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

Question 1.

(a) A camera is defined as follows: The View Reference Point is at (1,0,0), the camera is pointing at the point (2,0,1) and the View Up Vector is (0,1,0). Where does the point (2,1,2) map to in camera coordinates?

[10 Marks]

(b) Describe the concept of the scene graph, referring to the following: local transformation matrix, current transformation matrix, world coordinates and rendering traverse.

[7 Marks]

(c) When ray-tracing a simple scene there is a trade off between projecting rays into world co-ordinates and transforming objects into camera co-ordinates. Describe the trade off, and give an outline of how to implement both methods referring to the view transformation matrix and scene graph.

[8 Marks]

(d) Describe, with the aid of diagrams, the stages involved in rotating an object about an arbitrary axis.

[8 Marks]

Question 2.

(a) Describe how images are computed in ray tracing. Give an outline of the algorithm for tracing a ray.

[11 Marks]

(b) Describe the use of hierarchical bounding volumes to speed up ray tracing and give pseudo-code for a method to traverse a scene graph to create hierarchical bounding boxes.

[11 Marks]

(c) Describe the regular space subdivision method for speeding up ray tracing, and give psuedo-code for a method that traces a ray through the space subdivision.

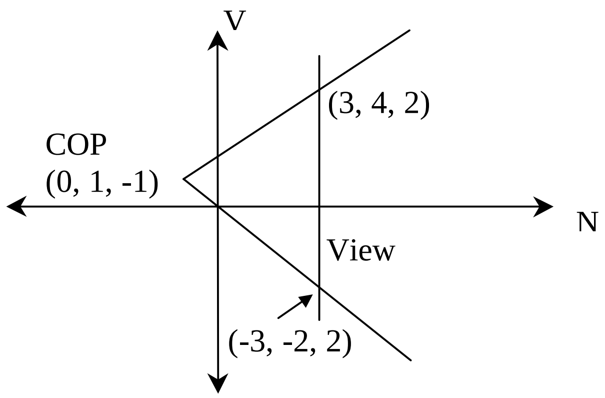
[11 Marks]

Question 3.

(a) With the aid of a diagram explain *Canonical Perspective Space* and *Canonical Parallel Space*. Indicate the positions of the COP, view plane, view plane window and clip planes, where relevant.

[7 Marks]

(b) Give the transformation matrices that can turn the following arrangement to a canonical perspective.



[10 Marks]

(c) Describe in detail the Sutherland-Hodgman algorithm for clipping a polygon in 2D. Explain how it can be generalised to 3D for clipping polygons against the canonical view volume.

[10 Marks]

(d) Explain why it is usually necessary for polygons to be clipped in a three-dimensional space rather than allowing all clipping to take place at the final 2D stage.

[6 Marks]

Question 4.

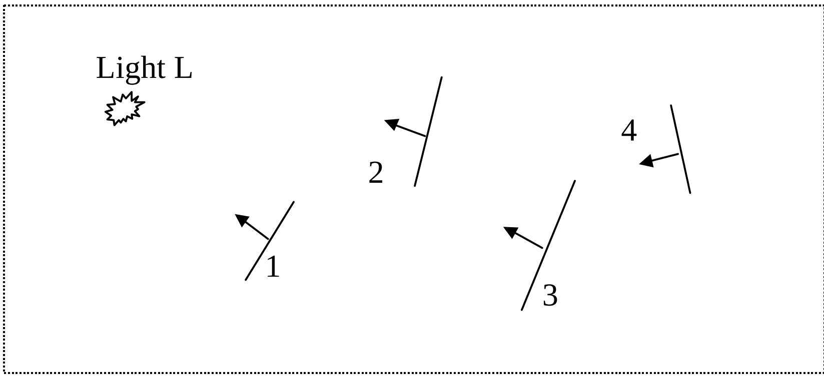
(a) Define a Binary Space Partition (BSP) tree in the context of a 3D scene constructed from planar polygons, in particular describing the BSP tree data structure.

[7 Marks]

(b) Describe the method for recursive building of a BSP tree. What steps should be taken in order to keep the tree size to a minimum?

[7 Marks]

(c) Given the following set of line segments and a point light source L, construct the Shadow Volume BSP tree by adding the polygons in increasing order. Explain your steps and indicate the final shadows.



[10 Marks]

(d) Describe the shadow buffer method for computing shadows.

[9 Marks]

Question 5.

(a) Outline the basic radiosity algorithm. Give the radiosity equation and explain its terms.

[12 Marks]

(b) How does substructuring helps to reduce the complexity of a Radiosity solution?

[8 marks]

(c) How does progressive refinement (PR) radiosity differ from the full matrix radiosity? What is the role of the ambient term in PR? How is it calculated and how is it used?

[13 Marks]

END OF PAPER