

UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

B. Sc. Examination 2012

COMPUTING AND INFORMATION SYSTEMS

IS53032A Advanced Graphics and Animation

Duration: 2 hours 15 minutes

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*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.*

*No calculators should be used.*

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

**Question 1** Transformations and projections

- (a) What is the difference between orthographic projection and perspective projection? [4]
- (b) Giving an example, explain why orthographic projection might be useful in practice. [2]
- (c) Describe the effect of the following transformations:
- i. translation [2]
  - ii. rotation [2]
  - iii. scale [2]
  - iv. perspective projection [2]
- (d) Explain how projection transforms are performed in a shader. Edit the Cg shader below so that it performed the correct transforms including projection. [5]

```
#pragma vertex vert
#pragma fragment frag
#include "UnityCG.cginc"

float4 _Colour;

struct v2f {
    float4 pos : SV_POSITION;
    float3 colour : COLOR0;
};

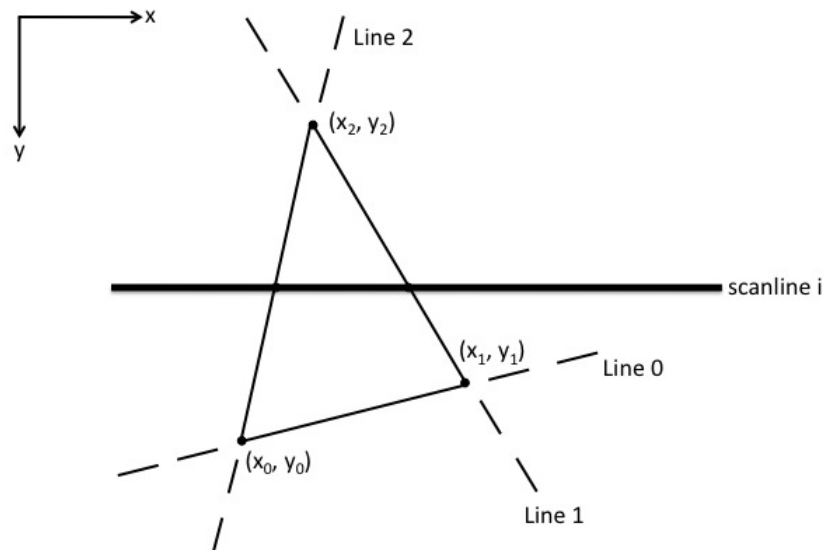
v2f vert (appdata_base v)
{
    v2f o;
    o.pos = v.vertex;
    o.colour = _Colour;
    return o;
}

half4 frag (v2f i) : COLOR
{
    return half4 (i.colour, 1);
}
```

- (e) Edit the shader from part (d) so that the colour of the surface of the object changes with height. The top of the object should be a different colour from the bottom, the colour should not change as the object moves. [6]

**Question 2** Rasterization

- (a) Additive colour mixing is used in computer graphics. Explain what is meant by this. [5]
- (b) With reference to the diagram below, describe the algorithm to scanline fill a triangular polygon. [10]



- (c) Explain the reasoning behind the Z-buffer algorithm. Describe the algorithm in pseudocode. [10]

**Question 3**      Illumination and shading

- (a) What is meant by the term ‘depth cueing’? [3]
- (b) Which three aspects of light reflection does the Phong illumination model capture and which phenomena of real physical reflection do these represent? [6]
- (c) Explain the differences between flat shading and interpolation shading. [4]
- (d) Describe four ways that light can be sent into a scene. Provide an example of that type of lighting and a basic diagram for each. [12]

**Question 4**     Rendering

- (a) Explain why global illumination is required to achieve superior photorealism. [3]
- (b) Describe the basic principles in the ray-tracing approach to producing computer generated images. State two advantages and two disadvantages of this technique. [10]
- (c) Explain why a ray of light is traced backwards through the scene in ray tracing. [6]
- (d) Rendering techniques can be view-dependent or view-independent, with advantages and disadvantages in both instances.
  - i. Ray-tracing is view-dependent. State three advantages of this. [3]
  - ii. Radiosity is view-independent. State three disadvantages of this. [3]

**Question 5** Textures

- (a) Why is the ability to add surface texture useful in computer graphics? [4]
- (b) What is procedural texture mapping and what advantages does it offer? [4]
- (c) Describe three coordinate systems used in texture mapping. [9]
- (d) Explain the process involved when a sphere is used as the map shape in texture mapping. [8]