NEWCASTLE UNIVERSITY

SEMESTER 1 2008/09

GRAPHICS

Time allowed - 1½ Hours

Instructions to candidates:

Answer TWO questions

Marks shown for subsections are indicative only

[Turn over

Question 1.

a) The illumination at a point on a curved surface is a function of the characteristics of the light source and the surface, the direction of the viewer, and the normal vector of the surface. Explain the difference between Gouraud and Phong shading in relation to the way in which the surface normal is used when shading a curved surface approximated by triangular polygons, and comment on the strengths and weaknesses of the two algorithms. [7 marks]

b) In computer graphics, objects such as circular disks and spheres are typically approximated by using simpler objects constructed from flat polygons.

    i) Using any method appropriate, describe a procedure for generating a polyhedron to approximate a circular disk. Write pseudocode using OpenGL calls to implement your procedure. This should take the form of a function with a parameter to represent the "quality" of the approximation. [7 marks]

    ii) Using any method appropriate, describe a procedure for generating a polyhedron to approximate a sphere. You should only generate polygons for the surface of the sphere. Write pseudocode using OpenGL calls to implement your procedure. This should take the form of a function with one or more parameters to represent the "quality" of the approximation. [11 marks]

Question 2.

a) In order for polygons to display correctly (specifically in OpenGL), the polygons comprising graphical models must be *simple*.

    i) Describe what is meant by "simple" and state two other constraints that should be maintained for polygons in OpenGL. [4 marks]

    ii) Devise a test to determine whether a two-dimensional polygon as defined by a series of vertices {A, B, C, D,...} is *simple*. [4 marks]

b) A games company has been asked to create a football game. The client wants players to be able to see the action in detail. This functionality has already been implemented. Describe how this could be extended, using OpenGL, to add to the scene a real-time top-down view map of the pitch, without creating additional geometry, giving any factors that should be given special attention. [7 marks]

c) A solid of rotation is formed by rotating a 2-dimensional shape about an axis. An approximate representation of such a solid can be achieved by rotating a 2-dimensional representation of the cross-section in a fixed number of angular steps. Outline how you would generate a representation of such a solid, and describe the case of generating an approximation to a hollow cylinder by rotating a rectangle (in the x-y plane) around the y-axis in a series of steps. Suggest how the plane equations of each face might be computed efficiently. [10 marks]

[Turn over

Question 3.

a) Describe the z-buffer algorithm, including its strengths and weaknesses, and explain its significance in computer graphics.

[8 marks]

b)

   i) Describe what is meant in computer graphics by "picking" and give an example of a context in which it should be used. [3 marks]

   ii) Describe two different approaches to picking, and explain the advantages and disadvantages of each approach. [5 marks]

c) In a typical graphics application a developer must decide whether or not to use display lists. Describe an example in which it is appropriate to use display lists and explain the rationale, including two arguments in favour of their use and two against. [5 marks]

d) Jimmy wants to write code to make a red cube spin whilst moving towards a blue cube. Indicate the different errors in his pseudocode fragment below, and how it could be modified to achieve the desired effect. [4 marks]

```
render()
{
        glTranslate3f(0.0f,5.0f,0.0f);
        glColor3f(0.0f,0.0f,1.0f);
        drawCube();
        glRotate(angle,0.0f,0.0f,0.0f);
        glTranslate3f(0.0f,distance,0.0f);
        drawCube();
        glColor3f(1.0f,0.0f,0.0f);
}
```