1(a) What is the purpose of visible surface-detection algorithms? [5 marks]

(b) Explain the use of back-face detection (culling), and describe how to implement it. [5 marks]

(c) Briefly describe the following visible-surface detection algorithms:

(i) Scan-line method
(ii) Depth-sorting method (painter’s algorithm)
(iii) Ray-casting method [20 marks]

(d) Describe the depth-buffer (z-buffer) algorithm in detail. What are the advantages and disadvantages of the z-buffer algorithm in terms of memory and processing? Describe a method of alleviating one of the disadvantages. The z-buffer deals only with opaque surfaces and is not capable of dealing with transparencies, describe why and propose a solution. [20 marks]

2 Use "OpenGL-like" commands and pseudo-C for implementations in this question.
(a) What is the advantage of using subdivision when displaying 3D object representations?  

[5 marks]

(b) Use subdivision techniques to demonstrate how to display a circle represented as a square.  

[7 marks]

(c) Adapting the same routines used in (b) above, demonstrate how a hollow cone can be represented by a pyramid (with a square as the base and an additional point representing the apex of the pyramid).  

[13 marks]

(d) What methods are used to represent curves in 3D?  

[5 marks]

(e) How are Bézier splines used to represent curves? What special properties do each of the control points have? Describe what geometric and parametric continuity are. Implement a routine that accepts the control points of a Bézier curve and draws the curve as a series of lines.  

[20 marks]

3 (a) Describe which structures would be sufficient (and why) to be able to implement the following routines into your 3D polygon graphics engine:

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

[15 marks]

(b) Briefly describe how an illumination model can be used to calculate light intensities in terms of ambient light, diffuse reflection and specular reflection.  

[10 marks]

(b) Describe in detail how to implement the following polygon-rendering algorithms, highlighting the differences amongst them:
(i) Flat shading
(ii) Gouraud shading
(iii) Phong shading

[25 marks]