UNIVERSITY OF VICTORIA
EXAMINATIONS APRIL 2007
CSC 405/505: COMPUTER GRAPHICS

Instructor: B WYVILL Duration: 2 hours

TO BE ANSWERED IN EXAM BOOKLETS

STUDENTS MUST COUNT THE NUMBER OF PAGES IN THIS EXAMINATION PAPER BEFORE BEGINNING TO WRITE, AND REPORT ANY DISCREPANCY IMMEDIATELY TO THE INVIGILATOR.

THIS QUESTION PAPER HAS 3 PAGES INCLUDING THIS PAGE.

Instructions

- Please fill in your **name**, **ID number**, and **login ID** on the exam booklet.
- All answers are to be provided in the exam booklet.
- All questions carry equal weight, you may attempt all questions.
- Full marks may be obtained for correct answers to four questions.
- The total will be calculated by adding the marks for the best four answers.
- **Show all your work, for every question.**
- This is a closed-book exam but a single double sided sheet of notes is permitted.
- Calculators are permitted.
- State any assumptions you make.
- Ensure all cell phones are turned off.
- You are required to remain for the first 30 minutes.
- You are required to remain for the last 30 minutes.

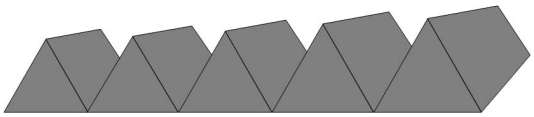

Figure 1: Model of the roof used in question one.

Question 1 ..... *(10 points)*

Shading

(a) Compare and contrast the Phong and Gouraud shading models applied to a triangle mesh? [4]

(b) Early in the morning a pirate adrift on a raft in the Indian Ocean sees a ship approaching from the West. At the top of the 50 metre high mast is affixed a gold coin. He sees the glint of the gold when his raft is 100metres from the ship. What angle does the sun make with the horizon? [2]

(c) A triangular mesh is used to represent a model of a house. The architect has placed a series of cylinders each with an equilateral triangular cross section, on the flat roof so that apex of the triangle points upwards. The model is rendered using Phong shading. When the light source shines from above and left of the building, describe the appearance of the shading of the roof. (see Figure 1). [4]

Question 2 ..... *(10 points)*

Ray Tracing I

(a) Describe a test to quickly eliminate a ray that does not hit a sphere and also returns the intersection points if the ray does hit the sphere? [2]

(b) A ray, origin $E = (0, 0, 0)$ is fired in the direction of the vector $\mathbf{V} = (1, 1, 0)$ at a unit sphere, origin $\mathbf{O} = (1 + \sqrt{2}, 1, 0)$. Does the ray intersect the sphere? [4]

(c) In the previous question calculate the intersection point if the centre of the sphere is moved to the point $\mathbf{O} = (0.9999 + \sqrt{2}, 1, 0)$. (You can approximate). [4]

Question 3 ..... *(10 points)*

Ray Tracing II

(a) A unit sphere is transformed by scaling it by $(1, 2, 1)$ and translating it to the position $\mathbf{O} = (1, 0, 0)$ in the scene. Describe a method for finding the intersection of the ray origin $E = (-\sqrt{2}, 0, 0)$ and direction $(1, 1, 0)$ and the ellipsoid? [4]

(b) How is the normal at the intersection point in the scene calculated? [4]

(c) Write brief notes describing how uniform space subdivision may be used to speed up ray tracing. [2]

Question 4 ..... *(10 points)*
Rendering

(a) Describe the Z-buffer algorithm. How does it solve the hidden surface problem? [3]

(b) Compare and contrast Z-buffer and ray tracing. [4]

(c) Describe the anti-aliasing method used in A-buffer. How is the partial coverage of a pixel by a polygon fragment calculated? [3]

Question 5 ..... *(10 points)*
General

(a) What is meant by a ray signature? [2]

(b) Describe why and how jittering is used in ray tracing. [2]

(c) Why are homogeneous coordinate systems used in computer graphics? [2]

(d) What is a scene graph? [2]

(e) Distinguish between Phong shading and the Phong light model. [2]

END