KANDIDATNUMMER:

EKSAMEN

EMNENAVN: **Matematikk for spillprogrammering**

EMNENUMMER: **REA2061**

EKSAMENSDATO: **06. Juni 2014**

KLASSE: **Bachelor spillprogrammering**

TID: **09.00-14.00**

EMNEANSVARLIG: **Bernt Tore Jensen (tlf. 46250024)**

ANTALL SIDER UTLEVERT: 5

TILLATTE HJELPEMIDLER: Godkjent kalkulator og alle skriftlige hjelpemidler

INNFØRING MED PENN.

Ved innlevering skilles hvit og gul besvarelse og legges i hvert sitt omslag.

Oppgavetekst, kladd og blå kopi beholder kandidaten.

Husk kandidatnummer på alle ark.

There are 5 problems, each contributing 20 percent towards your grade. Explanations and calculations must be included.

Problem 1:

In this problem you will calculate probabilities when throwing dice. The dice are fair and have 6 sides numbered 1 to 6.

a) What is the probability of getting at least one 6 when you throw 2 dice?

b) What is the probability of getting at least one 6 when you throw 7 dice?

c) What is the probability of getting all different values (i.e. 1, 2, 3, 4, 5 and 6) when you throw 6 dice?

Problem 2:

a) Write down the matrix of the following Markov chain

$$\begin{tikzcd} 1 \arrow[loop left, "1"] & 2 \arrow[l, "0.3"'] \arrow[r, bend right, "0.7"'] & 3 \arrow[l, bend right, "0.1"'] \arrow[r, "0.9"] & 4 \arrow[loop right, "1"] \end{tikzcd}$$

What are the transient and absorbing states in this Markov chain? Is this an ergodic Markov chain? Explain!

b) Using the Markov chain in a) and assuming the starting state is state 2, calculate the expected number of moves needed before absorbsion.

All relevant matrices should be included in the calculation. In case you need the formula for the inverse of a 2 by 2 matrix, it is given by

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1} = \frac{1}{ad-bc}\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

c) Give an example of a Markov chain which does not have any absorbing states and is not ergodic.

Problem 3

In this problem you will do bitwise logic (and, or, not, xor) on an integer variable. Let x be an integer with 16 bits. Do the following operations on x.

a) Set bits 4 and 11.

b) Set bit 1 and clear bit 5.

c) Clear every bit except bit number 3, which is left intact.

The answer in each of the parts a) - c) should be one line of code in a programming language like C++. If you do not use C++ syntax, you should explain the meaning of the symbols that you use.

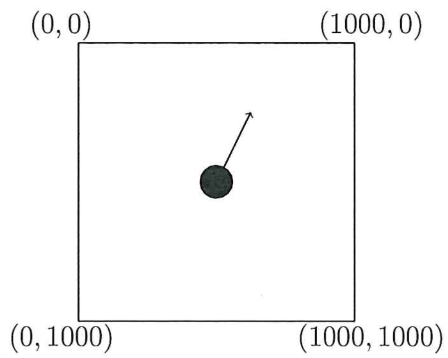
d) Explain what the following does to the variable y. Hint: the result is independent of the value already stored in y.

i) `y = y | ~y`
ii) `y = y & ~y`
iii) `y = y ^ ~y`

The symbol ~ denotes bitwise not, and ^ is exclusive or.

Problem 4.

A small ball with radius 50 is moving with a certain velocity around on a flat surface with size 1000 by 1000. Viewed from above we have the following figure.



The collision with the edges of the surface is elastic. You can assume that the ball is described using the class

```
class ball
{
public:

vector2f position;  // the 2d-position of center of the ball
vector2f velocity;  // the 2d-velocity of the ball

void update(float dt); // dt = seconds since last update

// + other stuff not needed for this problem
};
```

The vector class is defined as

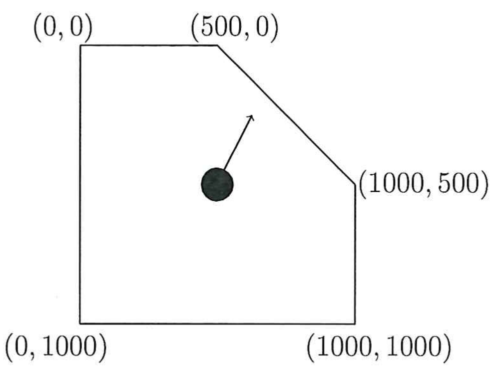
```
class vector2f
{
public:

float x;
float y;
};
```

a)

Implement the update function of the ball. The function should handle change in position and test for and handle collisions with the edges. I suggest you use C++, but detailed pseudo-code is also acceptable.

b)

An obstacle is introduced on the surface.



Implement the update function as you did in a) with the new obstacle. The collisions are still elastic.

Problem 5:

a)

You will make 4 by 4 matrices to do transformations in space. You need to write down the products of the relevant matrices in the correct order, but you do not have to compute the products. Include explanations and figures.

i) Find the matrix which first rotates $30°$ around the y-axis, and then rotates $45°$ around the z-axis.
ii) Find the matrix which rotates $30°$ around the line through the origin with direction $(1, 1, 0)^T$.

b)

Use quaternions to rotate the point $(0, 1, 0)$ $90°$ around the z-axis. Include all calculations.

c)

In the plane, use complex numbers to rotate the point $(1, 2)$ $30°$ around the point $(3, 1)$.