THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATION
Professional Graduate Diploma

COMPUTER GRAPHICS

8th May 2001 – 2.30 p.m. – 5.30 p.m.
Answer THREE questions out of FIVE. All questions carry equal marks.
Time: THREE hours.

*The marks given in brackets are **indicative** of the weight given to each part of the question.*

1. *a)* Most colour graphics display devices permit only a small subset of the colours in a palette to be displayed.

i) Why is this? **(3 marks)**

ii) Explain how a Colour Look-Up Table (CLUT) can be used to relate the displayable colour set to the palette colour set. **(6 marks)**

iii) A device is required to display up to 100 colours from a palette of 4000 colours. How small can the CLUT be made? **(6 marks)**

b) Explain how colour is physically produced on a raster graphics screen. You should make reference to electron guns, triads and shadow masks in your answer. **(10 marks)**

2. *a)* Describe the three key characteristics which can be determined from a light energy spectrum. **(6 marks)**

b) What is a colour gamut? From what limitation do all colour gamuts suffer in practice? **(4 marks)**

c) A colour is defined as (0.9, 0.4, 0.4) in the RGB model. What are its components in the CMYK model? **(4 marks)**

d) Briefly describe the three main components in Phong's illumination model. **(6 marks)**

e) What additional light sources can be added to Phong's model to improve visual realism and how can they be taken into account? **(5 marks)**

3. A drawing package requires the implementation of scan conversion algorithms to display primitive shapes. *[Note: your answers to each section of this question should identify any limitations of algorithms. Implementations can be given in your preferred programming language. Assume that you have been provided with a function write(x, y) for displaying a point on the screen.]*

a) Describe the mid-point line algorithm for scan converting straight lines between the points (x1, y1) and (x2, y2), giving any restrictions which the algorithm places on the end points. **(13 marks)**

b) Describe how the algorithm can be extended to scan convert lines between all possible choices of end points. **(12 marks)**

4. A three-dimensional graphics package makes use of a number of transformations to manipulate primitive shapes. In each of the following, draw a diagram to show the effects of the transformations in question and derive the transformation matrix.

a) Give the matrices for a rotation of angle θ about the x-axis and for a rotation of angle φ about the y-axis. Multiply the matrices together to give a composite rotation matrix. **(9 marks)**

b) An arbitrary unit direction vector U = (u1, u2, u3) can be rotated into the positive z-axis by applying a rotation about the y-axis followed by a rotation about the x-axis. By multiplying the composite matrix derived in part *a)* by the vector U, and equating it with a unit vector along the positive z-axis, generate three equations in θ and φ, the solutions of which define the composite rotation matrix from U onto the positive z-axis. **(5 marks)**

c) Solve the three equations to give the sines and cosines of θ and φ in terms of u1, u2 and u3. **(11 marks)**

5. A drawing package needs to be able to define and efficiently display Bézier curves. Your answers to each section should include a diagram where appropriate.

a) Describe the Bézier form of the cubic polynomial curve segment. **(4 marks)**

b) Describe the iterative evaluation method for displaying a parametric cubic and identify the number of multiplications and additions required for each point. **(6 marks)**

c) Show how forward differences can be used to reduce the number of calculations and identify how many multiplications and additions are required for each point. **(7 marks)**

d) Describe the recursive sub-division method for displaying a parametric cubic. **(6 marks)**

e) Give a suitable flatness test for a Bézier curve segment undergoing recursive sub-division. **(2 marks)**