EXAM IN

COMPUTER GRAPHICS

TSBK05

Time:	11th of August, 2005, 8-12
Room:	Ter1
Teacher:	Ingemar Ragnemalm, visits around 10
Allowed help:	None
Requirement to pass:	Grade 3: 21 points Grade 4: 31 points Grade 5: 41 points ECTS: E: 21 points D: 26 points C: 31 points B: 36 points A: 41 points

Answers may be given in swedish or english.

Good luck!

1. OpenGL programming

a) Most 3D programs works with several different coordinate systems, at least the following three: Model coordinates, world coordinates and camera (view) coordinates.

Outline how an OpenGL-based program works with these three coordinate systems. Give brief code snippets showing how at least two instances of a model are drawn in two different locations. Do not write code for drawing the models polygon by polygon though, rather use a call like drawmodel() that we assume draws the model in model coordinates. Use OpenGL calls. Minor errors in naming or parameters are acceptable as long as the principles are demonstrated.

b) Simple OpenGL programs can run into problems with incorrect rendering when using transparency. Why? How can this problem be avoided? (Disallowing transparency is not a valid answer.)

(5p)

2. Transformations

a) A plane is given by a point **p**, located in the plane, and a normal vector **n**. The normal vector is guaranteed to be in the X-Y plane, that is, its Z component is zero. Give a sequence of 4x4 matrixes, including multiplication order, that performs mirroring over the given plane. You don't have to multiply the matrices together.

b) The following matrix is the result of a matrix multiplication of standard 3D transformations. Suggest a sequence of such matrices, named by function, that would produce this result.

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & -2 & 0 & 2 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(7p)

3. Curve generation

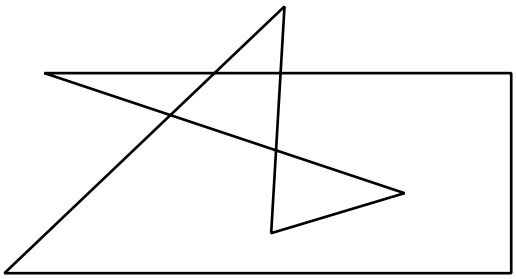
a) Derive the incremental updating of the decision variable in the midpoint algorithm to plot an 4-connected circle with radius R, centered in origin, starting at (0, -R). Also, calculate the starting value for the descicion parameter.

b) In order to draw any part of the curve in a), you must use different expressions for different parts of the curve. At what points must the algorithm switch expressions, and why? Illustrate this in a figure. (You don't have to derive the incremental updating expressions for the other parts.)

(7p)

4. Miscellaneous

a) When filling polygons in 2D graphics, what is the difference between using the odd-even test and the winding number test? Use the figure below for clarifying the difference.



b) How does double buffering work? Will it work the same way in full-screen as when working in a window covering only a part of the screen? (Motivate your answer.)

(4p)

5. Mapping techniques

a) Descibe the difference in computations between affine texture mapping and perspective correct texture mapping. Why is affine texture mapping faster?

b) What is a billboard? Give an example of when a billboard or billboard-like object (impostor) is useful.

c) Describe how mipmapping works. How much is the added memory cost?

(6p)

6. Collision detection

a) One model for efficient collision detection is the use of two phases, the broad phase and the narrow phase. Describe this method in some detail; what kind of tests are done in each phase, and how should the two phases be balanced for best performance?

b) When objects are moving in high speed, how should collission detection be modified to avoid misses?

(6p)

7. Visible surface detection and scene management

a) When Painter's algorithm (non-BSP version) sorts polygons, how does it tell which one out of two polygons that is the closest and the farthest one?

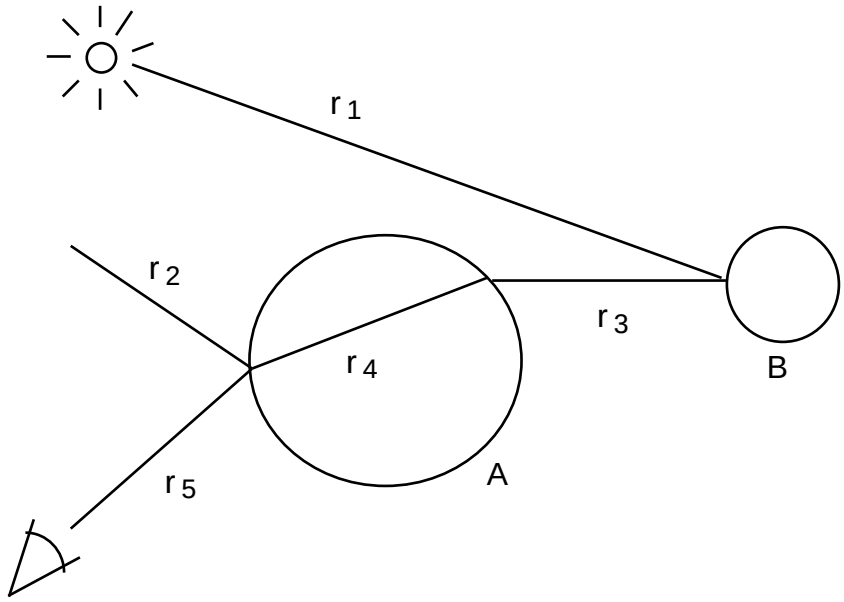
b) Describe, using a figure, how a BSP tree is built from a set of polygons.

c) Outline the principle for portals, using a figure. For what kind of environments is this suitable?

(7p)

8. Light, shading and ray-tracing

b) The following figure shows a simple scene with five rays cast in a ray-tracing procedure. The object A is transparent, glass-like (no reflections other than perfect mirroring), and the object B is non-transparent and diffuse. There are *no other objects* in the scene! Outline how the final pixel value is calulated from these rays. What rays give a contribution? What is the point with the ray r_1?



b) Describe the three-component shading model (Phong model) by a formula. Define each symbol appropriately.

c) Describe a method for anti-aliasing in ray-tracing.

(8p)