UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE FOUR

COMPUTER GRAPHICS

Wednesday 18 April 2001

14:00 to 15:30

Examiners:

Prof. K. Turner (External)

Prof. G. Plotkin (Chairman)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

1. (a) Explain why a homogeneous coordinate system is used to represent affine transformations. *[2 marks]*

   (b) State the role or significance of each of the elements in a single, 3D coordinate, homogeneous, transformation matrix.

   [8 marks]

   (c) What are canonical view-volumes and why are they used?

   [5 marks]

   (d) The perspective canonical view-volume is often transformed to the parallel canonical view-volume since processing of the latter is much easier. A transformation matrix for achieving this is:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{1}{(1-d)} & \frac{-d}{(1-d)} \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

   Show how this matrix may be derived.

   [10 marks]

2. (a) A Bézier curve is defined by the set of control points: $\{(0,0),(2,8),(6,3),(7,5)\}$ and the point half way along the curve is at approximately (4,4.75). Sketch the curve, its control points and its convex hull and explain how it is possible to draw a close approximation to the curve given only these five points.

[*7 marks*]

(b) Briefly outline how you would extend the Bézier method to generate surfaces, giving expressions for the coordinates of a point on the surface. Define the terms used.

[*7 marks*]

(c) Describe how to generate large, arbitrary-shaped, Bézier surfaces.

[*5 marks*]

(d) Sketch the Bézier cubic blending functions and hence explain how curve endpoints are interpolated.

[*6 marks*]

3. (a) An alphabet used to define rendering techniques makes use of the letters: E - eye; L - light source; D - diffuse reflection; and S - specular reflection. Each of the regular expressions listed below fully defines a rendering technique. Name them.

   i. LDS*E
   ii. LD*E
   iii. L(S|D)*E
   iv. LDE

[*2 marks*]

(b) Compare bidirectional ray tracing with standard ray tracing, clearly stating the advantages of the former. Note that you do not need to describe the general ray tracing algorithm.

[*10 marks*]

(c) The goal of Image Based Rendering (IBR) is to generate a continuous representation of the *plenoptic function*. Briefly describe the plenoptic function and its role in IBR.

[*7 marks*]

(d) Image Based Lighting is an IBR technique. Describe this process in general terms.

[*6 marks*]