	Surname	Initials
Student No		

University of Cape Town

Department of Computer Science

Computer Science CSC1016S

Final Exam

November 2006

Marks: 100 Time: 3 hours	• Approximate marks per question are shown in brackets • The use of calculators is permitted

COURSE CODE: CSC1016S

This paper consists of 17 questions and 26 pages (including this cover page).
Answer all questions in the exam.

Mark Allocation							
Question	**Marks**	**Internal**	**External**	**Question**	**Marks**	**Internal**	**External**
1	[4]			10	[4]		
2	[10]			11	[2]		
3	[4]			12	[4]		
4	[6]			13	[3]		
5	[10]			14	[6]		
6	[10]			15	[4]		
7	[8]			16	[4]		
8	[10]			17	[10]		
9	[1]						
	Total				**Total**		
					Grand Total		
					Final Mark		
Internal Examiner:				**External Examiner:**			

Section A

Question 1. File IO [4 marks]

Examine the Java application listed below.

```
import java.util.*;
import java.io.*;
public class Mystery
{
     public static void main (String [] args) throws
                           FileNotFoundException
     {
                Scanner a = new Scanner (new FileInputStream
                                     ("file1.txt"));
                PrintWriter b = new PrintWriter(new
                                FileOutputStream("file2.txt"));
                PrintWriter c = new PrintWriter(new
                                FileOutputStream("tmp.txt"));

                while (a.hasNextInt())
                     b.println(a.nextInt());
                while (a.hasNext())
                     c.println(a.next());
                a.close();
                b.close();
                c.close();
                a = new Scanner (new FileInputStream
                                     ("tmp.txt"));
                b = new PrintWriter(new
                          FileOutputStream("file1.txt"));
                while (a.hasNext())
                     b.println(a.next());
                a.close();
                b.close();
                c.close();
     }
}
```

Before the program is run, the file “`file1.txt`” contains the lines:

```
1
2 3 4
4.5
hello goodbye
```

And the file “file2.txt” contains the lines:

```
34 5 78
50 40
10
```

Write down the **exact** contents of both of these files after the program is run.

file1.txt:

[2]

file2.txt:

[2]

Question 2. Exceptions [10 marks]

```
import java.util.*;
import java.io.*;

public class ExceptionQ
{
     public static void main(String [] args)
                     throws ExceptionA, ExceptionC
     {
           Scanner scan = new Scanner (System.in);
           int n;
           System.out.println("Type in a positive even
                                 integer less than 100:");
           n= scan.nextInt();
           checkQ(n);
     }

     public static void checkQ(int n)
                          throws ExceptionA, ExceptionC
     {
           if (n<0)
                throw new ExceptionA("Integer is
                                          negative.");
           else if (n>=100)
                throw new ExceptionB("Integer is not less
                                         than 100.");
                else if ((n%2)!=0)
                     throw new ExceptionC("Integer is
                                                   odd.");
           System.out.println("Well done.");
     }
}
```

a) Is ExceptionB a checked or unchecked exception? Give a reason for your answer.

[2]

b) Rewrite the main method so that all of the checked exceptions thrown are caught and the program loops until the user inputs a correct answer. You should use an *exception-controlled* loop to do this.

[8]

Question 3: Exceptions [4 marks]

Examine the program below and write down the **exact** output to the screen when this program is executed.

```
public class OutputMysteryDemo2
{
    public static void main(String[] args)
         {
        try { exercise(-1);}
           catch(Exception e)
                {System.out.println("Caught in main.");}
           finally
                {System.out.println("Done.");}
    }

    public static void exercise(int n) throws Exception
    {
        try
        {
            if (n > 0)
                throw new Exception( );
                else
               System.out.println("No Exception.");
                try
                {
                     System.out.println("Nested try.");
                     if (n < 0)
                       throw new NegativeNumberException( );
                }
                finally
                {
                     System.out.println("Nested finally.");
                }
                System.out.println("Still in exercise.");
        }
        catch(NegativeNumberException e)
        {
            System.out.println("Caught in exercise.");
        }
        finally
        {
            System.out.println("In finally block.");
        }
        System.out.println("After finally block.");
    }
}
```

[4]

Question 4. UML and Patterns [6 marks]

a) Imagine that you have been given a lucrative part-time job to design and implement an application for managing a snail-racing contest. Two of the classes you will require are a **Race class** (for raees between 7 snails at a time) and a **Competitor class** (for contestants taking part in the race. Draw a UML class diagram showing these two classes, including the **relationship** between the classes, possible **instance variables** and possible **class methods** for both classes.

[4]

b) What is a pattern? Give an example of a pattern in your answer.

[2]

Section B

Question 5. [10 marks]

For each of the following statements, indicate whether it is true or false.

a) An interface can be extended by another interface but not by a class.

[1]

b) A class can implement only one interface.

[1]

c) An interface can be specified as the type of a variable, the type of a method parameter or the return type of a method.

[1]

d) An interface can have private, protected or public methods.

[1]

e) A graphical user interface is not allowed to implement multiple interfaces in order to avoid conflicts.

[1]

f) The **set** method of **ArrayList** can only change existing items or add a new item in the first empty location.

[1]

g) To empty a linked list, one must traverse the list and delete every item one by one.

[1]

h) It is possible to access objects of a non-static inner class in a static method of the outer class.

[1]

i) Private members of an inner class are not accessible to the outer class, but private members of the outer class are accessible to the inner class.

[1]

j) A class that implements an interface but does not follow the semantics of the interface will fail to compile.

[1]

Question 6 [10 marks]

Complete the methods **push**, **pop**, and **clear** in the following class definition. ArrayStack is a data structure that implements a stack using an array and it contains integers. The variable n keeps track of the number of items in the stack and must be updated appropriately whenever the number of items changes. Items are pushed only if they are positive, otherwise they are ignored. The method pop returns -1 if the stack is empty; otherwise, pop returns the item at the top.

```
public class ArrayStack
{
      private int[] array;
      private int n;

      public ArrayStack()
      {
            array = new int[100];
            n = 0;
      }

      public void push(int item)    // Adds item to stack [4]
      {
      }

      public int pop()  // Retrieves item from stack [4]
      {
      }

      public void clear()     // Empties the stack [2]
      {
      }

      public void output()
      {
            For(int i = 0; i < n; i++)
                  System.out.println(array[i]);
      }
}
```

[10]

Question 7 [8 marks]

a) Suppose class B is an inner class of A, and B is declared public. Write the code for creating an object of B outside of A.

[2]

b) Suppose classes A and B are as in the previous question and, in addition, B is declared static. How would you now create an object of B outside of A?

[1]

c) Suppose C is an inner class of B and B is an inner class of A. Suppose further that somewhere in B the method getName is invoked. Describe the steps Java follows when looking for the definition of getName.

[2]

d) What is the difference in the way getName is invoked in B if it is defined in A as opposed to being defined in C?

[2]

e) Suppose now that A and B each contain a method called getName. How would you call the getName defined in A from inside B?

[1]

Question 8 [10 marks]

Consider the following program.

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class GuiDemo extends JFrame implements ActionListener
{
    private JPanel redPanel;
    private JPanel bluePanel;

    public static void main(String[] args)
    {
        GuiDemo gui = new GuiDemo( );
        gui.setVisible(true);
    }

    public GuiDemo( )
    {
        Super("Menu Demonstration");
        setSize(300, 200);
        setDefaultCloseOperation(JFrame.DO_NOTHING_ON_CLOSE);
        setLayout(new GridLayout(2,1));

        redPanel = new JPanel( );
        add(redPanel);

        bluePanel = new JPanel( );
        add(bluePanel);

        JMenu colorMenu = new JMenu("Colours");

        JMenuItem redChoice = new JMenuItem("Red");
        redChoice.addActionListener(this);
        colorMenu.add(redChoice);

        JMenuItem blueChoice = new JMenuItem("Blue");
        blueChoice.addActionListener(this);
        colorMenu.add(blueChoice);

        JMenuItem exitChoice = new JMenuItem("Exit");
        exitChoice.addActionListener(this);
        colorMenu.add(exitChoice);

        JMenuBar bar = new JMenuBar( );
        bar.add(colorMenu);
        setJMenuBar(bar);
    }
    public void actionPerformed(ActionEvent e)
    {
        String command = e.getActionCommand( );

        if (command.equals("Red"))
            redPanel.setBackground(Color.RED);
        else if (command.equals("Blue"))
            bluePanel.setBackground(Color.BLUE);
        else if (command.equals("Exit"))
            System.exit(0);
    }
}
```

a) Draw a picture of the GUI produced by the above program when the user clicks on the word Colours.

[3]

b) Describe clearly the result of clicking on each menu item. A diagram might be helpful.

[3]

c) Rewrite the program to use buttons instead of menus. You can do this by adding a third panel for the buttons.

[4]

Section C

Question 9 [1 Mark]

Give the 4 bit binary coded decimal representation of the number 259.

[1]

Question 10 [4 Marks]

a) Using “N” bit word give the formula for the representation of a negative number “P” in the 2’s complement system.

b) Use a 4 bit binary word and the definition in a) to calculate the 2’s complement value of -3. no show all your working. No working, no marks.

c) Using a 4 bit binary word and the 2’s complement system show how the following computation is done. Show and explain all your working.

5-3

[4]

Question 11 [2 Marks]

Convert the decimal value 44.375 to binary. Show all your working. (No working no marks)

[2]

Question 12 [4 Marks]

Show how the decimal value of -46.125 = - 101110.001 is stored in IEEE 754 single (32 - bit) floating point format (sign bit, 8 bits exponent, 23 bits significant).
Show all your working.

[4]

Question 13 [3 Marks]

Using the truth table, prove the identity $\mathbf{\overline{A}\bullet B = \overline{A\ + \overline{B}}}$

[3]

Question 14 [6 Marks]

Three flat mates buy a CD if their combined age **AGE** is 45 $\leq$ **AGE** $\leq$ 20.
Flat mate A is 25, B is 20 and C is 18.

For this problem

a) Give the truth table:
b) Construct the Boolean expression for a true outcome:
c) Use karnaugh map to optimize this expression:
d) Draw the optimized circuit.

Show all working

[6]

Question 15 [4 Marks]

You are given the following state of the MIPS machine give all the steps when the next 2 instructions are carried out. Show all the values of the appropriate registers at each of the steps (load, increment, execute).

```
84      big:      addi    $t1, $t1, 4
88                sub     $t1, $t2, $t3
92                j       big
```

	Inst Reg	PC	$t1	$t2	$t3
Initially		88	7	6	15
Load					
Inc					
Execute					
Load					
Inc					
Execute					

[4]

Question 16 [4 Marks]

For a 2 pass assembler give

a) The two main purposes of the 1st pass

____

____

____

____

____

[2]

b) The two main purposes of the 2nd pass

____

____

____

____

____

[2]

Question 17 [10 Marks]

Write a MIPS assembler program to do the same as the following java program.

```
Public static void main (String args [])
{
      int [] Val ={2,-1,7,6,-3,-2,1,8,-9,10};
      int sum = 0;

      for (int i = 0; i < 10; i++)
            if (val [i] > 0) sum +=val [i];

      System.out.println(sum);
}
```

Note: In your MIPS program it is much easier for your loop to go from 0 to 40 in steps of 4 because of the byte addressing.

Given:

```
        .data
Sum:    .word  0
i:      .word  0
four:   .word  4
forty:  .word  40
val:
        .text
        .global main
```

[10]

MIPS Instruction Set

Category	Instructions	Example	Meaning
Arithmetic	Add	add $1, $2, $3	$1 = $2 + $3
	Subtract	sub $1, $2, $3	$1 = $2 - $3
	Multiply	mult $2, $3	HI, LO = $2 * $3
	Divide	div $2, $3	LO=$2/$3;HI=$2 mod $3;
	Move from HI	mfhi $1	$1 = HI
	Move from LO	mflo $2	$2 = LO
	Add immediate	addi $1, $2, 22	$1 = $2 + 22
Logical	And	and $1, $2, $3	$1 = $2 && $3
	Or	or $1, $2, $3	$1 = $2 !! $3
Data transfer	Load word	lw $1, 0($2)	$1=Memory($2+0)
	Store word	sw $1, 100($2)	Memory($2+100) = $1
	Load Immediate	li $1, 500	$1 = 500
	Load address	la $1, xyz	$1 = address of label xyz
Conditional Branch	Branch on equal	beq $1, $2, label	If $1 = $2 go to label
	Branch on not equal	bne $1, $2, label	If $1 != $2 go to label
	Branch on >=	bge $1, $2, label	If $1 >= $2 go to label
	Branch on >	bgt $1, $2, label	If $1 > $2 go to label
	Branch on <=	ble $1, $2, label	If $1 <= $2 go to label
	Branch on <	blt $1, $2, label	If $1 < $2 go to label
UnconditionalBranch	jump	j label	Go to label
	Jump register	jr $31	Go to address in reg $31
	Jump and link	jal label	$ra (= $31) = PC; go to label
Move	move	move $1, $2	$1 = $2
Service	**System Call Code**	**Arguments**	**Result placed in Register**
	Placed in $2 ($v0)		
Print _int	1	Put int in $4 ($a0)	
Print_string	4	Put addr of str in$4	
Read_int	5		Result put in $2 ($v0)

Assembler Directives:

.globl	Global directive
.text	Text (or Code) segment follows
.data	Data segment follows
.ascii str	Define a string
.asciiz str	Define a string with null terminator
val: .word 5	Defines a word called “val” and gives it a value of 5
str: .space n	Allocate n bytes

Register Names

0 –Zero; 1 – at; 2 – v0; 3- v1: 4 – a0; 5 – a1; 6 – a2, 7 – a3, 8 – t0, ..15 – t7;
16 – s0;… 23 – s7; 24 – t8; 25 – t9; 26 – k0; 27 – k1; 28 – gp; 29 – sp; 30 – fp; 31 - ra