Computer Programming
and
Introduction to Programming
Written Examination

4.7.2019

Instructions for students:

Write First Name, Last Name, Student Number and Signature where indicated. If not, the examination can not be marked.

Do not speak to any other student during the examination. If you speak to another student, your examination will be cancelled.

Use a pen, not a pencil.

Write neatly and clearly.
Reply to the following questions. You cannot consult any material. Point of correct answers are summed and then normalized so that if you answer to all the questions the final score is 17 points.

1. If a language uses 1000 unique characters, how many bits would be needed to represent all these characters? Why? [0.5 points]

   Sol
   Nine bits would be sufficient if there were only 512 different characters to represent. Ten bits is sufficient for 1024 different characters. Because 1000 is greater than 512, but not greater than 1024, at least 10 bits are needed if all characters are represented by the same number of bits.

2. What output is produced by the following statement? Explain. [0.5 points]

   System.out.println("5 plus (0 plus 25) is " + 5 + (0 + 25));

   Sol
   First the string “5 plus (0 plus 25) is ” is concatenated with the integer 5; since one of the operands associated with the “+” operator is a String, the result is a String. Then the string “5 plus (0 plus 25) is 5” is concatenated with the integer (0 + 25) with results: “5 plus (0 plus 25) is 525”.

3. For each of the following expressions, indicate the order in which the operators will be evaluated by writing a number beneath each operator. [0.5 points]

   ○ a % b - c * d * e

   ○ (a + b * c) / d % e

   ○ a + b / c / d

4. Write the output of these statements: [1 point]

   ```java
   int base = 2;
   int count = 3;
   if (count++ > 3 || count > base + 1 && --base + count > 0)
       System.out.println(base);
   else
       System.out.println(count);
   ```

   Res: 1
5. Complete the code statements below (replacing the three occurrences of the character “?” with three appropriate texts) so that the program prints 00000. [1 point]

```java
String s = "0101010101";
int index = ?;
while (index < s.length()) {
    if (index % ? == 0)
        System.out.print(s.charAt(?));
    index++;
}
```

Sol

```java
String s = "0101010101";
int index = 0;
while (index < s.length()) {
    if (index % 2 == 0)
        System.out.print(s.charAt(index));
    index++;
}
```

6. Write a method called randomOdd that accepts one integer parameters (max) representing an upper bound. If max >= 1 then the method must return a random positive odd integer result in the specified range: 1 <= result <= max. Else, if max < 1, the method must return 0. Hint: use the Random class and its nextInt(int range) method (it returns a random integer between 0 and range-1, included). [2 points]

Sol

```java
public static int randomOdd(int range) {
    Random generator = new Random();
    int result = 0;
    if (range >= 1)
        do {
            result = generator.nextInt(range + 1);
        } while (result % 2 == 0);
    return result;
}
```

7. Suppose you have a class called Actor. Write a constructor for the class that initializes the name and age instance variables (String and int) based on parameters passed to the constructor. [0.5 points]

Sol

```java
public Actor(String theName, int theAge) {
    name = theName;
    age = theAge;
}
```
8. What output is produced by the following code fragment? [1 point]

```java
public static void main (String[] args) {
    final int MAX = 10;
    for (int r = 1; r <= MAX; r++) {
        for (int t = 1; t <= r * 2; t = t + 2)
            System.out.print("*");
        System.out.println();
    }
}
```

Sol

*  
**  
***  
****  
*****  
******  
*******  
********  
*********  
**********

9. Write a method called `coprime` that accepts two positive integer parameters (>0) and returns a boolean value: true if the only positive integer that divides both of them is 1, and false otherwise. [2 points]

Sol

```java
public static boolean coprime(int a, int b) {
    int i = 2;
    while (i <= Math.min(a, b) && ((a % i != 0) || (b % i != 0))) {
        i++;
    }
    return (i > Math.min(a, b));
}
```
10. Create an interface called Runnable that includes two methods: start and stop. Both methods should take no parameters and should return a boolean result. Describe how a class must declare to implement this interface and what it means (what type of code must be included in this class, you do not need to write the actual code). [1 point]

Sol

```java
public interface Runnable {
    public boolean start();
    public boolean stop();
}
```

A class implementing Runnable would include an implements clause in the class header, such as:

```java
public class ControlPanel implements Runnable
```

The class would contain, among other things, two methods with signatures that match those specified in the interface.

11. Write code snippet that sets each element of an int[][] array called nums to the value of the constant INITIAL. Assume that nums has been already created, for instance: int[][] nums = new int[10][10]; [1 point]

Sol

```java
for (int i = 0; i < nums.length; i++)
    for (int j = 0; j < nums[0].length; j++)
        nums[i][j] = INITIAL;
```

12. Which instance data are accessible in class A3? [0.5 points]

```java
public class A1 {
    public int x;
    public int y;
    protected int z;
    ... }
public class A2 extends A1 {
    protected int a;
    private int b;
    private int c;
    ...}
public class A3 extends A2 {
    private int q;
    ...}
```
13. Complete the code statements below (replacing the occurrences of “?” with the appropriate texts) so that the program sorts the specified array of Comparable objects for the target using selection sort algorithm. [1 point]

```java
public static void selectionSort (Comparable[] list) {
    int min;
    Comparable temp;
    for (int index = 0; index < list.length-1; index++)
    {
        min = index;
        for (int scan = index+1; scan < list.length; scan++)
            if (list[scan].compareTo(list[min]) < 0)
                min = scan;
        // Swap the values
        temp = list[min];
        list[min] = list[index];
        list[index] = temp;
    }
}
```

14. Write a static method that computes an approximation of the cosine function by using the following series: [2 points]
\[
\cos(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \cdots = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!}
\]

\textbf{public static double} cosine\( (\text{double} \ x, \ \text{int} \ k) \) \{ ...\}

This method will return the result of the computation of the series where the index \( n \) ranges from 0 to \( k \) (not to infinite!). Assume that a static method \texttt{fact(int n)}, which returns the (int) factorial of \( n \), is already declared in your code.

\textbf{Sol}

\textbf{public static double} cosine\( (\text{double} \ x, \ \text{int} \ n) \) {
    double res = 0;
    for (int i = 0; i <= n; i++)
        res += Math.pow(-1, i) * Math.pow(x, 2 * i) / fact(2 * i);
    return res;
}

15. For the questions below, assume that \( \text{int}[\ ] \ a = \{6, 2, 4, 6, 2, 1, 6, 3, 5\} \) and consider the recursive method below. [1 point]

\textbf{public int} bar\( (\text{int}[\ ] \ a, \ \text{int} \ j) \) {
    if (j < a.length)
        return a[j] + bar(a, j+1);
    else return 0;
}

What is the result of bar(a, 6)?

Res: The bar method recursively sums the elements of array \( a \) starting at the location of the second parameter (7 in this case). So, bar(a, 7) sums up only the last three elements in the array, 6, 3 and 5, and so 14 is returned.

16. Write a recursive method that computes the following recursive function:
\( f(0) = f(1) = 1, f(n) = f(n-1) \cdot f(n-2) + 2 \). The method has a long parameter and returns a long number. (Only for COMPUTER PROGRAMMING students) [2 points]

Answer:

\textbf{public static long} recursive\( (\text{long} \ n) \) {
    long result;
    if (n==0 || n == 1)
        result = 1;
    else

result = recursive(n-1) * recursive(n-2) + 2;
return result;
}