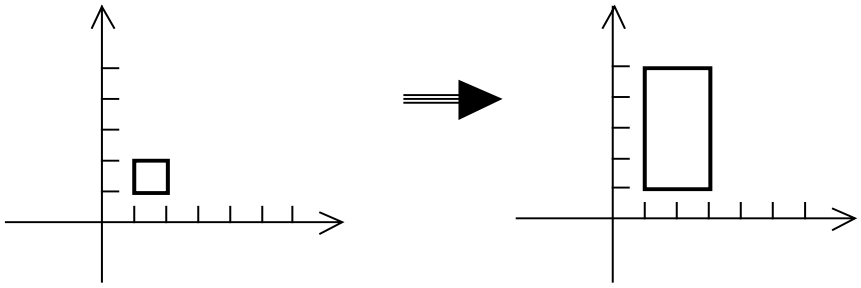
09.72.13 Tölvugrafík

Final exam **May 6th, 2003**
Teacher: Hjálmtýr Hafsteinsson **Time: 9^{00}-12^{00}**

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. Show transformation matrices for the following 2D transformations. If the transformations are composite, then it is enough to show the individual matrices, you do not have to multiply them.

a) The transformation described by the following image:



b) Reflection about $x = y$.

c) The transformaton that changes the box with the corners (1, 5), (4, 7), (7, 3), (4, 1) to the square centered at (0, 0) with sides of length 1.

2. *a)* Implement the so-called *Sierpinski carpet*, which is constructed by dividing a square into 9 equalsized squares (using two horizontal and two vertical lines). All of there subsquares, except the one in the center, is then divided recursively in the same way. Write a recursive function for the Sierpinski carpet in the same way as done for the Sierpinski gasket on page 76 of the textbook.

b) Explain in words how to extend this into three dimensions, thus building the *Sierpinski sponge*. Draw a rough image of this object.

3. We can define another shading method (in additon to flat shading, Gouraud shading, and Phong shading), that we can call *edge shading*. In it we find the normal vectors for the vertex points of the polygon and then interpolate the normal vectors along the edges of the polygon. All these normal vectors are then used in an illumination model to generate the color of the edge points, but the color of the interior points is found by interpolating the edge colors.

Compare this shading method to Gouraud and Phong shading. Which defects in shading can appear if this method is used?

4. *a)* Show an OpenGL *display*-function that makes the eye (i.e. the viewer) be just above and behind a spaceship, that can be moved in three dimensions. You can assume that you get the position and the direction of the spaceship in global variables. The function `spaceship( )` draws a spaceship at (0, 0, 0) in the direction of the negative z-axis.

b) In many game programs, where the eye is placed above and behind an object (a person, a car, a spaceship, etc.) that can be moved around and turned there is a delay in the movement of the eye. What is the reason for this and suggest methods to implement this delay.

5. Explain how you could use another *Z-buffer* (in addition to the usual depth buffer), as a sort of *shadow buffer*, to decide where shadows are supposed to appear in a scene with a single light source. It is probably easiest to think of this as two steps that are done consecutively.

6. In the image below there are two semicircles that touch at the point *P*. Each semicircle is parameterized with u=0 at the left end and u=1 at the right end. The image also shows for clarity, the midpoint of each semicircle, but they are not a part of the curves.

a) Is there C^1 continuity in *P*?

b) Is there G^1 continuity in *P*?