UNIVERSITY OF OSLO

Faculty of Mathematics and Natural Sciences

Exam in   **INF3320 – Computer graphics and geometric modelling**
Day of exam: **13.12.2013**
Exam hours: **14:30-18:30**
This examination paper consists of 2 page(s).
Appendices: **0**
Permitted materials: None

*Make sure that your copy of this examination paper
is complete before answering.*

All tasks are equally important.

Task 1: Computer Graphics

Explain the following terms from computer graphics:
   a) Vertex buffer object
   b) Depth buffer
   c) GPGPU
   d) Rasterization
   e) View frustum
   f) Modelview matrix
   g) Projection matrix

Task 2: Programmable OpenGL pipeline

In this task, we will examine the OpenGL pipeline with programmable shaders.
   a) Write down the different stages of the programmable OpenGL pipeline. Explain what the different stages do, and illustrate with a figure.
   b) Which parts parts of the pipeline are programmable?
   c) What are the three different variable qualifiers that are special for shaders? Explain what these different variables are, and give an example of what each can be used for.

Task 3: Lighting

In this task, we will examine lighting of a 3D scene.
   a) Write down Phongs lighting model using the half vector. Explain the different terms and illustrate with a figure.
   b) Explain which vectors have to be normalized in Phongs lighting model, and why.

   c) Phongs lighting model is an example of a direct lighting technique. Explain what
       global illumination is, and give an example of such a technique.

Task 4: Triangle meshes and transformations

Triangles are central in computer graphics, and we will in this task examine triangles and
triangle meshes.
   a) Explain how the color of a fragment is computed using barycentric coordinates.
       Illustrate with a figure, and write down the expression for barycentric interpolation.
   b) Explain what a manifold mesh is, and what an oriented mesh is. When is it important
       that a mesh is oriented and a manifold surface?
   c) Given a triangle mesh M, write down the OpenGL commands required to rotate the
       mesh θ degrees around the line given by the two points $p_0=(1, 5, 9)$, $p_1=(3, 2 ,8)$.
       Illustrate with a figure.

Task 5: Bézier curves

In this task, we will examine Bézier curves in the plane.
   a) Write down the expression for a cubic Bézier curve.
   b) Explain the de Casteljau algorithm for evaluating a point on a Bézier curve, and
       illustrate with a drawing.
   c) Explain how we can divide a Bézier segment into two different Bézier segments.
       Illustrate with a drawing, and give an example in which splitting a Bézier segment is
       useful.