1 (a) Describe and justify which structures would be sufficient to be able to implement the following rendering routines:

(i) Wire-frame
(ii) Wire-frame with back-face detection
(iii) Flat shading
(iv) Gouraud shading
(v) Phong shading

[15 marks]

(b) Using pseudo-code similar to OpenGL describe how you would use a Bézier spline to produce a camera animation where both the camera’s orientation and position follow the curve. How would the Bézier spline’s geometric and continuity properties ensure a smooth animation?

[20 marks]

(c) Describe the subdivision techniques used to render Bézier surfaces (Lane and Carpenter’s algorithm).

[8 marks]

(d) Propose another subdivision technique which is more suitable for ductile solids, such as a cylinder (Clarke’s algorithm).

[7 marks]
2(a) Describe how the shadow buffer algorithm is used to generate shadows for a scene with more than one light source (Williams’s algorithm).

[10 marks]

(b) What is the difference between global and direct illumination? Use the light transport notation to explain the difference between a renderer similar to OpenGL and a ray-tracer.

[10 marks]

(c) Describe the recursive ray-tracing algorithm (Whitted’s algorithm).

[10 marks]

(d) Compare and contrast a ray-tracer’s shadow generation with the shadow buffer algorithm.

[8 marks]

(e) Illustrate the viewing pipelines for a renderer using z-buffer and Gouraud shading, one using the painter’s algorithm and Phong shading and another using a ray-tracer.

[12 marks]

3(a) Describe how an empirical illumination model could be used to calculate light intensities in terms of diffuse light, specular reflection and diffuse reflection.

[17 marks]

(b) Describe in detail how you would integrate the following polygon-rendering algorithms with the z-buffer and scan-line polygon filling algorithms (Note: the scan-line polygon-filling algorithm does not need to be described):

(i) Flat shading
(ii) Gouraud shading
(iii) Phong shading

Include in your answer techniques for optimising the performance of the algorithms.

[33 marks]