UNIVERSITI SAINS MALAYSIA

Stamford College

First Semester Examination
2004/2005 Academic Session
October 2004

External Degree Programme
Bachelor of Computer Science (Hons.)

CMT315 – Computer Graphics & Visual Computing

Duration : 2 hours

INSTRUCTIONS TO CANDIDATE:

- Please ensure that this examination paper contains **FIVE** questions in **SIX** printed pages before you start the examination.
- Answer any **FOUR (4)** questions.
- Where an algorithm or coding is asked for, you may write in any suitable pseudocode. Correct syntax for any programming language is not expected.
- On each page, write *only your **Index Number***.

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1. (a) An output device has 525 scan lines, with the size of raster (in bytes) being 183 750 bytes, and each pixel consist of 4 bits. Calculate the aspect ratio (the height and width aspect) of this device.

(20/100)

(b) Various attempts to build special-purpose graphics systems have been proposed, these includes the *display processors* and the *pipeline* architectures? Briefly explain each architecture, and explain what problems (or advantages) that each architecture trying to solve over the use of general-purpose computer in early graphics system.

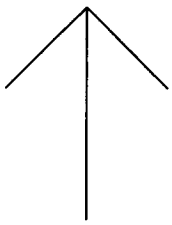
(25/100)

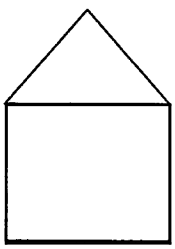
(c) (i) The result of the scan conversion is an image stored on frame buffer and later displayed on our monitor. What is *scan conversion*? Assume that the monitor is CRT, list and explain the characteristics of a good CRT monitor to display colour image.

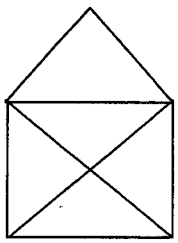
(ii) The two words *interlaced* and *non-interlaced* occur frequently in discussions about the refresh rate of CRT monitors. What do they mean?

(25/100)

(d) Write an OpenGL code segment to draw the following objects. Note that you must use either GL_LINE_STRIP or GL_LINE_LOOP only. Note, to help your drawing, you can invent your own coordinates values for the objects below.

(a) 

(b) 

(c) 

(30/100)

2. (a) For each of the following *logical input device*, describe their functionality i.e. what being captured/measured, how and when they are used :

(i) String

(ii) Locator

(iii) Pick

(iv) Choice

(v) Stroke

(30/100)

(b) In a typical graphics application program, the programmer must decide whether or not to use *display lists*. Consider at least two applications. For each, list at least two factors in favor and at least two factors against the use of display list.

(30/100)

(c) A triangle with the vertices of (0,0,0), (1,1,0) and (5,2,0) is to be modified to twice its original size but with the point (1,1,0) is *fixed* to its original position, and then the triangle is to be rotated 90 degree about a line that goes through origin to point (2,2,2) with (4,4,4) as a fixed point.

(i) Sketch the drawing of the triangle at each of the step as described in the above. Label your sketches clearly indicating the axes, types of operations, and reference point/line.

(ii) Write OpenGL codes to *construct* the triangle, and to carry out the transformation operations as specified above.

(40/100)

3. (a) This question is about the *Cohen-Sutherland* line clipping algorithm:

(i) Carefully discuss the *rationale* behind the various tests and methods for calculating the intersection of line segment(s) with clipping window in *Cohen-Sutherland* line clipping algorithm?

(ii) Calculate the number of arithmetic and logical operations performed in the *Cohen-Sutherland* line clipping algorithm for several different line orientations relative to a clipping window.

(30/100)

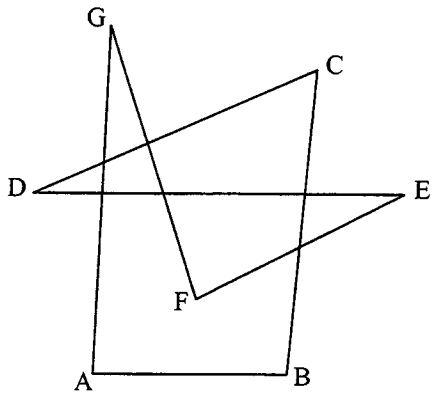
(b) Aliasing is an undesirable effect often found in computer generated images – staircase effects or jaggies are quite visible on the edges of polygon or line segments.

(i) Show with appropriate illustrations, how antialiasing by *area averaging* technique solve this problem.

(ii) It was said this visual artifact can be *eliminated* for good by increasing the resolutions of the frame buffer. Discuss this statement by providing justifications of whether you agree or against it.

(35/100)

(c) (i) A test of whether a point is inside/outside a polygon provide the basis for many fill area algorithms. Fill the area *inside* the following polygon using *odd-even* rule and *winding-number* rule. Show the result of each rule separately.



(ii) In a scan line fill area algorithm, illustrate with appropriate diagram how this algorithm solves the problem known as *singularity*?

(35/100)

4. (a) This question is related to the concept of *viewing* and *projection* in OpenGL.

(i) Viewing transformation is one of a series of transformations in the graphics pipeline. Explain what this transformation does (the effect on the objects after the transformation). Provide at least one OpenGL's API that performed this transformation, and briefly describe how it functions.

(ii) Projection *normalization* is an essential part in the projection transformation, in which view volume is converted to *canonical* form (a unit cube). Explain why is this process is essential. Another way of saying it is what will happen if we do not do projection normalization?

(35/100)

(b) *Phong Reflection Model* (PRM) provides a simple formula to simulate the interaction between light and material (object) to produce a realistic output.

(i) Briefly describe the main components of PRM, explain the rationale for each of this component, and show how they are combined to calculate pixel intensity.

(ii) Often, when a large polygon is shaded by Open GL, it is rendered *brightly* in one area and more *dimly* in others. Explain why the image is uneven. Describe how you can avoid this problem.

(35/100)

(c) *Gouraud* shading is claimed to produce image that is smoother and more realistic compared to the image shaded with *Phong* method. Argue this statement by providing justification either supporting or against it.

(30/100)

5. (a) (i) Sketch the Bezier curve with control points. (Note that only an estimate of the curve is required, not the exact curve.)

P1=(5,5,0), P2=(8,5,0), P3=(10,8,0), and P4=(10,10,0);

(ii) List and explain important features of Bezier curve, use diagram whenever appropriate to support your answer.

(32/100)

(b) Visualization is a new field emerging from the applications of computer graphics.

(i) What is it, and why it is an important field?

(ii) Compare and contrast the differences between scientific visualization and business visualization.

(iii) What are the types of data and visualization techniques commonly used in scientific visualization?

(iv) Give two examples of application of visualization, include in your answer how visualization techniques are used in the chosen applications.

(35/100)

(c) (i) The *alpha component* in RGBA mode can be used to blend colours from various objects that contribute to the same pixel. Describe, how this process of *compositing* is done.

(ii) Logical exclusive-or operation (XOR) is an interesting writing mode. Why it is so? Give an example where XOR mode is useful in graphics application.

(33/100)

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