Name _____

GPU Programming
EE 4702-1
Midterm Examination

Friday, 6 November 2009, 9:40–10:30 CST

Problem 1	_____	(40 pts)
Problem 2	_____	(20 pts)
Problem 3	_____	(20 pts)
Problem 4	_____	(20 pts)
Exam Total	_____	(100 pts)

Alias _____

Good Luck!

Problem 1: [40 pts] Write OpenGL code to render a filled circle (a disc) of radius `r`, centered at the origin and with normal $(0, 1, 0)$.

- The distance between all vertices in a primitive should be approximately `vert_dist`.
- Use triangle strips. Multiple strips are okay, but there should be no easy way to make the strips longer.
- Use `glVertex3f` calls, don't try to construct arrays.
- Don't specify colors, normals, or other attributes.
- Assume transformations, lighting, etc, have all been set up. Start with `glBegin`.

☐ Code rendering a circle of radius `r`, center at origin.

☐ Vertex distance about `vert_dist`.

☐ Good use of strips.

☐ Code reasonably efficient.

Problem 2: [20 pts] Answer the normal questions below.

(*a*) Show an expression for the normal to triangle ABC, where A, B, and C are the vertex coordinates.

☐ Normal to ABC

(*b*) In the code sample below the pair of triangles is rendered using two different methods, identified as Method 1 and Method 2.

Describe the difference in appearance of the triangles rendered using Method 1 and Method 2 when diffuse lighting is used and `norm_ABC != norm_CBD`.

```
pVect norm_ABC = find_normal(A,B,C);    pVect norm_CBD = find_normal(C,B,D);

// Method 1
glBegin(GL_TRIANGLES);
glNormalfv(norm_ABC);
glVertex3fv(A);  glVertex3fv(B);  glVertex3fv(C);

glNormalfv(norm_CBD);
glVertex3fv(C);  glVertex3fv(B);  glVertex3fv(D);
glEnd();

// Method 2
pNorm norm_X = norm_ABC + normCBD; // Sum of two vectors normalized.
glBegin(GL_TRIANGLES);
glNormalfv(norm_ABC);  glVertex3fv(A);
glNormalfv(norm_X);    glVertex3fv(B);  glVertex3fv(C);

glVertex3fv(C);        glVertex3fv(B);
glNormalfv(norm_CBD);  glVertex3fv(D);
glEnd();
```

☐ Difference in appearance between Method 1 triangles and Method 2 triangles.

Problem 3: [20 pts] Consider the three methods of specifying vertices shown below.

```
switch ( opt_method ) {

case VM_Individual: {   /// Use Individual Vertices
    glBegin(GL_TRIANGLE_STRIP);
    for ( int i=0; i<coords_size; i+=3 ) {
        glNormal3f(coords[i],coords[i+1],coords[i+2]);
        glVertex3f(coords[i],coords[i+1],coords[i+2]);  }
    glEnd();
    break;  }

case VM_Array: {        /// Use Vertex Arrays
    glNormalPointer(GL_FLOAT,0,coords);
    glEnableClientState(GL_NORMAL_ARRAY);
    glVertexPointer(3,GL_FLOAT,3*sizeof(float),coords);
    glEnableClientState(GL_VERTEX_ARRAY);
    glDrawArrays(GL_TRIANGLE_STRIP,0,coords_size/3);
    glDisableClientState(GL_NORMAL_ARRAY);
    glDisableClientState(GL_VERTEX_ARRAY);
    break;  }

case VM_Buffer: {       /// Use Buffer Objects
    glBindBuffer(GL_ARRAY_BUFFER,gpu_buffer);
    glVertexPointer(3,GL_FLOAT,3*sizeof(float),NULL);
    glEnableClientState(GL_VERTEX_ARRAY);
    glNormalPointer(GL_FLOAT,0,NULL);
    glEnableClientState(GL_NORMAL_ARRAY);
    glDrawArrays(GL_TRIANGLE_STRIP,0,coords_size/3);
    glBindBuffer(GL_ARRAY_BUFFER,0);
    glDisableClientState(GL_NORMAL_ARRAY);
    glDisableClientState(GL_VERTEX_ARRAY);
  break;  } }
```

(*a*) Why is the individual vertex method slower than the others?

☐ Reason that individual vertex method slower than the others.

(*b*) When used the right way the method using buffer objects is much faster than the others.

☐ Why are buffer objects faster than vertex arrays, when used the right way?

☐ Describe a situation in which the buffer object and vertex array method would have about the same performance.

Problem 4: [20 pts] Answer each question below.

(*a*) OpenGL allows different material property colors for ambient, diffuse, emissive, and specular lighting. However only a few of these can be changed from vertex to vertex. Why?

☐ Why can't all material properties be changed each vertex?

(*b*) OpenGL lets you specify any transformation matrix for the projection, it doesn't have to be a frustum.

☐ Describe the appearance of a scene in which the projection matrix were identity. What parts of world space would be visible?

(*c*) Textures are provided or used to generate multiple MIPMAP levels. Explain what a MIPMAP level is and why it is necessary.

☐ What is a MIPMAP level?

☐ Why is it necessary?