THE UNIVERSITY OF WESTERN AUSTRALIA

Department of Computer Science and Software Engineering

MID-SEMESTER TEST, 2019

CITS3003
Graphics and Animation

FAMILY NAME:_____ GIVEN NAMES: _____

STUDENT ID: | | | | | | | | | SIGNATURE:_____

This Paper Contains: **4** pages **(including title page)**
Time allowed: **40 Minutes**

INSTRUCTIONS:

Write your names and student numbers on this page.

There are 3 questions in total. Question 1 and 3 have subparts. Each question, including any subparts, carries 10 marks. Answer all questions. Write your answers on this sheet in the space provided after each question.

Calculators, notes and books are not allowed.

Total marks are 30.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.

Therefore, any candidate who has brought any unauthorised material whatsoever into the examination room should declare it to the supervisor immediately. Candidates who are uncertain whether any material is authorised should ask the supervisor for clarification.

Supervisors Only – Student left at:

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Question 1-(a) [2 marks]
Why is ray tracing not a preferred way of rendering in graphics even though it can produce global lighting effects?

Although ray tracking can produce global lighting effects such as shadows and multiple reflections, ray tracing gets complicated with multiple light object interactions making it slow and not well-suited for interactive applications.

[Ref: Lecture 1, slide 17 and slide 26]

Question 1-(b) [2 marks]
Name four primitives and four attributes in OpenGL.

Primitives: Points, lines, line_strip, line_loop, triangles, triangle_strip, triangle_fan
(only 3 required)

Attributes: Color, size, width, stipple pattern
(only 3 required)

[Ref: Lecture 2, slides 9 and 10]

Question 1-(c) [6 marks]
Write the names of the three main elements of image formation [3 marks] and explain briefly [3 marks] why it is beneficial for these elements to be independent of each other.

The three main elements of image formation are:

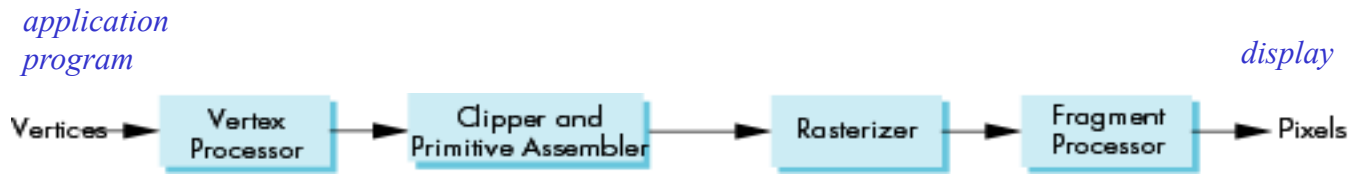
1. Objects
2. Viewer
3. Light source(s)

It is beneficial to model these elements independent of each other because it leads to simple software Application Programme Interfaces (APIs) i.e. we can specify objects, lights and camera parameters separately and let the implementation determine the final image. This also leads to fast hardware implementation.

[Ref: Lecture 1, slides 11 and 12]

Question 2. [10 marks]

Draw a diagram [2 marks] showing the four main blocks of the OpenGL pipeline architecture. Briefly explain the functionality of each block [2 marks each].



Vertex Processor: Performs per vertex operations such as transforming the vertices from one coordinate system to another. It performs projections (e.g. perspective projection) of the vertices. It also computes vertex colours.

Clipper and Primitive Assembler: Primitive assembler collects/groups vertices into geometric objects such as line segments, polygons, curves and surfaces. Primitive assembly is necessary before clipping and rasterization can be performed. Clipping is then performed on a primitive by primitive basis rather than a point by point basis. Clipping is the process of removing (clipping out) parts of objects that are outside the viewing volume.

Rasterizer: Rasterizer produces a set of fragments for each object that is not clipped out. Fragments are potential pixels which have a location (in the frame buffer), colour, depth and alpha attributes. Rasterizer interpolates vertex attributes (colour, transparency) over the object.

Fragment Processor: Processes fragments (received from the rasterizer) to determine the colour of the corresponding pixel in the frame buffer. The fragment colour can be determined by texture mapping or by interpolation of vertex colours. Fragments may be blocked by other fragments closer to the camera. Hence, hidden-surface removal is also performed in the fragment processor.

[Ref: Lecture 3, slides 15 to 19]

Question 3-(a) [4 marks]
Describe one advantage [2 marks] and one disadvantage [2 marks] of the OpenGL pipeline architecture. Be specific rather than simply mentioning the speed aspect of the pipeline architecture.

Advantage: All steps can be implemented in hardware on the graphics card for fast execution.

Disadvantage: Since objects passed to the pipeline are processed one at a time in the order they are generated by the application program, it can consider (generate) only local lighting (e.g., no shadows).

[Ref: Lecture 3, slide 14]

Question 3-(b) [4 marks]
What are the applications of vertex shader i.e. what operations can be performed at the vertex shader. Write any two.

1. Geometric transformations such as change relative location, rotation, scale of objects/camera

2. Geometric transformation to apply 3D perspective – make far objects smaller

3. Moving vertices such as perform morphing, compute wave motion & deformation due to physical forces. Simulate particle effects – for fire, smoke, rain, waterfalls, Compute fractals

[Ref: Lecture 6, Slide 3]

Question 3-(c) [2 marks]
Consider a point and a vector, both represented in homogeneous coordinates. What happens when a vector is added to a point?

It translates/moves the point to a new location in the direction of the vector by a distance equal to the magnitude of the vector.

Consider a point $P = [1\ 2\ 3\ 1]^T$ and a vector $v = [3\ 2\ 5\ 0]^T$, their addition $P + v = [4\ 4\ 8\ 1]^T$ gives another point at a different location.

[Lecture 8, slide 26 and slide 28]

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