University of Cape Town ~ Department of Computer Science

Computer Science 1015F ~ 2008

January Exam

Question	Max	Internal	External	Question	Max	Internal	External
1	9			7	3		
2	8			8	8		
3	8			9	15		
4	15			10	10		
5	10						
6	14						
				TOTAL	**100**		

Marks : 100

Time : 180 minutes

Instructions:

    a) Answer all questions.

    b) Write your answers in the space provided.

    c) Show all calculations where applicable.

Question 1 [9]

a) What is the purpose of an operating system?   [1]

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b) Give 2 examples of operating systems (from different companies or communities).   [2]

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c) What is the purpose of random-access memory?   [1]

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d) What is an algorithm?   [1]

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e) List 2 reasons why algorithms must be precise.   [2]

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f) Briefly describe 1 advantage and 1 disadvantage of using Java bytecode, as opposed to machine code.   [2]

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Question 2 [8]

Consider the following program and answer the questions that follow.

```java
import java.util.Scanner;

class Test
{
    public static void main ( String [] args )
    {
        Scanner input = new Scanner (System.in);

        int a = input.nextInt();
        int b = input.nextInt();
        int c = input.nextInt();

        int x = Math.min (Math.min (a, b), c);
        int y = Math.max (Math.max (a, b), c);

        System.out.println ((a+b)/6.0f+(b+c)/6.0f+(a+c)/6.0f);
    }
}
```

a) What does this program do?   [2]

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b) What is the output if the input is the numbers 5, 3 and 7?   [1]

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c) List all methods (other than main) from the program.   [1]

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d) Why must the main method be static?   [1]

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e) Rewrite the first statement of the main method in such a way that there is a syntax error.   [1]

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f) In the context of a debugger, what is a breakpoint?   [2]

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Question 3 [8]

a) Briefly describe an algorithm to take a taxi or bus to town. Assume you are at the bus/taxi stop.
   There should be at most 6 steps.   [3]

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b) Write the Java statement to input the number of taxis that pass you into the variable **N**. You
   may assume **N** is already declared as an int and there is already a Scanner object named **input**.
                                                                                                    [2]

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c) Write the Java statement to calculate the variable **totalTime** (in seconds) as the time you wait
   for **N** taxis to pass if one taxi passes every **timePerTaxi** seconds. You may assume **totalTime**
   and **timePerTaxi** are already declared as float variables and **N** is declared as an int.   [1]

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d) Write the Java statement to output "Time wasted at bus stop: ", immediately followed by the
   value of the variable **totalTime**.   [2]

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Question 4 [15]

Examine the following code and answer the questions that follow.

```java
public class Driver {
   public static void main (String[] args) {
      for ( int date=0; date<10; date++ ) {
         if (date%2 == 0) {
            System.out.println(convertDate(date));
         }
      }
   }
   // convert a number to a day of the week
   public static String convertDate(int number) {
      String date = "";
      if (number == 2)
         date = "Monday";
      if (number == 3)
         date = "Tuesday";
      if (number == 4)
         date = "Wednesday";
      if (number == 5)
         date = "Thursday";
      if (number == 6)
         date = "Friday";
      if (number == 7)
         date = "Saturday";
      if (number == 8)
         date = "Sunday";
      return date;
   }
}
```

a) What is the output of this program?   [4]

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b) Rewrite the convertDate method, converting the *if-else* statement to an equivalent *switch* statement. [4]

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c) What is the result of each of the following expressions? The result will be either true or false. Assume variable `week = 7`. [2]

i. `week > 6 || week == 5`

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ii. `week < 3 || week > 4`

_____

iii. `week > 3 && week < 0`

_____

iv.   `week >= 5 || week < 0`

_____

d) Write a Java method to print out a blank grid for a working week calendar, such as:

```
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|   |   |   |   |

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|   |   |   |   |

+ - + - + - + - +
```


Your method should have the header:

`void printGrid ( int numberOfWeeks, int numberOfWorkingDays )`

The above pattern is produced when invoking `printGrid(2,4).`   [5]

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Question 5 [10]

a) If a class called **Student** is created and one of the data fields (or instance variables) for the **Student** class is a reference to a **Date** object, what is the relationship between the Student object and the Date object? [1]

    i.   The **Date** object is a **Student** object.

    ii.   The **Date** object has a **Student** object.

    iii.   The **Student** object is a **Date** object.

    iv.   The **Student** object has a **Date** object.

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b) Write skeleton Java code to illustrate the above description (i.e., create the Student class and a public Date object such as enrolmentDate). [2]

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c) Write the body of the main method of a driver program to create an object of the **Student** class, called **aStudent.** [1]

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d) Can **enrolmentDate** be accessed by calling **aStudent.enrolmentDate** from the driver program? Why or why not? [1]

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e) What do you need to change in the Student class so that the value of **enrolmentDate** can be accessed from the driver class? List two ways and write code to illustrate your methods. Explain which one is the better way.   [5]

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Question 6 [14]

a) Consider the Person class below, and add constructors, accessor and mutator methods as described by the comments below:

```
public class Person
{
    private String name;
    private int age;
    private double average_weight_gain;
```

// i) Constructor with three arguments that are used to initialize the instance variables   [2]

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// ii) Accessor methods for all the instance variables   [3]

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// iii) Two mutator methods with one argument each to set the *name* and *age* instance variables

[2]

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// iv) One mutator method with an array argument that is used to calculate the
// *average_weight_gain* instance variable, returning no value   [3]

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```
    }
```

a) Consider the driver class below, and add a statements to create an object called **aPerson** of type **Person** for "Peter", age 21, with an average monthly weight_gain of 0.0kg, using your constructor above. Use your mutator method above to calculate the average weight gain of the person over the festive period from November to February - his weight gains were 0.1 kg, 1.2 kg, 0.5 kg and -1.2 kg. Display the name, age and average weight gain for the person using your accessor methods above. [4]

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

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```
    }
}
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Question 7 [3]

a) How can arrays be tested to check if their content is identical?   [3]

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Question 8 [8]

The following set of methods sorts an array of numbers in descending order. Complete the missing methods as indicated by the comments.

```
/**
Precondition:  The array has values.
Action:Sorts a so that a[0] >= a[1] >= ... >= a[a.length-1]
                                                                [4]
*/
public void selectionSort ( int[] a )
{
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```
}

/**
Returns the index of the largest value among
a[start], a[start + 1], ... a[a.length-1]                        [4]
*/
private int LargestIndex ( int start, int[] a )
{
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```
      return indexOfMax;
   }


   /**
   Precondition:  i and j are legal indices for the array a.
   Postcondition:  Values of a[i] and a[j] have been
   interchanged
   */
   private void swap ( int i, int j, int[] a )
   {
      int temp;
      temp = a[i];
      a[i] = a[j];
      a[j] = temp;
   }
```

Question 9 [15]

a) Match each of the following terms to the concepts below: [2]

   overriding, overloading, inheritance, composition

   _____ variables and methods automatically exist in the subclasses of a base class

   _____ methods in base class and subclass with same signature but different code

   _____ methods in base class and subclass with same name but different signature

   _____ a class has an instance variable which is itself an Object

b) Suppose that a 2-dimensional array `sales` has been declared as below.

   ```
   int[ ][ ] sales ;
   ```

   Give Java code to fill `sales` with 120 zeroes: there must be 100 rows each with 12 elements, and every element must be initialised to 0. [4]

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c) Suppose your program has changed the values in `sales` to contain monthly sales data from 100 shops. Give Java code to print monthly totals – i.e., print the sum of the values in each column of `sales`. The 12 values should appear one after the other on the same single line of output, separated by spaces. [4]

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d) Consider the classes below, then list the output of the `main` program. [5]

```java
public class Person
{
   protected String name;
   protected String address;
   public Person(  )
   {   name = "unknown"; address = "N/A";
       System.out.println("Created unknown person");
   }
   public Person( String pname, String adr )
   {   name = pname; address = adr;
       System.out.println("Created person");
   }
}


public class Child extends Person
{
   int age;
   public Child  (String cname, String adr, int years )
   {   super ( cname, adr );
       age = years;
       System.out.println("Created child");
   }
   public Child (  )
   {   age = 0;
       System.out.println("Created unknown child");
```

```
        }
    public String toString( )
     {
        return (name + " ( " + address + ") aged " + age));
     }
 }


 public class Test
 {
    public static void main ( String args[ ] )
    {
       Child ann = new Child( "ann", "UCT", 6);
       Child kiddie = new Child(  );
       System.out.println( kiddie );
    }
 }
```

Output from running Test is:

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Question 10 [10]

a) Convert the binary number 101010_2 to hexadecimal. [1]

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b) Convert the hexadecimal number CAB_{16} to binary. [1]

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c) Convert 43_{10} to binary (i.e., convert the decimal number 43 to base 2). Show your working. [2]

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d) Convert 3.375_{10} to binary (i.e., convert the decimal number 3.375 to base 2). Show your working. [3]

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e) What is the 8-bit *two's complement* binary representation of the decimal number -13_{10}? Show your working. [3]

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