Name:

_____

_____

Student Number:

_____

Please fill in your Student Number and Name.

Student Number : _____

University of Cape Town ~ Department of Computer Science

Computer Science 1016S ~ 2007

November Examination

Question	Max	Internal	External
1	25		
2	9		
3	8		
4	8		
5	7		
6	5		
7	6		
8	5		
9	12		
10	15		
TOTAL	**100**		

Marks : 100

Time : 3 hours

Instructions:

a) Answer all questions.

b) Write your answers in the space provided.

c) Show all calculations where applicable.

Section A: Recursion, Files and Exceptions

Question 1: Recursion, Files and Exceptions [25 marks]

Examine the following Java application and answer the questions that follow.

```
public class Exam1Demo {

   public static void main(String[] args)
   {
      int[] a = {0, 2, 4, 6, 8, 10, 12, 14, 16, 18};
      int result, no=14;
      result = look(a, 0, 9, no);
      if (result >= 0)
         System.out.println(no + "=" + result);
      else
         System.out.println(no+ "!");
   }

   public static int look (int[] a, int first, int last, int item)
   {
      int result = 0;
      if (first > last)
         result = -1;
      else
      {
         int cent = (first + last)/2;
         if (item == a[cent])
            result = cent;
         else if (item < a[cent])
            result = look(a, first, cent-1, item);
         else if (item > a[cent])
            result = look(a, cent+1, last, item);
      }
      return result;
   }

}
```

a) Describe in clear English what this program does. [2]

b) Write down the *exact* output of this program. [2]

c) Write down the exact output of the program if you altered line 3 of the application from

```
int[] a = {0, 2, 4, 6, 8, 10, 12, 14, 16, 18};
```

to

```
int[] a = {10, 12, 14, 0, 8, 16, 18, 4, 2, 6};
```

Explain, or justify, your answer. [3]

d) How could you alter this program so that it always generates a `StackOverflowException`? [1]

e) A `StackOverFlowException` is an unchecked exception. Explain what this means. [1]

f) When using files in an application, explain under which conditions a checked `FileNotFoundException` can be thrown. [2]

g) Rewrite the main method in the program above so that the integers for array `a[]` are read from a **text file** named afile.dat. You may assume that afile.dat contains exactly 1000 integers and that all necessary libraries are imported. However, the FileNotFoundException **must** be handled. [7]

```
public static void main(String[] args) {
```

```
int result, no=14;
result = look(a, 0, 9, no);
if (result >= 0)
   System.out.println(no + "=" + result);
else
   System.out.println(no+ "!");
```

```
}
```

h) The application could also be written to use a **binary** file. Give one advantage and one disadvantage of doing this. [2]

i) Now write a **recursive** method

`public static void edges(int[] a, int first, int last)`

for the class `Exam1Demo`. This method will print to the screen the array `a[]` from the outsides to the middle. For example, for the array `a[]` given above, the output will be:

```
0 16
2 14
4 12
6 10
8
```

and for an array `int[] a = {3, 4, 5, 9}` the output will be:

```
3 9
4 5
```

Note that **no marks** will be given for iterative solutions. [4]

```
public static void edges(int[] a, int first,  int last)
{
```

_____

_____

_____

_____

_____

_____

_____

_____

_____

```
}
```

j) Which would be better, an iterative or recursive definition of the `edges` method? Give a reason for your answer. [1]

_____

_____

_____

Section B: UML, Interfaces and Generics

Question 2: UML [9 marks]

Draw a UML class diagram to describe the relationships between classes in a tournament management system (e.g., the South African Tiddlywinks Cup). This tournament takes place in local stadiums and comprises a number of matches between different teams. In each match, there are 2 teams. Each team has from 15 to N players and each player can play for only one team.

Hint: Underlined words are the names of the classes.

Requirements: There should be all the following links: association, aggregation, multiplicity and navigation. The match class diagram should have at least 2 attributes and 2 operations (those you consider are most important and express the relationship with other classes).

Question 3: Interfaces [8 marks]

Given the following code

```
public class Person implements Cloneable, Comparable
{
    ..............
}
```

a) Explain what a **Cloneable** interface is and what it is used for [2]

b) If there is no **clone()** method in the **Person** class, can we compile the program successfully and why? [2]

c) Explain what a **Comparable** interface is and what it is used for? [2]

d) If there is no **compareTo()** method in the **Person** class, can we compile the program successfully and why? [2]

Question 4: Generics [8 marks]

Examine the following class:

```
public static class Pair
{
   private String first;
   private String second;
   public Pair()
   {
      first = "";
      second = "";
   }
   public Pair(String firstItem, String secondItem)
   {
      first = firstItem;
      second = secondItem;
   }
}
```

a) Explain what generic classes are and why they are needed. [2]

b) Convert the **Pair** class into a generic class called **GPair**. [2]

c) Give code examples using the **Pair** and **GPair** classes to demonstrate the necessity of generic classes. [2]

```
public static void main(String[] args)
{
   //write your code here









}
```

d) When should one use the **Pair** class instead of the **GPair** class? Or should one never use the **Pair** class again? [2]

Section C: Linked structures, Numbers Systems and GUIs

Question 5: Linear Data Structures [7 marks]

a) Give an example of where one would use a queue data structure to advantage. [1]

b) Provide a diagram to show how a queue is structured, showing the links necessary for it to work. [2]

c) Give the Java code that would implement a suitable node for a queue. [3]

d) What is a circular queue? [1]

Question 6: Boolean Logic [5 Marks]

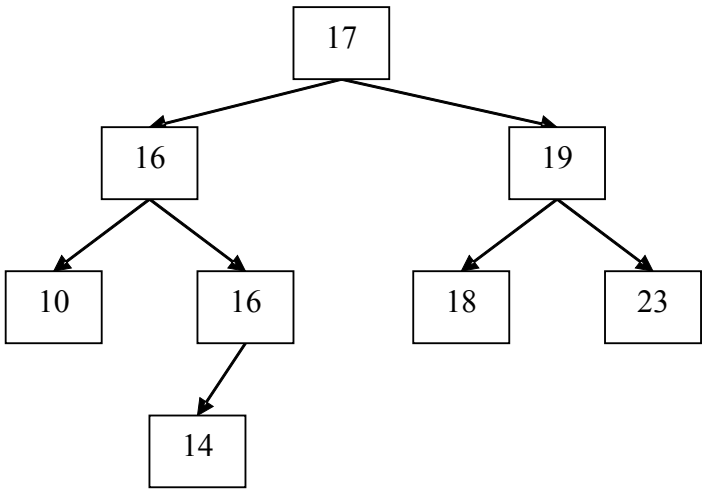
Provide a truth table to verify the equality of the following Boolean expression:

$X \cdot Y + \overline{X} \cdot Y + \overline{X} \cdot \overline{Y} + X \cdot \overline{Y} = 1$ [5]

Question 7: Trees [6 marks]

a) When referring to a binary tree, what is meant by the binary search tree storage rule? Explain the rule fully. [2]

b) Does the tree below satisfy the binary search tree storage rule? [1]



c) Provide the pseudo code for the algorithm that prints the contents of the above tree in numerical order. [3]

Question 8: Number Systems [5 marks]

a) Convert 73.125 from Decimal to the following number systems. Show all of your working.

i. Binary: [2]

ii. Octal: [1]

b) Illustrate the IEEE 754 format for single precision floating point numbers.

Show all of your working and illustrate how the decimal value of:

-135.75 = - 100001.11

is stored in IEEE 754 single (32-bit) floating point format (sign bit, 8 bits exponent, 23 bits significand). [2]

Question 9: GUI Programming [12 marks]

Examine the program below and answer the questions that follow.

```
 1 //** Menu Gui Answer **//
 2 import javax.swing.JFrame;
 3 import javax.swing.JPanel;
 4 import java.awt.GridLayout;
 5 import java.awt.Color;
 6 import javax.swing.JMenu;
 7 import javax.swing.JMenuItem;
 8 import javax.swing.JMenuBar;
 9 import java.awt.event.ActionListener;
10 import java.awt.event.ActionEvent;
11
12 public class GuiQuestion extends JFrame implements
ActionListener
13 {
14     public static final int WIDTH = 300;
15     public static final int HEIGHT = 200;
16
17     private JPanel redPanel;
18     private JPanel whitePanel;
19     private JPanel bluePanel;
20
21     public static void main(String[] args)
22     {
23         GuiQuestion gui = new GuiQuestion( );
24         gui.setVisible(true);
25     }
26
27     public GuiQuestion( )
28     {
29         super("Gui Question");
30         setSize(WIDTH, HEIGHT);
31         setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
32         setLayout(new GridLayout(3, 1));
33
34         bluePanel = new JPanel( );
35         bluePanel.setBackground(Color.LIGHT_GRAY);
36         add(bluePanel);
37
38         whitePanel = new JPanel( );
39         whitePanel.setBackground(Color.LIGHT_GRAY);
40         add(whitePanel);
41
42         redPanel = new JPanel( );
43         redPanel.setBackground(Color.LIGHT_GRAY);
44         add(redPanel);
45
46         JMenu colorMenu = new JMenu("Paint Colors");
47
```

```
48          JMenuItem redChoice = new JMenuItem("Red");
49          redChoice.addActionListener(this);
50          colorMenu.add(redChoice);
51
52          JMenuItem whiteChoice = new JMenuItem("White");
53          whiteChoice.addActionListener(this);
54          colorMenu.add(whiteChoice);
55
56          JMenuItem blueChoice = new JMenuItem("Blue");
57          blueChoice.addActionListener(this);
58          colorMenu.add(blueChoice);
59
60          JMenuBar bar = new JMenuBar( );
61          bar.add(colorMenu);
62          setJMenuBar(bar);
63      }
64
65      public void actionPerformed(ActionEvent e)
66      {
67          String buttonString = e.getActionCommand( );
68          if (buttonString.equals("Red"))
70              redPanel.setBackground(Color.RED);
71          else if (buttonString.equals("White"))
72              whitePanel.setBackground(Color.WHITE);
73          else if (buttonString.equals("Blue"))
74              bluePanel.setBackground(Color.BLUE);
75          else
76              System.out.println("Unexpected error.");
77      }
78  }
```

a) Illustrate the GUI produced by the above program when the program is run **and** the menu items selected. [2]

c) Explain the code at lines 27 – 32. Describe in your own words what it does. [2]

d) Why is there not an "exit" item in the menu? Refer to the code in answering this question. [2]

e) Explain the code at lines 60 – 62. Describe clearly in your own words what it does. [4]

f) Referring to the code given, write down the line numbers of the code that would need to be changed, showing the replacement code required, to produce the following output (the horizontal bars must be in the colours indicated): [2]

Line	New code:

Section D: Ethics, Cyberlaw and Development

Question 10: Ethics, Cyberlaw and Development [15 marks]

a) What does Gotterbarn mean when he says "We have mistakenly understood computer ethics as different from other professional ethics"? [4]

g) What are two forms of legal property protection that can be applied to software? List two key characteristics. [4]

h) In a developing country, such as the countries in Sub-Saharan Africa, the cost of software relative to the incomes of computer professionals is far higher than in the developed world. Does that change the legal and ethical considerations in copying software? Consider both the cases where the software in question is produced in the developed world and in the developing world. [7]