THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3343 ZA**

BSc Examination

CREATIVE COMPUTING

Computing Art and Image Effects

Date and Time: Wednesday 4 May 2016, 14.30 – 16.45

Duration: 2 hours 15 minutes

There are FIVE questions on this paper. Candidates should answer **THREE** questions. All questions carry equal marks and full marks can be obtained for complete answers to **THREE** questions. The marks for each part of a question are indicated at the end of the part in [.] brackets.

Only your first **THREE** answers, in the order that they appear in your answer book, will be marked.

There are 75 marks available on this paper.

A hand held calculator may be used when answering questions on this paper but it must not be pre-programmed or able to display graphics, text or algebraic equations. The make and type of machine must be stated clearly on the front cover of the answer book.

1.

(a) Select a painting of Piero della Francesca considered in the subject guide or the accompanying book by Kemp. Briefly describe the composition and comment on the use of *perspective*. Focus on the way parts of the picture are connected by whole or implied lines.

[4]

(b) Uccello's systematic attempts to represent scenes in perspective produced unrealistic structural effects. Give examples of such effects in one of his paintings (such as *St. George and the Dragon*).

[4]

(c) Explain how the relative position of distance points with respect to the vanishing point can indicate the optimal viewing distance for a picture.

[4]

(d) Consider a wire frame (i.e. only facet edges shown) cube of side length 16 units oriented to a viewer so that one pair of opposite facets is normal to the observer's line of sight, which passes through the centre of that pair of opposite facets. The observer's eye is at the origin of the coordinate system. Let the nearest facet to the observer be at z=-8 and the furthest be at z=-22. Also let the ViewPort be of width 7 and height 4 at position z=-d, where d>0. The sides of the view window are aligned with the sides of the cube facets that are normal to the viewer's line of sight, so that the edges of these facets appear horizontal or vertical to the viewer. For the calculations below use a diagram to show your workings.

(i) Calculate the minimum value of d so that two of the edges of the cube do not lie within the ViewPort in a perspective projection.

[3]

(ii) Calculate the maximum value of d so that only the four edges of the facet furthest from the observer still lie within the ViewPort in a perspective projection.

[3]

(iii) For the previous case calculate the projected ViewPort coordinates of the vertices of the visible facet.

[3]

(iv) Calculate the minimum value of d so that no edges of the cube lie within the ViewPort in a perspective projection.

[2]

(v) Now consider that the ViewPort distance is set at d=-6 and the observer's eye is moved to position (0,0,-e). Calculate e such that it is the minimum value for which all edges of the cube lie within the ViewPort.

[2]

2.

(a) Name and briefly describe two types of aids used by painters in their quest to achieve accurate perspective representation.

[4]

(b) Describe a painting of your choice that illustrates the use of perspective aids.

[4]

(c) In the case of linear mapping between triangles, specify how the coordinates of a point belonging to the source triangle can be calculated from a corresponding point in the destination triangle. Draw a diagram to illustrate your explanation.

[5]

(d) Assume a destination triangle with vertices (1,1), (6,2), (2,6) and a source triangle with vertices (2,5), (4,3) and (1,2). Find, showing your working, the coordinates of the point in the destination triangle that correspond to the point (2,1) of the source triangle.

[3]

(e) Given a set of red/cyan filter glasses and a single monitor, describe the process of constructing a stereoscopic image of a scene, using a camera and a software package such as Processing. What is a side effect of this representation approach?

[4]

(f) Write a Processing program that does the following:
(i) Loads two input images.
(ii) Creates a stereoscopic image using appropriate filters.
(iii) Shows the result.

[5]

3.

(a)

(i) The subject guide considers two well-known buildings, whose exteriors are in the form of planar facets, for which one building the shape appears smoothly curved at a distance greater than several times its height, while for the other building the planar surface structure is still apparent at a large distance. Identify the buildings or provide two other examples of structures that illustrate these properties. Draw a line sketch of each one in sufficient detail to show its general form.

[5]

(ii) In what way are the planar facets connected, in each building, such that one appears curved and the other still planar-facetted at large distance?

[3]

(b)

(i) For a basic three-dimensional facetted shape of your choice, having at least five vertices. Define the setup data and write Processing code to define and draw an instance of the object, assuming that the actual and observer frames are the same, i.e. the observer is at the origin, looking along the negative z-axis.

[5]

(ii) Sketch the appearance of the scene you have defined, as viewed with an orthographic projection along the z-axis.

[3]

(c)

(i) Explain the basis of forming a body of extrusion beginning with the definition of the basic cross-section, including a description of how facets are generated with vertices stored in a consistent, clockwise order when seen from outside.

[6]

(ii) Give an example of how a simple path of extrusion may be set and the cross-section shape varied along the path, including a simple sketch of the result.

[3]

4.

(a) For one of the paintings included in the subject guide or the course text by Kemp, for which you name the painting and the artist, describe the composition in terms of light sources, light and shade effects therein and how directly and indirectly lit surfaces reflect.

[6]

(b) Describe what is meant by the terms *gloss* and *shine* of a surface.

[4]

(c) For the Phong reflection model, explain how highlight width depends on glossiness m. Provide an appropriate formula.

[4]

(d) For the Phong reflection model, state the expression of the specular reflection component in terms of gloss and shine. Draw a diagram to illustrate your answer.

[4]

(e) Consider a light source with colour $C_L=(R_L,G_L,B_L)$ and a facet F of colour $C_F=(R_F,G_F,B_F)$, as represented in RGB. Calculate the colour components of reflected light in terms of R_L,G_L,B_L, R_F,G_F and B_F if:

(i) the facet is perfectly matt
(ii) the facet is a perfect shiny

[4]

(f) Consider a room with a white light source of intensity 1 and a Facet F with a shine of constant value 0.5, a gloss of 5 and a perfectly yellow colour C1 = (1,1,0), represented in RGB with each component in the range [0,1]. Calculate the value of the specular reflection component at an observer's eye view direction that is $\pi/2$ radians from the reflection direction.

[3]

5.

(a) Umberto Boccioni strived to convey a sense of motion in his works. Explain how he did this by describing

(i) one painting that you name, such as 'The city rises'

[4]

(ii) one sculpture that you name, such 'Unique forms of continuity in space'

[4]

(b) Write a Processing program that in every iteration

(i) Draws a rectangle, centered on the mouse position

(ii) When the mouse button is pressed the colour of the rectangle is changed to a random one and it is rotated by pi/6 radians around the mouse position

(iii) Creates a trailing animation effect

Briefly explain each line of code with an inline comment

[8]

(c) Describe how a weighted median filter is different from a weighted mean (averaging) filter. Explain why the former generally produces more sharply delineated features, with larger expanses of uniform tone, than the ones produced by the latter.

[3]

(d) Consider the filter mask $\begin{pmatrix} 1 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ and the grey level pixel array

$$\begin{pmatrix} 15 & 15 & 21 & 21 \\ 14 & 14 & 18 & 18 \\ 1 & 1 & 3 & 2 \\ 1 & 3 & 2 & 1 \end{pmatrix}$$

Calculate the integer values of the 4 internal (non-edge) pixels in the array resulting from applying the mask separately with each of:

- a weighted mean filter, rounding as required,
- a weighted median filter.

[6]

END OF PAPER