



Computer Graphics

Teacher: Kári Halldórsson

Date: 13. November 2006

Time: 14:00 – 17:00

Allowed resources: Pocket calculator and the attached formula sheet
The front and the back of the last page can be used if you run out of space.

Name _____

SSN _____

1. (5%)

The shading type used by OpenGL can be defined by calling:

```
glShadeModel(GL_FLAT);
```

or

```
glShadeModel(GL_SMOOTH);
```

Briefly describe the difference between the two and how it affects the calculations done by OpenGL.

2. (5%)

Briefly describe (no math needed) the shading model used to color polygons, Gouraud shading. What defect can appear when using this type of shading which can be fixed by using Phong shading and other "pixel-shaders" and give an example for when this defect can manifest itself.

3. (5%)

Alpha-Blending is enabled with:

```
glEnable(GL_BLENDING);
```

Briefly describe where in the OpenGL graphic pipeline this has an effect on its calculations and how those calculation change.

4. (5%)

Describe what the following code does and how the three constants shown affect what happens:

```
glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGBA | GLUT_DEPTH);
```

5. (40%)

Values are entered this way into a matrix that transforms coordinates relative to position and orientation of a camera:

$$\begin{bmatrix} u_x & u_y & u_z & -eye \circ u \\ v_x & v_y & v_z & -eye \circ v \\ n_x & n_y & n_z & -eye \circ n \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- a) How does this matrix look like after executing the following code ? (20%)
(and what is this matrix called).

```
glLoadIdentity();  
gluLookAt(3.0, 5.0, 8.0, 1.0, 1.0, 2.0, 0.0, 1.0, 0.0);
```

- b) Describe what happens when the following code is executed and show the values entered into the appropriate matrix. (10%)

```
gluPerspective(90.0, 1.5, 15.0, 85.0);
```

- c) According the results of a) og b), where does a point appear on a 800x600 screen which is created using the following code ? (10%)

```
glBegin(GL_POINTS);  
    glVertex3f(3.0, 2.0, 4.0);  
glEnd();
```

6. (15%)

There is one light source in a lighting model of a OpenGL program. It has the ambient value (0.0, 0.0, 0.0), diffuse value (0.6, 0.4, 0.7), specular value (0.8, 0.8, 0.8) and is positioned at the point (5.0, 9.0, -1.0).

Additionally we have a global ambient factor of (0.2, 0.2, 0.2) in the model.

A camera is positioned in the point (5.0, 6.0, 8.0) and is directed at the point P.

P is defined with the color values: ambient (0.1, 0.3, 0.2), diffuse (0.2, 0.6, 0.3) and specular (0.6, 0.6, 0.6) and a shininess coefficient of 6. It has the position (4.0, 5.0, 4.0) and the normal (0.0, 1.0, 0.0).

What will be the blue color value of the point P on the screen ?

7. (10%)

Bezier curve coefficients can be calculated by expanding and then factoring Bernstein polynomials:

$B^L = ((1-t)+t)^L$ for a bezier curve with $L+1$ control points.

The center of a sphere is supposed to move along a bezier curve with 4 control points.

$$P_1 = (3, 0, 1), \quad P_2 = (2, 7, 0), \quad P_3 = (-4, 3, 3), \quad P_4 = (0, 0, 7)$$

The motion is supposed to start 7.5 seconds after the application gets executed (at time 7500) and it is supposed to stop 15 seconds after execution (at time 15000).

Where is the sphere (i.e. its center) at 10 seconds (at time 10000) after execution?

8. (15%)

A triangle is sent through the OpenGL graphics pipeline and ends up on the screen with corners at pixels:

P1: (0, 0)

P2: (3, 6)

P3: (8, 4)

The corners have the color values:

P1: (0.1, 0.1, 0.8)

P2: (0.3, 0.9, 0.3)

P3: (0.7, 0.2, 0.2)

What color value does the pixel (3, 2) get on the screen ?

Bonus question yay! (3%)

A: What did you do last summer again?

B: I told you! I spent it with my uncle in Alaska hunting wolverines!

A: Did you shoot any?

B: Yes, like 50 of 'em! They kept trying to attack my cousins, what the heck would you do in a situation like that?

A: What kind of gun did you use?

B: A freakin' 12-gauge, what do you think?

Who are having this conversation and in which movie?