

UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For the following qualifications :-

M. Sc.

D12: Graphics

COURSE CODE : COMPOD12

DATE : 08-MAY-01

TIME : 14.30

TIME ALLOWED : 2 *hours* 30 minutes

01-NO050-3-30

0 *2001 University of London*

TURN OVER

Answer three questions out of the following five.

Question 1.

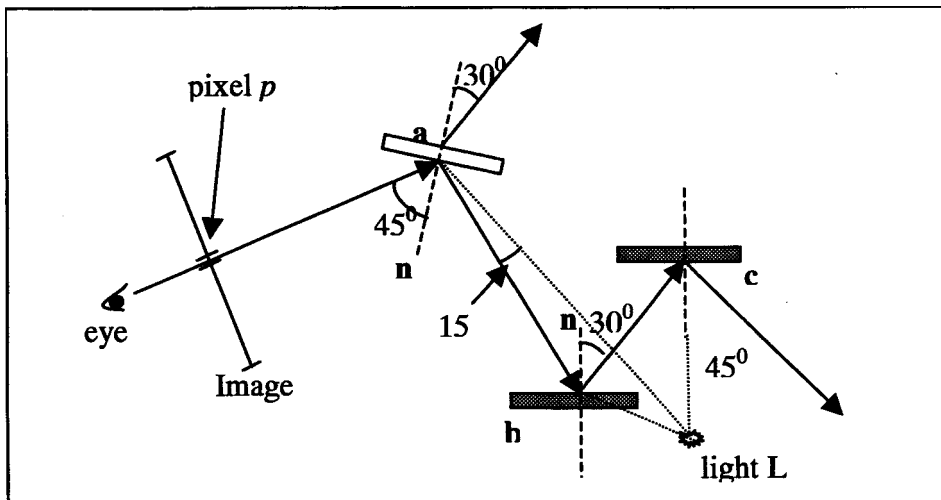
a) Give the formula for computing the local illumination at a surface point p as seen from the viewpoint v .

[6 Marks]

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

[8 Marks]

c) Assuming monochromatic light, compute the intensity of pixel p in the figure below using Ray Tracing. Dotted lines labelled n are the normal to the surfaces.



Intensity of light $L = 1.0$, Intensity of ambient colour = 0.2, Background colour = 0.5

Material of surface a: $k_a = 0.2$, $k_d = 0.2$, $k_r = k_s = 0.3$, $k_t = 0.3$, m (shininess) = 2

Material of surface b: $k_a = 0.2$, $k_d = 0.3$, $k_r = k_s = 0.5$, $k_t = 0$ (surface is opaque)

Material of surface c: $k_a = 0.2$, $k_d = 0.4$, $k_r = k_s = k_t = 0$ (surface is opaque)

($\cos(7.5) = 0.98$, $\cos(15) = 0.96$, $\cos(30) = 0.87$, $\cos(35) = 0.82$, $\cos(45) = 0.71$, $\cos(60) = 0.5$.)

[12 marks]

d) Briefly describe a method for accelerating the testing of shadow rays in ray tracing.

[7 Marks]

[Total 33 Marks]

Question 2.

a) Describe the data structure and algorithm for the Edge Table method for scan-converting a polygon.

[11 Marks]

b) When scan-converting polygons using the Edge Table care must be taken to avoid drawing pixels twice. Why might a pixel be filled twice? Why is this a problem, and how is it addressed when filling spans?

[7 Marks]

c) Outline a polyhedron representation that would allow you to identify the problem edges in part b) efficiently.

[8 Marks]

d) Describe how the Edge Table method can be extended to support Gouraud shading.

[7 Marks] _

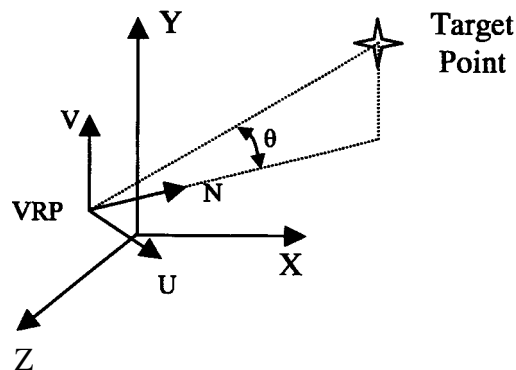
[Total 33 Marks]

Question 3.

- a) 3D scenes are usually described in a *scene graph*. Explain the role of transformations in the scene graph, and the process by which the vertices of a polyhedron can be mapped into world co-ordinates.

[9 Marks]

- b) A camera is modelled by pointing it towards a target point. However since the camera can only rotate about the vector $(0, 1, 0)$ the N axis cannot point directly at the target. Instead the camera rotates until the angle θ between the N axis and the direction to the target point is as small as possible as shown in the following figure:



If the camera is located at the point $(2, 1, 0)$ and is pointing at the target $(1, 2, -1)$ where does the point $(2, 2, 4)$ map to in camera co-ordinates?

[11 Marks]

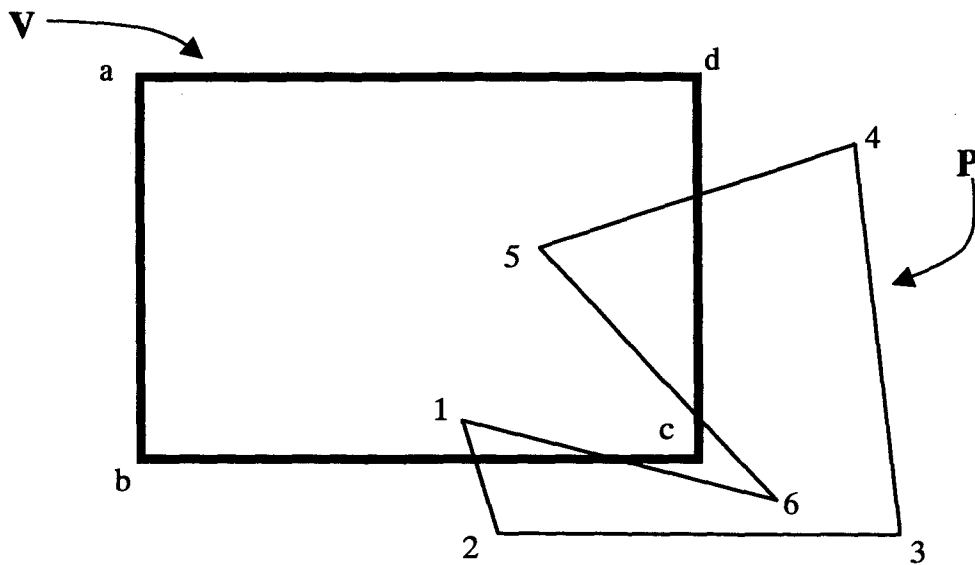
- c) A collection of objects is to be drawn to the screen so that only the visible surfaces are shown. Describe the conditions that have to be met such that it does not matter in which order the objects are drawn. If these conditions are not met, describe list priority techniques that assist in resolving the conflict. For each technique give examples of situations where it does and does not work.

[13 Marks]

[Total 33 Marks]

Question 4.

a) Using the example in the figure below describe the WEH ER ATHERTON clipping algorithm and show what the result will be after polygon P is clipped against the viewing region V.



[15 Marks]

b) What are "Fake Shadows" and how are they computed?

[8 Marks]

c) What is a shadow volume? How are shadow volumes used for computing shadows in the method by CROW?

[10 Marks]

[Total 33 Marks]

Question 5.

a) Explain the meaning of the form factor in the context of Radiosity. Give the formula for the form factor $F_{A_i:A_j}$ between the two patches i and j .

[7 Marks]

b) Describe two common ways for computing the form factors.

[10 Marks]

c) In the figure below the table on the right gives the form factors between pairs of patches. Why do the form factors of patch 4 not add up to 1, ($\sum_{k=1}^6 F_{4k} < 1$)? What does this imply in terms of the outgoing radiosity of patch 4?

[3 Marks]

E=4, B=O, AB=O

$B=O, AB=O$ | 6
 5 | 4 | 3
 B=O, | B=O, | B=O,
 AB=O | AB=O | AB=O

2: B=O,
AB=O

length of each patch = 1
p for all patches = 0.7
Emittance = 0 except patch 1

— i =

	1	2	3	4	5	6
1	0	.1	.2	.4	.2	.1
2	.1	0	.3	.1	.05	.1
3	.2	.3	0	0	0	.05
4	.4	.1	0	0	0	.1
5	.2	.05	0	0	0	.3
6	.1	.1	.05	.1	.3	0

d) Assuming monochromatic light (only one wavelength), give the values of ORad and Rad after two iterations of progressive refinement radiosity for the set-up of the figure above. Explain your calculations at each step.

[13 Marks]

[Total 33 Marks]