

UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

Department of Computing

B. Sc. Examination 2014

IS53032A

Advanced Graphics and Animation

Duration: 2 hours 15 minutes

Date and time: Wed 14th January 2015 at 2.30pm

There are five questions in this paper. You should answer no more than three questions. Full marks will be awarded for complete answers to a total of three questions. Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] brackets.

There are 75 marks available on this paper.

**THIS PAPER MUST NOT BE REMOVED
FROM THE EXAMINATION ROOM**

TURN OVER

Question 1 Transformations, projection and rasterisation

(a) What is meant by:

- i. world coordinate system [2]
- ii. object coordinate system [2]

(b) Explain the context of the following Unity script and what it does. [4]

```
for (var child : Transform in transform) {  
    child.position += Vector3.up * 10.0;  
}
```

(c) The endpoints of a given line are (0,0) and (6,18). Compute the equation of the line and each value of y as x steps from 0 to 6. [5]

(d) The matrix $\begin{pmatrix} 1 & a \\ b & 1 \end{pmatrix}$ defines a transform called a *shearing*. The special case when $b = 0$ is called *shearing in the x direction*. When $a = 0$, we have *shearing in the y direction*.

Sketch the effect of these shearing transformations on the square $A(0,0)$, $B(1,0)$, $C(1,1)$, and $D(0,1)$ when $a = 2$ and $b = 3$. [12]

TURN OVER

Question 2 Surfaces and shading

- (a) The painter's algorithm is a form of hidden surface removal.
- i. What is the underlying concept of the painter's algorithm? [3]
 - ii. What difficulties might be encountered in implementing the painter's algorithm? [2]
- (b) With polygon filling, all of the pixels within the boundaries of the polygon must be set to the specified colour or pattern.
- i. Explain the differences between *recursive seed fill* and *scanline fill*, [4]
 - ii. Sketch diagrams to show how these two algorithms work. [4]
- (c) Explain the following shader code: [12]

```
layout (std140) uniform Matrices {
    mat4 projModelViewMatrix;
    mat3 normalMatrix;
};

in vec3 position;
in vec3 normal;
in vec2 texCoord;

out VertexData {
    vec2 texCoord;
    vec3 normal;
} VertexOut;

void main()
{
    VertexOut.texCoord = texCoord;
    VertexOut.normal = normalize(normalMatrix * normal);
    gl_Position = projModelViewMatrix * vec4(position, 1.0);
}
```

TURN OVER

Question 3 Textures

- (a) A shader is a computer program that is used to do shading, usually used to program the GPU rendering pipeline.
- i. What is the difference between a vertex and a fragment shader? [3]
 - ii. What kind of things can fragment shaders do? [3]
 - iii. What types of input do fragment shaders take? [3]
- (b) What is the difference between texture mapping and procedural texturing? [4]
- (c) Explain the steps required to carry out texture mapping of an image onto a polygon using a planar map shape. [8]
- (d) How might you ensure that an object's texture remains in the correct place when that object moves? [4]

TURN OVER

Question 4 Representing the real world

- (a) What is a BRDF? [3]
- (b) What is the rendering equation? Why is it useful? [5]
- (c) Although the rendering equation is very general, it does not capture every physical aspect of light transport. Describe three aspects that it cannot capture. [9]
- (d)
 - i. Explain the concept of ray-tracing. [5]
 - ii. Describe THREE advantages of using ray-tracing to render a scene. [3]

TURN OVER

Question 5 Post-processing and display

The ultimate aim of realistic graphics is the creation of images that provoke the same responses that a viewer would have to a real scene.

- (a) In relation to this, what problems do computer screens pose? [5]
- (b) How does tone mapping offer a solution to this problem? [5]
- (c) Why does a linear scaling not work? [5]
- (d) By what process can a non-HDR camera produce an HDR image? [5]
- (e) Why is a specific file format needed for HDR images? [5]

END OF EXAM