CS_151 Introduction to Computing

(Attempt 2 questions out of 3)

Question 1.

(a.) What is the value of the following Java expressions?

(i) `(true && false)|| true`

(ii) `1 != 0`

(iii) `10 % 3 == 3`

(iv) `(2000 % 4 == 0 && 2000 % 100 !=0) || 2000 % 400 == 0`

[4 marks]

(b.) Write a program that takes as input a number between 0 and 23 (which corresponds to an hour on a 24-hour clock) and prints the according '12 hour display' using 'am' and 'pm', to the screen. For instance, input '20' should result in '8pm'. (Also check if there are any special cases!)

[7 marks]

(c.) (i) What is the difference between a primitive type and an object type in Java?

(ii) What do we mean by *type conversion*? In the following program you find various examples of type conversions. Identify and name them.

```
public class SampleProgram{
  public static void main(String[] args){
    double r = Double.parseDouble(args[0]);
    int n = (int) r;
    System.out.println("The result is " + n);
  }
}
```

[6 marks]

(d.) Explain the object oriented concept of *inheritance*. What are its advantages? What are *abstract classes*? Finally give an example that demonstrates the use of the keyword *super* in a constructor call.

[8 marks]

Question 2.

(a.) Linear - Quadratic - Logarithmic - Constant Time.

What is the (worst case) run time of an optimal algorithm for each of the following computational problems? (By run time here we mean number of comparisons depending on the input size.) Briefly describe in each case how the algorithm you have in mind is working. Below, by an 'array' we mean an array of integers.

i) Finding a minimal element in an array.

ii) Finding a minimal element in a sorted array.

iii) Deciding whether or not all elements in an array are equal.

iv) Deciding whether or not all elements in an array are different.

v) Finding a pair of two numbers in an array whose product equals a given number.

vi) Finding a false coin in a set of gold coins (where the false one is not as heavy as the other ones) using a balance scale. (With the balance scale you can compare the weights of two sets of one or more coins.)

[9 marks]

(b.) i) Carefully explain each line in the following method

```
static int F(int n){
   if (n == 0 || n == 1) return n;
   else return F(n-1) + F(n-2);
   }
```

ii) Which function is computed? What is F(0), F(1), F(8)?

[5 marks]

(c.) Write a `for`-loop and a `while`-loop, both of which will print the first 10 even numbers to the screen.

[5 marks]

(d.) Explain the typical structure of a class and the use of the privacy modifiers.

[6 marks]

Question 3.

(a.) You want to create a new data-structure and have the choice between a linked list implementation and an array implementation. Discuss space and time requirement for operations such as creating a new object, inserting/deleting elements and accessing elements.

[7 marks]

(b.) True or false. Justify your answers.

i) Constructors must have the same name as the class and can be overloaded.

ii) An accessor method always has `void` as return type.

iii) The static and dynamic type of a variable must always be the same.

iv) On a queue, a remove operation carried out after an add operation always yields the original queue.

v) Quick-sort is a recursive sorting algorithm which is 'quadratic' in the worst case.

[10 marks]

(c.) Write a method that searches for a given integer in a given array of integers.

[4 marks]

(d.) What is the difference between linear search and binary search? Assume that you search for an element in a sorted array containing 1000 elements. In both cases, how many comparisons do you need in the worst case?

[4 marks]