CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2008/2009
Examination Period:	Autumn
Examination Paper Number:	CM0304
Examination Paper Title:	Graphics
Duration:	2 hours

Do not turn this page over until instructed to do so by the Senior Invigilator.

Structure of Examination Paper:

There are 3 pages.

There are 4 questions in total.

There are no appendices.

The maximum mark for the examination paper is 100% and the mark obtainable for a question or part of a question is shown in brackets alongside the question.

Students to be provided with:

The following items of stationery are to be provided:

ONE answer book.

Instructions to Students:

Answer THREE questions.

The use of translation dictionaries between English or Welsh and a foreign language bearing an appropriate school stamp is permitted in this examination.

1. **BSP Trees**

   (a) What is a BSP tree? Describe how it is constructed in principle for a scene consisting of convex, simple, flat polygons in 3D. There is no need to describe the individual operations in great detail.

   [7]

   (b) Describe an algorithm together with the necesary mathematical calculations to compute the intersection of a convex, simple, flat polygon with m vertices $v_0, v_1, \ldots, v_{m-1}$ and a plane given by its unit normal n, $\|n\| = 1$, and distance d from the origin.

   [12]

   (c) Show that splitting a convex polygon using a plane can result in at most two convex polygons.

   [6]

   Total: [25]

2. **Lighting**

   (a) List the different types of light used in the Phong illumination model and explain their basic properties. For each type of light, if an observer looks at a given point on the surface, what determines the intensity of the reflected light observed?

   [9]

   (b) What are ambient, directional, point and spot light sources? For each of these light source types, clearly state all necessary parameters to define them and give an equation to compute the intensity $I(p, L)$ of monochromatic light arriving at a point p emitted by a light source of intensity L.

   [9]

   (c) Describe a possible approach for rendering shadows cast by polygons onto other polygons for point light sources using a graphics pipeline. For what type of scenes is your method suitable? What are its limitations?

   [7]

   Total: [25]

3. **Rendering Polygons**

(a) Describe the scan-line algorithm for drawing an arbitrary 2D polygon in a given colour, assuming its vertices are given by pixel coordinates.

[10]

(b) Describe how the Gouraud and Phong shading techniques compute the colour of the pixels rendered for a polygon by a graphics pipeline. Explain the calculation required in terms of the vertices and vertex normals, but there is no need to describe how the illumination model is evaluated.

[8]

(c) Many graphics systems can only render convex polygons. Outline an approach to spatially partition general 2D polygonal areas bounded by piecewise linear curves (as shown in the figure below) into convex polygons for rendering. Justify that the resulting polyogns are convex.

[7]

Total: [25]

4. **Radiosity**

(a) Describe the basic idea of the radiosity rendering technique. State the radiosity equation and clearly explain the meaning of all symbols involved.

[12]

(b) Outline the main steps of the radiosity algorithm for scenes described by parametric surfaces. There is no need to list a detailed algorithm or any equations, but clearly state what has to be computed in each main step.

[5]

(c) Discuss why the standard radiosity algorithm cannot easily handle point light sources. How could the standard radiosity approach be modified to better handle point light sources?

[8]

Total: [25]