Midterm Exam

CMSC 740 Spring 2002
Time Limit: 75 minutes, Maximum Marks: 60
Open book, open notes

Name:

UMD Student Id:

Notes:
1. This exam has five pages. Please make sure that you have all of them.
2. If the meaning of a question is doubtful, state a meaningful, non-trivial assumption and proceed.
3. Advice: To maximize the partial credit, divide your time as per the minutes shown. Point value of each question equals its recommended time value in minutes.

Q1 \[8 \times 5 = 40 \text{ minutes}\]
1. Assume that you are given two graphics images showing the same object as bump mapped in one and displacement mapped in the other. If the images are identical in all other respects, how will you tell which object is displacement mapped?

2. Flood fill the following figure using an 8-connected algorithm. Using this example and the example given in the class state a necessary condition for the 8-connected flood fill algorithm to result in a leak.
3. OpenGL code to display the simple scene graph (a) is given below. Write a similar style OpenGL code to traverse and display hierarchical scene graph (b). Use OpenGL commands to push and pop matrices. The matrices are represented by $M_i$ and the geometry by $G_i$.

```cpp
glMultMatrix ( M1 );
display_geometry( G1 );
```

4. Suggest a method to find the visible portals at runtime in a recursive cells-and-portal visibility culling method.
5. We have come across refresh rate and interactivity rate. Are these two terms equivalent for (a) vector graphics? (b) raster graphics?


7. (a) Can aliasing occur for texture-mapped triangles under parallel projection? If yes, draw an example below. If no, why not?

(b) Environment mapping only produces approximately correct results. Show below one region on the teapot that is rendered incorrectly by using environment mapping and explain why it is incorrect.
8. (a) Why can’t Lambertian and Phong illumination models successfully model anisotropic reflections and whereas BRDF representations can?

(b) What illumination model will you use to render slightly translucent wax candles? Assume that you do not have to model the flame.

Q2 \[4 + 4 + 6 + 6 = 20\ minutes\]
Vernal equinox occurred yesterday (March 21). This day has been celebrated by almost all cultures of the world in various ways. The ancient Mayans were no different. At Chichen Itza they built a massive stone pyramid (Pyramid of Kulkulkan) that is aligned such that on the Vernal Equinox, the shadow cast by the Sun appears as a \textit{serpent of light} on one of the pyramid’s faces.
1. You have been given the model of the pyramid as a triangle mesh. For rendering such a model will you prefer normal per vertex or normal per triangle? Why?

2. What illumination and shading models are best suited for rendering the stone pyramid in daylight?

3. To get the correct surface texture of the pyramid, you decide to take four photographs of the pyramid, one each from directly in front and center of each of its side faces. Assume that you lighted up the pyramid from all sides with a number of sufficiently large and powerful lights so that light changes across the texture maps are not an issue. You were planning to texture map these on to the triangle mesh, but then you remembered our discussion in class on perspective foreshortening. Your camera captures perspective projection images. Will you no longer need to perform perspective foreshortening after texture mapping? Explain why or why not.

4. The location of the sun is 6 degrees North of the true West and 20 degrees above the horizon. Assume that the coordinate system of the model is aligned along the East-West (x-axis) and North-South (y-axis). You have been asked to render the shadow due to the sun using the shadow Z-buffer algorithm. Specify the matrices (or the sequence of matrices in correct order) that you will use to render the shadow Z-buffer.