downward

Specular brightness along the X-axis for the actual sphere.

Graphs are drawn for the film plane, the 5 marking correspond to those here.

Normals are always computed for the point on the actual sphere.

If the actual sphere (not the polygonal approximation) was lit perfectly, the specular component of the light along the film plane (in the X-direction for Z=0) is shown in the graph on the right. For the following questions, sketch a similar graph. (The important thing is the rough shape)

If FLAT SHADING is used, graph the brightness along the film plane for:

<table>
<thead>
<tr>
<th>The diffuse component:</th>
<th>max</th>
<th>The specular component</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

If GOURAUD SHADING is used, graph the brightness along the film plane for:

<table>
<thead>
<tr>
<th>The diffuse component:</th>
<th>max</th>
<th>The specular component</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

If PHONG Shading is used, graph the brightness along the film plane for:

<table>
<thead>
<tr>
<th>The diffuse component:</th>
<th>max</th>
<th>The specular component</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
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