BROCK UNIVERSITY

Final exam
Course: COSC 3P98 Computer Graphics
Date of exam: Monday December 12, 2016
Time of exam: 1600-1900

pages: 13 (single-sided)
students: 16
hours: 3
Instructor: B. Ross

NAME (print): ___________________________________

STUDENT NUMBER: ________________________________

There are 7 questions totaling 160 marks.
One 3” by 5” card of hand-written, non-machine-duplicated notes is permitted.
No other aids are permitted. Use or possession of unauthorized materials will automatically result in a grade of zero for this examination.
Please answer all questions on the exam paper. Use the back of pages if necessary.
Keep written answers brief yet complete, and to the point. Write neatly and legibly.
A grade of 40% is required on this exam to pass the course.

Question	Total	Mark
1	**24**	
2	**20**	
3	**18**	
4	**25**	
5	**20**	
6	**52**	
7	**1**	
Total:	**160**	

Question 1 [24] Multiple choice: select the **best** answer to each question
[+2 correct, 0 nothing, -0.5 wrong guess; one free wrong guess without penalty]

1. Before a new scene is rendered in 3D, the depth buffer is initialized to:

a. the smallest or most negative value possible
b. the greatest or most positive value possible
c. the center of gravity
d. the aspect ratio

2. If you want the face of a polygon to be a single colour, you should use:

a. convex hull peel
b. flat shading
c. alpha channel
d. fast-distance normals

3. Which of the following is **not** a characteristic of old-school vector graphics displays?

a. image refresh times depend upon image complexity
b. only straight-line shapes are possible
c. much lower resolution than RGB monitors of that era
d. usually monochrome (green on black background)

4. An advantage of a procedural texture is:

a. it is continuous in XYZ space, which means it defines colour on all parts of a surface
b. any digital image can be used to wrap onto a surface'
c. it is ideal for fast interactive applications
d. only needs integer arithmetic

5. The main contribution of homogeneous transformation matrices is:

a. all operations can be implemented with matrix addition
b. all transformations become affine
c. all operations can be implemented with matrix multiplication
d. all transformations are automatically normalized

6. Which of the following is an example of an affine transformation:

a. rotation
b. inversion in a unit sphere
c. glSwapBuffers
d. perspective foreshortening

Question 1. (cont)

7. A hit spot is:

a. shiny area of specular reflection
b. where animated 3D objects collide
c. where eye ray hits an object during ray tracing
d. a popular nightclub

8. In ray tracing, refraction is:

a. the pure mirror reflection off of objects
b. shadows
c. recursive reflection
d. semi-transparency of objects

9. The main advantage of the Midpoint (Bresenham's) line drawing algorithm over the basic algorithm is:

a. fast integer arithmetic
b. accurate floating point arithmetic
c. stair-casing (aliasing) is minimized
d. Professor Bresenham offers technical support.

10. Which is true of colour map mode graphics:

a. also known as colour index mode
b. permits many pixel colours to be instantly changed with a single colour map alteration
c. good for some colour-coded applications (e.g. user interfaces)
d. all of the above

11. A complementary problem to triangulation is:

a. Voronoi diagram
b. quadrangulation
c. strangulation
d. Quick hull

12. Which of the following is not a recursive algorithm:

a. Quick hull
b. ray tracer
c. linear interpolation
d. area subdivision

Question 2 [20] Define and discuss the following terms or OpenGL /GLUT commands:

a) Z-buffer

b) glutDisplayFunc(F);

c) Key frame

d) Frustum

e) Minimal-weight triangulation

Question 3 [18]

(a) [10] Show that rotation is **not** commutative in 3D. Do this with 90 degree rotation values within the X and Y rotation matrices.

Question 3 (cont)

(b) [8] Discuss OpenGL's use of a stack of transformation matrices. What is the main purpose of using a stack? What OpenGL commands are used, and how do they work? Use an illustration to help your discussion.

Question 4 [25]

(a) [15] Identify the 3 types of lighting effects found in OpenGL's basic lighting model. Discuss how each effect contributes to the overall lighting of an object. Include equations for the monochrome versions of these effects, and discuss the equations and their parameters.

Question 4 (cont)

(b) [10] Explain the basic steps used in performing Gouraud shading. Include a diagram. Include in the discussion the pertinent place where the lighting model discussed in class is included in the Gouraud process. Also list one advantage and one disadvantage of Gouraud shading.

Question 5 [20]

Write pseudo-code for the basic ray tracing algorithm. Discuss all the important steps, as well as how it is called and how it terminates. Also include pseudo-code for the high-level routine that calls the ray tracer on each pixel.

Question 6 [52]

All the code in this question should be written in C, OpenGL, and GLUT.
Please read the entire question before beginning. Question parts rely on the use of others. Please do <u>not</u> implement anything that is not requested (user commands, lighting, textures, menus, ...). Use the backs of pages if necessary.

(a) [6] Define a suitable data structure in C that can hold a colour bitmap. (You do NOT need to use dynamic memory. You can assume the bitmap is a fixed size).

(b) [10] Write some OpenGL/GLUT code that renders this bitmap on a suitably defined 2D window. (You do **not** need to define this window).

6 (cont)

(c) [2] Draw the default orientation of the X, Y and Z axes using the right-hand coordinate system. (There is no code in this question!)

(d) [24] Write some callback code that renders the bitmap image in 3D! The rendering works as follows. The bitmap is placed over the X-Z plane, using the orientation you gave in (c) above. If you looked at the X-Z plane from the positive Y axes, it would look like the 2D bitmap in (b). Then each pixel is drawn as a line in 3D, where the base of the line is the pixel location on the X-Z plane, and the top (high portion) of the line extends towards the positive Y (0,1,0) direction, parallel to the Y-axis. The height (max Y value) of the line is equivalent to the greyscale luminosity of that pixel's RGB colour. The colour of the line is the bitmap's pixel colour.

6 (cont)

6 (cont)

(e) [10] Finally, write some OpenGL/GLUT commands that set up the 3D graphics environment suitable for your code in (d). (i.e. window definition, callback, ...). Again, don't include code for anything not used in (d) (e.g. mouse I/O,...).

Question 7 [1]
What are you going to do for the 3P98 project?

☺☺☺ **Happy Holidays!** ☺☺☺