University College London

Computer Science Department

Dummy Cover Sheet

B.Sc. Degree; B. Eng. Degree 1996

Computer Graphics

2 hours 30 minutes

Question 1 is worth 22 marks and should take about 30 minutes to answer: each of the other questions is worth 26 marks and should take about 40 minutes to answer.

Answer question 1 and any three of questions 2-6.

Note: where an algorithm is asked for, you may write in any suitable pseudo-code. Correct syntax for any computer language is not expected.

Use of electronic calculators is permitted.

Compulsory Question

Question 1

(a) Describe what is meant by the terms *window* and *viewport* in computer graphics and explain what they are used for.

[6 marks]

(b) Describe the main kinds of transformation used to manipulate windows and viewports, and show how homogeneous co-ordinates may be used to simplify implementation of these operations.

[6 marks]

(c) Describe what is meant by *clipping* in computer graphics. Explain how a line may be clipped against a rectangle using the Liang-Barsky algorithm. [NOTE: you are expected to explain how the algorithm works, rather than write code or pseudo-code.]

[13 marks]

[TURN OVER]

*Answer **three** of the following **five** questions.*

Question 2

(a) Describe what is meant by a raster graphics system and explain why such systems are nearly always used for computer graphics nowadays.

[7 marks]

(b) Explain the principles underlying the way a line may be drawn efficiently in a raster graphics system, illustrating your answer by reference to Bresenham's algorithm.

[8 marks]

(c) Explain how the same principles may be extended for drawing a simple, polynomial curve such as a cubic spline. Describe how best to draw a Bézier spline.

[10 marks]

Question 3

(a) Explain what is meant by hidden surface elimination in computer graphics and describe the two main approaches used in raster graphics systems for developing algorithms for this purpose. Discuss the relative advantages and disadvantages of each approach.

[8 marks]

(b) Describe the main steps in Warnock's algorithm for hidden surface elimination to the stage where image regions may be labelled as "full" (F), "empty" (E) or "partially filled" (P), and explain the meaning of these terms.

[10 marks]

(c) Describe what tests are used to identify regions as F, E or P as above and discuss what the advantages of Warnock's algorithm are over other algorithms.

[7 marks]

[CONTINUED]

Question 4

(a) Describe what is meant by a spline curve and explain why cubic splines are frequently used in computer graphics.

[9 marks]

(b) A cubic spline curve is often written as: $\mathbf{x}(t) = \mathbf{T}.M.G$. Describe what **T**, M and G are and explain why it is often useful to represent a spline curve this way. Describe how the blending functions are determined and how it is possible efficiently to transform between one type of spline and another.

[9 marks]

(c) Explain how spline curves may be used to construct surfaces with similar properties and describe how you would arrange to join two Bézier surface patches smoothly and why it works.

[7 marks]

Question 5.

(a) Describe what is meant by a *volumetric or spatial occupancy representation* in computer graphics, explain what they are used for and how they may efficiently be encoded using an *octree.*

[7 marks]

(b) Explain how, in principle, an octree may be used to generate a picture efficiently and describe in detail an algorithm based on a "back to front traversal" of the octree..

[11 marks]

(c) Explain what a fractal is and describe how random fractal surfaces may be generated from an initial control surface by random displacements.

[7 marks]

[TURN OVER}

Question 6.

(a) Explain what is meant by rendering in computer graphics and describe what effects it is important to include in the rendering process.

[7 marks]

(b) Describe how the reflection of light at a surface may be modelled.

[9 marks]

(c) Describe Goraud and Phong techniques for shading a surface represented by polygonal facets, explaining their similarities and differences.

[9 marks]

[END OF PAPER]