THE UNIVERSITY OF WESTERN AUSTRALIA

Department of Computer Science and Software Engineering

MID-SEMESTER TEST, 2020

CITS3003
Graphics and Animation

FAMILY NAME:_____ GIVEN NAMES: _____

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

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

This is not a graded test. Due to online teaching mode, this test will not contribute to your final grade. It is provided for your self-assessment only. No submission is required. The pattern and format have been kept consistent with the exams of previous years, only for the usual experience. You may choose to ignore the NOTE below. The sample solution will be uploaded soon. You may like to mark your answers for self-assessment in the light of the sample solution.

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.

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Question 1-(a) [2 marks]
What do you understand by the terms ‘luminance image’ and ‘colour image’? Differentiate between the two by describing the key properties of the two.

- Luminance image is a monochromatic image, with values describing the levels of gray colour.
- Colour image has perceptual attributes of hue, saturation and lightness.

[Ref: Lecture 1, slide 18]

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

Attributes: Color, size, width, stipple pattern

[Ref: Lecture 2, slides 10 and 11]

Question 1-(c) [5 marks]
Write the names of the three main elements of image formation [3 marks] and explain briefly [2 marks] why it is beneficial for these elements to be independent of each other.

The three main elements of image formation are:

- Objects
- Viewer
- 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]

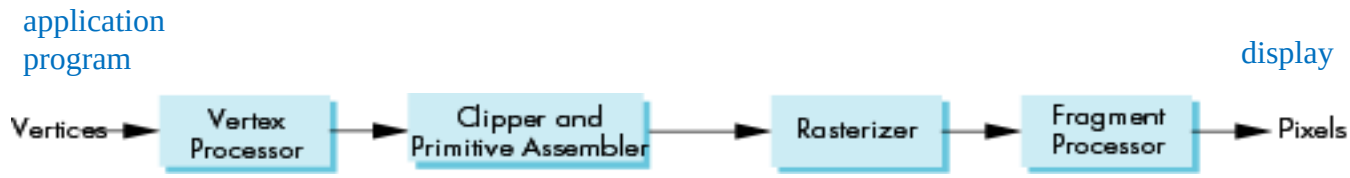
Question 1-(d) [1 mark]
What is the dimensions and type of the data expected by the function ‘glUniform3f’?

Dimension = 3
Type = floats

[Ref: Lecture 2, slide 14]

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]
OpenGL chooses to only display triangles because of their three desirable properties. What are those properties? [3 marks]. How polygons other than triangles would be treated by OpenGL?

Desirable properties:

- Simple (edges can not cross)
- Convex (all points on line segment between two points in a polygon are also in the polygon)
- Flat (all vertices are in the same plane)

If other polygons are used, they must be tessellated into triangles.

[Ref: Lecture 3, slides 5 and 6]

Question 3-(b) [2 marks]
What are the applications of vertex shader i.e. what operations can be performed at the vertex shader. Write any two.

- Geometric transformations such as change relative location, rotation, scale of objects/camera
- Geometric transformation to apply 3D perspective – make far objects smaller
- 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 4]

Question 3-(c) [4 marks].
Name four standard transformations? [2 marks] For M1= ABCD and M2 = DCBA, is it true in general that M1 = M2? - provided that A, B, C and D are standard transformations. [2 marks]

The four standard transformations are

- Rotation
- Translation
- Scaling
- Shear

No, because matrices do not commute in general.

[Lecture 9, slide 2 and slide 17]

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