UNIVERSITY OF VICTORIA
FINAL EXAMINATIONS APRIL 2014
CSC 305: INTRODUCTION TO COMPUTER GRAPHICS

Instructor: B WYVILL Duration: 120 minutes

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** and **ID number** on the exam booklet.
- All answers are to be provided in the exam booklet.
- Full marks may be obtained for correct answers to four questions.
- **Show all your work, for every question.**
- This is a closed-book exam but a single 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.

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

(a) Distinguish between the following: The Phong Light Model. Phong Shading and Gouraud Shading applied to a triangle mesh. [2]

(b) Joe Hacquick's ray tracer is not behaving properly and his images have a number of black pixels. What is the likely bug? [4]

(c) A ray in the direction $(3, 3, 0)$ hits a sphere at a point p where the normal is given by $(-4, -3, 0)$. Calculate the normalized direction of the reflected ray. [2]

(d) A pirate is [2]

Given a viewer positioned at $V = (-7, 9, -5)$, a light at $L = (203, 104, 205)$ and a surface given by the 3 points $P_0 = (3, 4, 5)$, $P_1 = (3, 4, 6)$ and $P_2 = (4, 4, 5)$.

Calculate the surface colour at P_0 using the Phong illumination model, assuming that the light's colour is $C = (1, 1, 1)$ and the ambient and diffuse colour of the surface is $I_a = I_d = (0.8, 0.2, 0.3)$.

The ambient coefficient is $K_a = 0.2$, the diffuse coefficient $K_d = 0.6$ and the specular coefficient is $K_s = 0.2$, with specular power being $n = 20$. Use white as the specular colour I_s.

Describe which version of the Phong illumination model you use.

Question 2 ..... *(4 points)*
Ray-tracing

(a) Compare and contrast uniform space subdivision and KD trees as a way of reducing ray object intersection tests. [4]

Question 3 ..... *(8 points)*
Implicit modelling

(a) In the polgonization algorithm described in class (due to Wyvill, Wyvill and McPheeters) parts of an iso-surface is found in each cubic voxel. Given a field value at each cube vertex, how is the intersection between the iso-surface and the curb edge calculated? [4]

(b) Skeletal point primitive A has a radius of $R_A = 1.0$ and is placed at position $(-1, 0, 0)$. A second point primitive, B has a radius of $R_B = 2.0$ and is placed at $(0.5, 0, 0)$. The filter fall off function used is $f = (1 - (r/R)^2)^2$ where r is the distance between the skeleton point and the point whose field is to be calculated and R is the radius of the point primitive. Calculate the total field at 0.5 intervals along a line between the two points, and sketch the contours representing the sum of the fields due to each point at values of $0.5625 = 9/16$ and where the field just reaches zero. [4]

Question 4 ..... *(4 points)*
Splines

(a) Given four points $P_0 = (0, 3, 4)$, $P_1 = (2, 5, 8)$, $P_2 = (3, 2, 6)$ and $P_3 = (0, 6, 5)$. Calculate the coefficients to build a Catmul-Rom spline and evaluate the spline with tension $\tau = 0.5$ at $t = 0.5$ (hint: $P_i = P_2$). [4]

Question 5 ..... *(4 points)*

Theory

(a) What coordinate system does the tangent space describe? [1]

(b) Distinguish between parametric and modelling space for parametric curves. [1]

(c) Why is the distance in skeletal implicit modelling modified by a field function? [1]

(d) What is the difference between Phong shading and Phong illumination? [1]

END