Please fill in your Student Number and Name.

Student Number : _____

Name:

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Student Number:

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University of Cape Town ~ Department of Computer Science

Computer Science 1016S / 1011H ~ 2009

November Exam

Question	Max	Internal	External	Question	Max	Internal	External
1	4			7	20		
2	16			8	20		
3	8						
4	12						
5	10						
6	10						
				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 **calculate** that returns the n^{th} number in the following sequence:

2 5 7 12 19 31 50 …

The first two numbers of this sequence – F_0=2 and F_1=5 - 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 [16]

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

```
public class Exam1Demo {

   public static void main ( String [] args ) {
      int [] a ={2, 14, 21, 25, 33, 46, 52, 67, 71, 80};
      int result, no=52;
      System.out.println ("First Last Middle");
      result = search (a, 0, 9, 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)
         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]

b) Rewrite the main method in the program above so that the integers for array **a[]** are read from a file named "exam.dat". [8]

You may assume that "exam.dat" contains at most 50 integers; these integers are in strictly increasing numerical order; the file is terminated by the integer -1; and that all necessary libraries have been imported. The FileNotFoundException must be handled.

```
public static void main ( String[] args )  {
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```
        int result, no=52;
        result = Exam1Demo.search(a, 0, i-1, no);
        System.out.println("First Last Middle");
        if (result >= 0)
           System.out.println(no+" in element "+result);
        else
           System.out.println(no+" not found");
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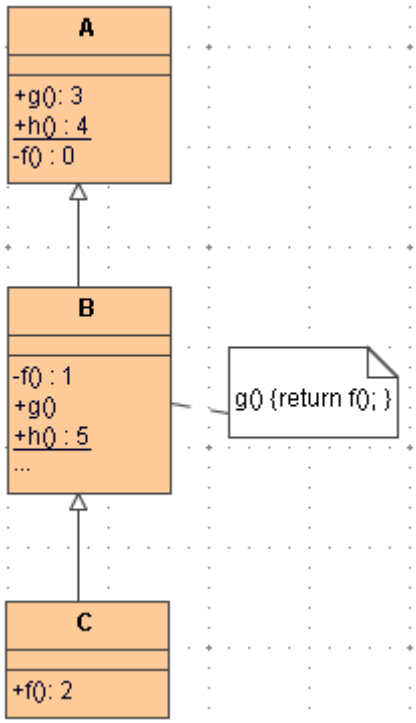
```
}
```

c) Consider the situation where the file "exam.dat" did not have a terminator value of -1. Now explain 2 different ways in which the end-of-file could be detected. Discuss the advantages and disadvantages of each method. [4]

Question 3 [8]

Use the following UML diagram to answer the questions that follow. In the diagram, **g():3** implies that the member method named **g** returns a constant value of 3.



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]

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b) What do each of the following accessibility modifiers in a UML class diagram indicate? [2]

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\- : _____

underline : _____

italics : _____

c) 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. Then, assuming those statements are removed, indicate the value returned by each statement that produces a return value. [4]

i. C ref1 = new A();

ii. A ref1 = new C();

iii. ref1.f();

iv. ref1.g();

v. ref1.h();

vi. A ref2 = (A) ref1;

vii. ref2.g();

viii. ref2.h();

Question 4 [12]

Use the following program to answer the questions that follow.

```
public class ASorter
{
    public static void sort(Comparable[] a, int numberUsed)
    {
        int index, indexOfNextSmallest;
        for (index = 0; index < numberUsed - 1; index++)
        {
            indexOfNextSmallest = indexOfSmallest(index, a, numberUsed);
            interchange(index,indexOfNextSmallest, a);
        }
    }

    private static int indexOfSmallest(int startIndex,
                                       Comparable[] a, int numberUsed)
    {
        Comparable min = a[startIndex];
        int indexOfMin = startIndex;
        int index;
        for (index = startIndex + 1; index < numberUsed; index++)
            if (a[index].compareTo(min) < 0)//if a[index] is less than min
            {
                min = a[index];
                indexOfMin = index;
                //min is smallest of a[startIndex] through a[index]
            }
        return indexOfMin;
    }

    private static void interchange(int i, int j, Comparable[] a)
    {
        Comparable temp;
        temp = a[i];
        a[i] = a[j];
        a[j] = temp; //original value of a[i]
    }

}
```

a) What is the name of this sorting algorithm? [2]

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b) What is the complexity of the sort ? [2]

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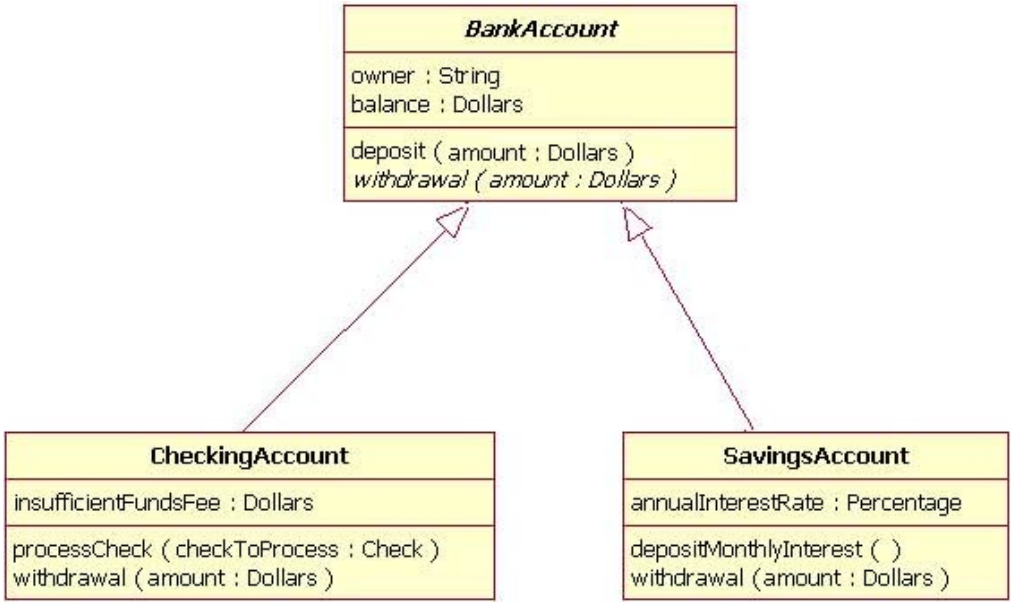
c) Explain how one would use this **sort** method with an array of Comparable type. [2]

d) List and explain the main differences between interfaces and abstract classes. [2]

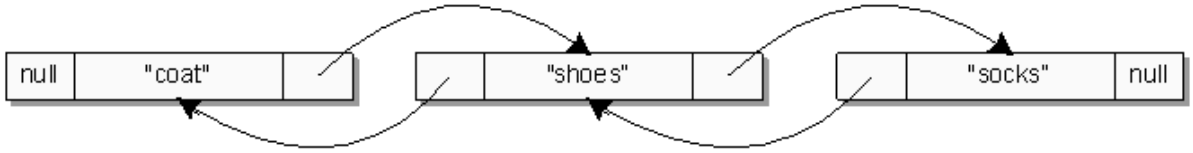
e) Why should one define an abstract method in an abstract class or an interface when its concrete subclasses implement the method anyway? Give a code example to illustrate your explanation. [4]

Note: You may use the *withdrawal* method in the UML diagram below to answer the question.


BankAccount
owner : String
balance : Dollars
deposit (amount : Dollars)
withdrawal (amount : Dollars)
CheckingAccount
insufficientFundsFee : Dollars
processCheck (checkToProcess : Check)
withdrawal (amount : Dollars)
SavingsAccount
annualInterestRate : Percentage
depositMonthlyInterest ( )
withdrawal (amount : Dollars)

Question 5 [10]

Use the following illustration of a doubly linked list and the code that follows to answer this question.




```
public void delete()
{
(i)   if (position == null)
        throw new IllegalStateException();                    [2 marks]
(ii)  else if ((position.previous == null)
        && (position.next != null))
      {
        head = head.next;                                     [4 marks]
        position = head;
        head.previous = null;
      }
(iii) else if (position.next == null)
      {
        position.previous.next = null;                        [3 marks]
        position = position.previous;
      }
(iv)  else
      {
        position.previous.next = position.next;
        position.next.previous = position.previous;           [1 mark]
        position = position.next;
      }
}
```

a) Explain what the conditions are in each of the four cases labeled (i) to (iv). That is, state where we are on the list and what the special circumstances are at that point that must be considered when deleting.

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b) Explain what the code achieves in cases (i) to (iii) whenever the associated condition is true. Your explanation should answer the following questions: Which is the current node after the method executes? Which nodes are the predecessor and successor of this current node? What changes, if any, occurred in other nodes?

Question 6 [10]

Use the code below to answer this question.

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

public class Events extends JFrame implements ActionListener,
WindowListener
{
   public static void main(String[] args)
   {
      Events gui = new Events();
      gui.setVisible(true);
   }

   public Events()
   {
      setTitle("Events Demo");
      setDefaultCloseOperation(JFrame.DO_NOTHING_ON_CLOSE);
      setSize(300, 200);
      setLayout(new FlowLayout());
      addWindowListener(this);

      JButton b = new JButton("Click");
      b.addActionListener(this);
      add(b);
   }

   public void actionPerformed(ActionEvent e)
   {
      System.exit(0);
   }

   public void windowOpened(WindowEvent e)
   {}

   public void windowClosed(WindowEvent e)
   {}

   public void windowClosing(WindowEvent e)
   {
      System.out.println("Ouch! Click somewhere else");
   }

   public void windowIconified(WindowEvent e)
   {
      System.out.println("I feel very small.");
   }

   public void windowDeiconified(WindowEvent e)
   {}

   public void windowActivated(WindowEvent e)
   {}

   public void windowDeactivated(WindowEvent e)
   {}
}
```

a) Draw the GUI that results from running the program. [3]

b) What happens when you click on the X button at the top right hand corner? [1]

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c) What happens when you click on the minimise button at the top right hand corner? [1]

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d) What happens when you click on the button labelled “Click”. [1]

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e) List all the changes that you would make to the program in order to use the **WindowAdapter** class rather than the **WindowListener** interface. [4]

Question 7 [20]

a) Action based ethical theories can either be based on how well they conform to rules and norms (***deontological*** ethical theory) or on what the outcomes are (***teleological*** ethical theory). Please explain the main differences between these two different approaches. Can they ever result in different ethical decisions? [6]

b) Should network managers be licensed? Discuss the advantages and drawbacks? [4]

c) How is Richard Stallman's idea of "copyleft" related to copyright? What does copyleft set out to achieve?. [4]

d) What sorts of Information and Communications Technologies are appropriate in the developing world? Give two (2) examples and justify each of them by saying why you think it is the right technology. [6]

Question 8 [20]

Matric Results Kiosks

Information kiosks are desktop computers placed in secure locations for members of the public to access various forms of information.

The government has decided to use existing kiosks in rural areas to distribute matric examination results. You have been hired as a consultant to develop additional software for these kiosks to enable this new function.

The results are stored on disk in a file named "results.txt", sorted on the subject name, with the following format:

```
StudentIDX SubjectA 56
StudentIDY SubjectA 69
StudentIDZ SubjectA 80
StudentIDX SubjectB 75
StudentIDZ SubjectB 72
```

a) Write a Java method to read the contents of this file into an array of objects of type Entry. Assume there are at most 5000 entries in the file and the student IDs and subjects do not contain spaces. [5]

```
class Entry
{
   public String studentID;
   public String subject;
   public int mark;
}
```

b) After the file has been loaded into memory, multiple students can look up their results by entering their studentIDs. Why is this process slow? What algorithms would you implement in your code to make looking up of results more efficient? [5]

Note: Do NOT write code – simply describe the algorithms you would use.

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

d) Discuss 2 major professional issues that arise in designing this application. [5]