

08.72.64 Tölvugrafík

Final exam

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Time: 9⁰⁰-12⁰⁰

All the problems have the same value. You only need to solve 5 problems out of 6. The best five solutions count.

All written material and a calculator are allowed.

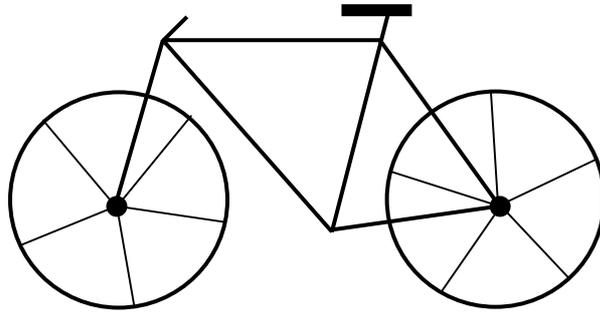
1.
 - a) Assume a cube with the opposite corners at $(3, 0, -2)$ and $(6, 3, -5)$. It is supposed to be converted to a unit cube in the same place (i.e. same center), that has been rotated θ degrees clockwise about its center along the y axis. Show the transformations that result in this change in the cube.
 - b) Write this operation as an OpenGL function that receives as parameters the two corner points and the rotation angle θ . You can assume some representation of 3D points and also a function that draws a cube from its two opposite corners.

2. In an OpenGL program the user controls an airplane. Using certain keys on the keyboard he/she can change the viewing direction. In the items below you are to write the parts of the `display`-function that make the viewing point and viewing direction correct. Make your own assumptions where you need to, and explain carefully the transformations that you use.
 - a) Looking straight to the left from within the airplane.
 - b) Looking down onto the airplane, always directly above it.
 - c) Looking at front of the airplane, from just in front of it.

3. Bump mapping is a method to make smooth objects appear to have surface structure. Is there any reason to use a mipmapping technique (as in texture mapping) for the surface structure that the bump mapping applies to the object? Explain the reason for needing such a technique or why it would not work.

4. Remember that the Phong reflection model uses the vectors l , n , v og r .
 - a) How should the surface be facing in order to *i)* maximize the specular reflection to the viewer? and *ii)* maximize the diffuse reflection to the viewer? Justify your answers.
 - b) What effect does the distance to the viewer have on the Phong model? What about the distance to the light source? Explain your answers.

5. A model of a bicycle has 4 parts: frame, handlebars (and front fork), front wheel, and back wheel. The handlebars can turn about the y -axis and the wheels can turn about the z -axis.



- a) Set up a hierarchical model of the bicycle and explain where the different transformations would appear in it.
- b) Write an OpenGL `display`-function that draws the bicycle based on some rotation of the handlebars and the wheels. You can assume functions that draw the four parts of the bicycle.
6. Cubic Bezier curves have four control points, P_0, P_1, P_2 og P_3 .
- a) What happens when two of these points are the same point (i.e. are in the same place)? Sketch such Bezier curves *i*) where $P_0 = P_1$, *ii*) where $P_1 = P_2$ and *iii*) where $P_0 = P_3$.
- b) What happens when three of the control points are the same, for example $P_0 = P_1 = P_2$?
- c) Can a cubic Bezier curve intersect itself? Explain why not or show four control points that give a self-intersecting Bezier curve.