

Please fill in your Student Number and Name.

Student Number : _____

Name: _____

Student Number: _____

University of Cape Town ~ Department of Computer Science

Computer Science 1016S / 1011H ~ 2009

January Exam

Question	Max	Internal	External	Question	Max	Internal	External	
1	4			7	10			
2	4			8	10			
3	10			9	20			
4	2			10	20			
5	8							
6	12							
					TOTAL	100		

Marks : 100

Time : 180 minutes

Instructions:

- a) Answer all questions.
- b) Write your answers in pen in the spaces provided.
- c) Show all calculations where applicable.

Question 1 [4]

Write the recursive function **evaluate** that returns the n^{th} number in the following sequence:

3 4 7 11 18 29 47 ...

The first two numbers of this sequence – $F_0=3$ and $F_1=4$ - are given.

In general,

$$F_{i+2}=F_i + F_{i+1}$$

(This is very similar to the Fibonacci sequence.)

[4]

Note: No recursion means no marks.

Question 2 [4]

Examine the following Java application. It uses a Binary search algorithm to find the position of a key in an array.

```
public class Exam2Demo {

    public static void main ( String [] args ) {
        int [] a = {2, 6, 8, 19, 21, 30, 38};
        int result, no=25;
        System.out.println ("First Last Middle");
        result = search (a, 0, 6, no);
        if (result >= 0)
            System.out.println (no+" in element "+result);
        else
            System.out.println (no+" not found");
    }

    public static int search( int[]a, int first, int last, int item)
    {
        int result = 0;
        if (first > last)
        {
            System.out.println (first+" "+last);
            result = -1;
        }
        else
        {
            int centre = (first + last)/2;
            System.out.println (first+" "+last +" "+ centre);
            if (item == a[centre])
                result = centre;
            else if (item < a[centre])
                result=search(a, first, centre-1, item);
            else if (item > a[centre])
                result=search(a, centre+1, last, item);
        }
        return result;
    }
}
```

a) What is the output from this program?

[4]

Question 3 [10]

You are given the Java program below:

```
import java.util.Scanner;  
public class Test  
{  
    public static void main (String args[])  
    {  
        Scanner keyboard = new Scanner(System.in);  
  
        int[] x = {20,30,50,60,10,70,31,53,62,25}; // 10 integer values  
  
        System.out.print("Pick an integer from 1 to 10: ");  
        int guess = keyboard.nextInt();  
        int box_number = guess - 1;  
        System.out.println("You have won R" + x[box_number] + "!");  
    }  
}
```

a) In this program, the following 2 errors could easily occur:

A float rather than an integer could be input; or

A “guess” greater than 10 could be input.

Show how exceptions can be used to indicate these errors by adding appropriate code into the program. [3]

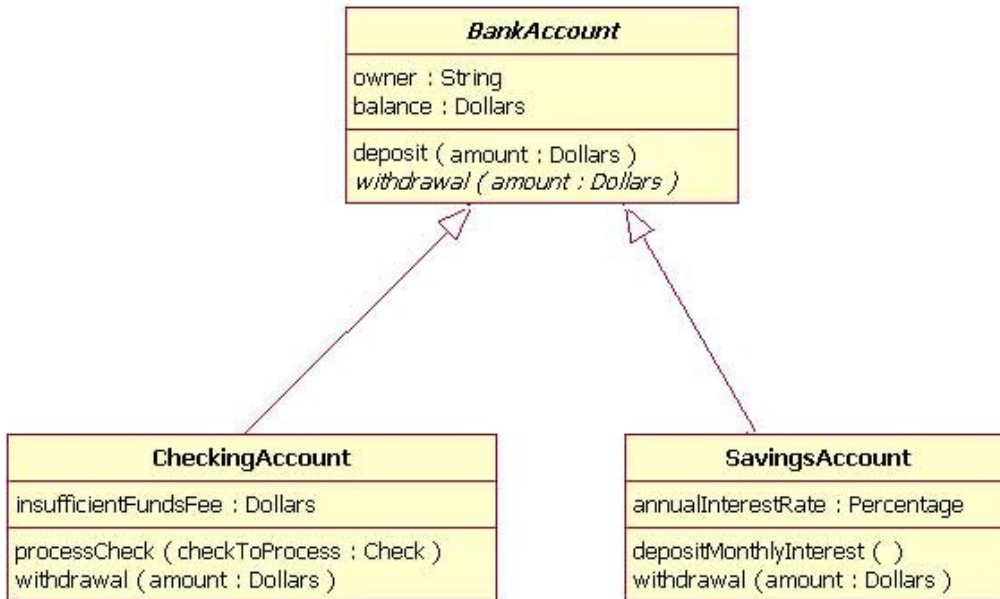
Question 4 [2]

Describe 2 advantages of using binary files instead of text files.

[2]

Question 5 [12]

Use the following UML diagram to answer the questions that follow.



- a) What principle of OOP design is illustrated in the inter-class relationships? What are the exact relationships among each set of related classes? [2]

- b) Which of the classes are abstract and which are concrete? How can you determine this from the UML? [2]

c) Explain the differences among the withdrawal methods in the three classes. Provide a code example to illustrate the benefit of this way of coding. [4]

d) In the following sequence of statements that appears in a method in an unrelated class, indicate which statements will result in a compile-time error. [4]

1. BankAccount ba = new BankAccount();
2. BankAccount ba = new CheckAccount();
3. CheckingAccount ca = new BankAccount();
4. CheckingAccount ca = new SavingAccount();
5. CheckingAccount ca = new CheckingAccount();
6. BankAccount ba = new SavingAccount();
7. ba.withdrawal(100);
8. ba.depositMonthlyInterest();
9. ba.deposit(200);

Question 6 [8]

Use the following program to answer the questions that follow.

```
1 public class ASorter {
2     public void sort(double[] a, int begin, int end) {
3         if ((end - begin) >= 1) {
4             int splitPoint = split(a, begin, end);
5             sort(a, begin, splitPoint);
6             sort(a, splitPoint + 1, end);
7             join(a, begin, splitPoint, end);
8         }
9     }
10
11     protected int split(double[] a, int begin, int end)
12     {
13         double[] temp;
14         int size = (end - begin + 1);
15         temp = new double[size];
16
17         double splitValue = a[begin];
18         int up = 0;
19         int down = size - 1;
20
21         for (int i = begin + 1; i <= end; i++)
22         {
23             if (a[i] <= splitValue)
24             {
25                 temp[up] = a[i];
26                 up++;
27             }
28             else
29             {
30                 temp[down] = a[i];
31                 down--;
32             }
33         }
34
35         temp[up] = a[begin];
36
37         for (int i = 0; i < size; i++)
38             a[begin + i] = temp[i];
39
40         return (begin + up);
41     }
42
43     protected void join(double[] a, int begin, int splitPoint,
44                         int end)
45     {
46         //Nothing to do.
47     }
```

a) What is the name of this sorting algorithm?

[2]

Question 7 [10]

- a) State the binary search tree storage rule. [2]

- b) Build a binary search tree for the following data:

{9 4 0 2 7 1 6 3 8}

[3]

c) Build a binary search tree for the following data:

{0 1 2 3 4 6 7 8 9}

[3]

d) Is there a difference in the search efficiency of the two trees? Why or why not?

[2]

Question 8 [10]

Use the code below to answer this question.

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

public class Buttons extends JFrame implements ActionListener
{
    public static final int WIDTH = 300;
    public static final int HEIGHT = 200;
    private JButton[] buttons = new JButton[12];

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

    public Buttons( )
    {
        super("Buttons");
        setSize(WIDTH, HEIGHT);
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setLayout(new GridLayout(4, 3));
        setResizable(false);
        for (int i=0; i<12; i++)
        {
            buttons[i] = new JButton();
            buttons[i].setActionCommand(Integer.toString(i));
            buttons[i].addActionListener(this);
            add(buttons[i]);
        }
    }

    public void actionPerformed(ActionEvent e)
    {
        JButton button = (JButton)e.getSource( ); // See question (b)
        button.setBackground(Color.PINK);
        button.setText("Button " + e.getActionCommand());
        button.setForeground(Color.WHITE);
    }
}
```

a) Draw the GUI that is displayed when the program is run.

[3]

b) What does the first line in the **actionPerformed** method do? [2]

c) Draw the GUI again, showing what happens when all the buttons have been clicked and describe what you cannot draw, e.g. colours. [5]

Question 9 [20]

a) How is ethics related to morality?

[1]

b) What would be one possible drawback or problem with using the ethical philosophy of “ubuntu” as a basis for computer ethics?

[2]

c) Consider the following passage from “Little Brother” by Cory Doctorow (p 11):

“The answer is something ingenious called TOR The Onion Router. An onion router is an Internet site that takes requests for webpages and passes them onto other onion routers, and on to other onion routers, until one of them finally decides to fetch the page and pass it back through the layers of the onion until it reaches you. The traffic to the onion routers is encrypted, which means that the school can't see what you're asking for, and the layers of the onion don't know who they're working for. There are millions of nodes the program was set up by the US Office of Naval Research to help their people get around the censor ware in countries like Syria and China, ...”

Why would anyone want to use a service like TOR? Please consider the needs of the user as well as the way in which the technology (for example, routers, encryption) works together to provide it.

[5]

e) What is the Digital Divide? Explain fully.

[4]

- b) Users will want to browse through the list of files that are available, by sorting the list on any of the 4 fields. Describe how you would adapt a standard sorting algorithm implementation to cater for sorting by one of the specified fields. How does the time complexity for this new algorithm compare to the fixed field sorting algorithm? [5]

Note: Do NOT write code – simply describe the changes you would make.

- c) Sketch a user interface for your application and explain how a user will interact with this application. [5]

