UNIVERSITY OF LONDON

CM3045

BSc EXAMINATION

COMPUTER SCIENCE

3D Graphics and Animation

Release date: Wednesday 8 March 2023 at 12:00 midday Greenwich Mean Time

Submission date: Thursday 9 March 2023 by 12:00 midday Greenwich Mean Time

Time allowed: 24 hours to submit

INSTRUCTIONS TO CANDIDATES:

Section A of this assessment paper consists of a set of **TEN** Multiple Choice Questions (MCQs) which you will take separately from this paper. You should attempt to answer **ALL** the questions in Section A. The maximum mark for Section A is **40**.

Section A will be completed online on the VLE. You may choose to access the MCQs at any time following the release of the paper, but once you have accessed the MCQs you must submit your answers before the deadline or within **4 hours** of starting whichever occurs first.

Section B of this assessment paper is an online assessment to be completed within the same 24-hour window as Section A. We anticipate that approximately **1 hour** is sufficient for you to answer Section B. Candidates must answer **TWO** out of the THREE questions in Section B. The maximum mark for Section B is **60**.

Calculators are not permitted in this examination. Credit will only be given if all workings are shown.

You should complete **Section B** of this paper and submit your answers as **one document**, if possible, in Microsoft Word or a PDF to the appropriate area on the VLE. Each file uploaded must be accompanied by a coversheet containing your **candidate number**. In addition, your answers must have your candidate number written clearly at the top of the page before you upload your work. Do not write your name anywhere in your answers.

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SECTION A

Candidates should answer the **TEN** Multiple Choice Questions (MCQs) quiz, **Question 1** in Section A on the VLE.

SECTION B

Candidates should answer any **TWO** questions from Section B.

Question 2 GPU Shaders

This question asks you describe your first peer review on GPU shaders.

In all of the following sub-questions you should:

- Describe your implementation.
- Explain all of the GPU and graphics techniques you used (e.g. give any mathematical equations and explain what they mean)
- Explain why you chose those method

Your answer to these questions should be at most 2 page (minimum font size 11, minimum margins 2cm), you can include additional pages for images or references.

(a) Describe how you implemented either of the following.

- A vertex shader that deforms an object
- A fragment shader that draws a colour pattern on an object

(10 marks)

(b) Describe how you would animate the above shader and explain the techniques you'd use.

(10 marks)

(c) If you implemented any of the following extensions, describe how you did it and explain the techniques you used.

- Create a complex animated shader that includes both vertex definition and fragment based patterns that work together
- Normal Extrusion is a popular example of a vertex deformation, research it and implement it.
- A very useful vertex technique for a lot of visual effects is drawing an outline around an object. This is commonly done using vertex normals. Research outline shaders and implement one.

(10 marks)

Question 3 Lighting

The second peer review asked you implement either the standard lighting equation or an alternative lighting model.

In all the following sub-questions you should:

- Describe your implementation
- Explain all of the GPU and graphics techniques you used (e.g. give any mathematical equations and explain what they mean)
- Explain why you chose those method

(a) Write down and explain the diffuse Lambertian component of the lighting equation and describe how you implemented it in a shader

(10 marks)

(b) Describe an alternative lighting model to the lighting equation and how you implemented it on the GPU.

(10 marks)

(c) If you implemented any of the following extensions, describe how you did it and explain the techniques used.

- Implement an alternative lighting model, e.g. from chapter 13 of Boreskov and Shikin
- Not all computer graphics aims to be realistic. Toon shading uses a lit shader to create an effect similar to traditional cartoons. Research and implement a lit Toon shader

(10 marks)

Question 4 Textures

The third peer review asked you to implement texture mapping in a shader programme.

In all of the following sub-questions you should:

- Describe your implementation
- Explain all of the GPU and graphics techniques you used (e.g. give any mathematical equations and explain what they mean)
- Explain why you chose those method

Your answer to this questions should be at most 2 page (minimum font size 11, minimum margins 2cm), you can include additional pages for images or references.

(a) Describe and explain GPU colour and normal mapping and how you implemented them in a shader

(10 marks)

(b) Explain one of the following techniques and give an example of how you implemented it in a GPU:
a. procedural texturing
b. animated textures
c. transparent textures.

(10 marks)

(c) If you implemented any of the following extensions, describe how you did it and explain the techniques used.

- Height maps are another texturing technique related to normal maps. Research and implement height maps in a shader
- Environment or reflection maps are a texturing technique that creates the appearance of reflections on an object. Research and implement environment or reflection maps
- Sketch shaders use textures to create the appearance of a hand drawn pen or pencil sketch. Research texture based sketch shaders and implement one.

(10 marks)

END OF PAPER