

THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATION
Professional Graduate Diploma

COMPUTER GRAPHICS

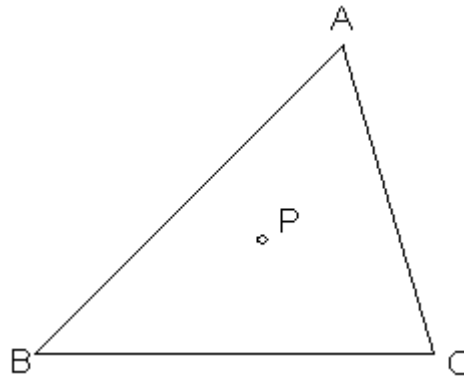
2nd May 2002, 2.30 p.m.-5.30 p.m.

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) Gouraud shading is a commonly used method for rendering polygon meshes.
- i) What is the main improvement offered by Gouraud shading over constant intensity (or flat) shading? **(2 marks)**
- ii) How can the normal vector at a vertex be determined from the surface normals of the polygons sharing that vertex? **(3 marks)**
- b) Consider the following triangle which is to be colour-filled using Gouraud shading.



- i) Given intensity values I_A , I_B and I_C for the three vertices A, B and C respectively, derive a formula for the intensity at the point P.
[You may assume you are working with the intensities of just one colour – equations for the other colours will be analogous.] **(10 marks)**
- ii) Derive an equation for the incremental interpolation of intensity along the edge AB. **(10 marks)**
2. a) Describe the functionality of a Window Manager in an X Windows implementation. **(10 marks)**
- b) Describe the control functions which a Window Manager typically adds to each X client application, giving examples of the user interface for each control. **(15 marks)**

3. a) Texture mapping is frequently used to improve visual realism.
- i) What are the three co-ordinate spaces used in texture mapping and how do they relate to each other? **(6 marks)**
 - ii) Why is inverse scanning preferred in texture mapping?
[You should make reference to pixel pre-images and anti-aliasing in your answer.] **(5 marks)**
 - iii) What further improvement to realism does bump mapping introduce? **(4 marks)**
- b) Consider the problem of mapping a texture defined on the unit square on to the surface of a cylinder of radius r and height h .
- i) Develop a suitable tiling scheme for this task. **(5 marks)**
 - ii) From this derive the mapping equations. **(5 marks)**
[You may ignore viewing and projection transformations as well as aliasing problems here.]
4. A drawing package needs to be able to define and to display Hermit curves. Your answer to each section should include a diagram where appropriate.
- a) Describe the controls which are required to generate a Hermit curve. **(4 marks)**
 - b) Show how a family of Hermit curves can be generated by changing the value of one of the controls. **(3 marks)**
 - c) Give the necessary conditions for two Hermit splines to be combined with G0 continuity. **(4 marks)**
 - d) Give the necessary conditions for two Hermit splines to be combined with G1 continuity. **(4 marks)**
 - e) Give the necessary conditions for two Hermit splines to be combined with C1 continuity. **(4 marks)**
 - f) Describe Horner's rule for reducing the number of calculations when evaluating a cubic polynomial, giving the number of calculations required both with and without the use of Horner's rule. **(6 marks)**
5. A drawing package uses scan conversion algorithms to display a number of primitive shapes. The implementation of the algorithms must be computationally efficient. The shapes must not have any visual irregularities. Your answers to each section should include a diagram where appropriate.
- a) A quarter circle of radius R is scan converted by incrementing the x ordinate in unit steps and calculating and rounding the y ordinate. Explain why this scan conversion approach is unacceptable. **(8 marks)**
 - b) Two straight lines are drawn using a scan conversion algorithm. One has a gradient of 0, the other has a gradient of 1. Both lines are drawn using 20 pixels. Explain why the two lines appear to have different intensities and provide TWO mechanisms by which this effect can be eliminated. **(9 marks)**
 - c) Given that the pixel at co-ordinates (x, y) lies on a circle centred at $(0,0)$, using considerations of symmetry state which other pixel co-ordinate points are known to lie on the circle. Which values of x and y , which lie on the circle, cannot have their additional points generated in this way? Give the reason why and state the additional points that can be generated from each of these values. **(8 marks)**