Birkbeck
(University of London)

BSc/FD EXAMINATION
Department of Computer Science and Information Systems

Introduction to Programming (BUCI007H4)

CREDIT VALUE: 15 credits

Date of examination: Thursday 29th May 2014
Duration of paper: 2.30 - 4.30

SUMMARY ANSWERS

There are in total ten questions in this paper.
Answer all ten questions.
Each question carries 10 marks in total.
Calculators and other electronic devices are not permitted.
The examination is closed book.
No supplementary material is provided.
This paper is not prior disclosed.
The quote marks for strings are in the following style: “string”.

1. Consider the following Java program.

```java
public class HelloPrinter {
    public static void main(String[] args) {
        System.out.println("Hello World");
    }
}
```

a) The above program is compiled and run in the BlueJ Java Development Environment. Describe what is observed when the program is run. (2 marks)

Answer: A window appears and displays the text "Hello World". Two marks. One mark for the window and 1 mark for the text.

b) Why is it necessary for a Java program to include a method called `main`? (2 marks)

Answer: The first method to run must be `main`. If there is no method `main` then the program does not run. Two marks.

c) List four of the reserved words used in the above program. (4 marks)

Answer: public, class, static, void. Four marks in total. One mark each.

d) State the name of the class in the program. (2 marks)

Answer: HelloPrinter. Two marks.

2. a) Find the values of the following arithmetical expressions when they are evaluated in a correct Java program.

   i) $3.5/2$
   ii) $35/2$
   iii) $9 + (7*4)$
   iv) $19 - (19\%3)$ (4 marks)

Answer: i) 1.75; ii) 17; iii) 37; iv) 18. Four marks. One mark each.

b) A variable of type `int` can take integer values in the range $-2^{31}$ to $2^{31} - 1$. Explain what is meant by the statement that a variable of type `int` has overflowed. (2 marks)

Answer: the statement means that there has been an attempt to give the variable an integer value outside the permitted range. Two marks. One additional mark, but only within the total of 2 marks, if it is stated that the value of `v` after overflow is arbitrary or of no use.
c) Consider the following Java instructions.

```java
int total = 0;
int a = total+1;
int b = a+1;
int c = 2*total;
total += 4;
```

What is the value of `total` and what are the values of `a`, `b` and `c` when the above instructions are executed in a correct Java program? (4 marks)

Answer: `total = 4`, `a = 1`, `b = 2`, `c = 0`. Four marks. One mark each.

3. a) Find the values of the following expressions when they are evaluated in a correct Java program. In all four cases state the type of the result.

i) "Harry".charAt(0)

ii) "AA"+1

iii) "AA"+"1"

iv) "John Smith".substring(0, 4) (4 marks)

Answer: i) 'H', char; ii) "AA1", String; iii) "AA1", String; iv) "John", String. Four marks, one mark each.

b) Find the values of the following expressions when they are evaluated in a correct Java program. The variable `x` is of type `int` and has the value 5.

i) `5 < 0`

ii) `x > 0`

iii) `x > 6 && x < 10`

iv) `0 < 10 || 10 < 20` (4 marks)

Answer: i) false; ii) true; iii) false; iv) true. Four marks. One mark each.

c) The following instructions are executed in a correct Java program. What are the values of `b1` and `b2`?

```java
String str = "test";
boolean b1 = str.equals("test");
boolean b2 = str.equals(str);
```

Answer: `b1` is true and `b2` is true. Two marks. One mark for each correct answer.
4. a) State what is meant by a *compile time error* and what is meant by a *run time error*.

   Answer: a *compile time error* is an error found by the compiler. A *run time error* is an error which occurs when a program that has successfully compiled is run. Four marks. Two marks for each statement.

   b) Identify four compile time errors in the following Java program.

   ```java
   import java.util.Scanner;
   public class HasErrors
   {
       public static vacant main(String[] args)
       {
           System.out.println("Please type in a number: ");
           Scanner in = new Scanner(System.in);
           int x = in.nextInt();
           System.out.println(Please type in another number: ");
           int x = in.nextInt();
           System.out.println("sum:" +x+y);
       }
   }
   
   Answer: i) vacant in place of void; ii) Missing quote marks in the argument for the second call of System.out.println(); iii) second declaration and initialization of x; iv) use of the variable y which has not been declared or initialized. Four marks. One mark each.

   c) A Java program to sort an array of numbers in increasing order has been written. The program compiles without any errors. Suggest one way of testing the program for *run time errors.*

   Answer: run the program with test data for which the correct result is known. Two marks.

5. a) Consider the following format specifier for floating point numbers: "%10.2f". Explain the role of the symbol % and the number 10 in the format specifier.

   Answer: the symbol % indicates the beginning of the format specifier. The number 10 specifies the width in characters of the field in which the number is to be printed. Four marks. Two marks for each explanation.

   b) It is required to print the numbers 0.361, 1.25, 31.75, 4.9752 on separate lines, placed such that the decimal points are aligned. For each number, the three digits to the
right of the decimal point are printed. State with reasons a single appropriate format
specifier. Add the notation for a new line to the format specifier.     (4 marks)
Answer: "%6.3f\n". Other format specifiers accepted, eg "%10.3f\n". The f is
required because the numbers are floating point. The field must include the three
digits to the right of the decimal point, the decimal point itself and at most two digits
to the left of the decimal point. It follows that the minimum width of the field is 6. The
3 specifies the number of digits to the right of the decimal point. Four marks. One
mark each for the reasons for f, 6, 3. One mark for a correctly placed new line.

c) Find the error in the format specifier "%5.2d".          (2 marks)
Answer: The symbol d indicates that an integer is to be printed, but the inclusion of
5.2 in the format specifier indicates that a floating point number is to be printed. Two
marks.

6. a) Show clearly which of the following can be chosen as names of variables in a correct
Java program and show clearly which cannot be chosen as names of variables.
   i) v                  ii) double
   iii) 6double          iv) con87stant
   (4 marks)
Answer: i) yes; ii) no; ii) no; iv) yes. Four marks. One mark each.

b) The following instruction is a correct declaration and initialization of a variable in a
Java program.
   int double_ = -4;
   Explain why the above instruction is an example of poor programming style. (2 marks)
   Answer: the variable double_ has a name which indicates that it is of type double,
   when in fact the variable is of type int. Also the variable name is very similar to a
   reserved word. Two marks for either answer.

c) The following Java instructions contain a compile time error. Describe the error.
   int bottles;
   bottles = bottles+4;  
   (2 marks)
   Answer: the variable bottles is used before it is assigned a value. Two marks.

d) The following Java instructions contain a run time error. Describe the error.
   int x = 4, y = 2;
   System.out.println("The sum of x and y is"+(x*y));
7. Consider the following Java method.

```java
public static double pm(double[] a)
{
    double m = 0;
    for(int i = 0; i < a.length; i++)
    {
        m = m+a[i];
    }
    m = m/a.length;
    return m;
}
```

a) Suppose that the method `pm` is called with the argument `a = {1.0, 4, 7}`. How many times is the for loop traversed? what value is returned by `pm`?

Answer: The for loop is traversed three times. The value returned by `pm` is 4.0. Two marks. One mark each.

b) Modify the method `pm` to produce a new method `pm1` which does not return a value but instead uses the instruction `System.out.println();` to output the string "The average value is: ", followed by the value of m. Note that it is necessary to supply `System.out.println()` with an appropriate argument. Write out the entire method `pm1`.

Answer:

```java
public static void pm1(double[] a)
{
    double m = 0;
    for(int i = 0; i < a.length; i++)
    {
        m = m+a[i];
    }
    m = m/a.length;
    System.out.println("The average value is: "+m);
```
Four marks. Deduct one mark for each error. Any reasonable answer accepted.

c) Modify the method \texttt{pm} to produce a new method \texttt{pm2} that returns the same value as \texttt{pm}, but which calculates this value using a while loop in place of the for loop. Write out the \textit{entire} method \texttt{pm2}. \hfill (4 marks)

Answer:

\begin{verbatim}
public static double pm2(double[] a)
{
    double m = 0;
    int i = 0;
    while(i < a.length)
    {
        m = m+A[i];
        i = i+1;
    }
    m = m/a.length;
    return m;
}
\end{verbatim}

Four marks. Deduct one mark for each error. Any reasonable answer accepted.

8. a) What is the value of \texttt{x} when the following instructions are executed in a correct Java program.

\begin{verbatim}
int x;
boolean flag = false;
if(flag)
{
    x = 4;
}
else
{
    x = 5;
}
\end{verbatim}

\hfill (2 marks)

Answer: \texttt{x} = 5. Two marks.

b) Consider the following instructions.

\begin{verbatim}
int x = 0, y = 0;
\end{verbatim}
if(x == 0)
{
    if(y == 0)
    {
        y = 1;
    }
    else
    {
        x = 4;
    }
}

The above instructions are compiled without error, however, the indentations are not appropriate for a human reader of the instructions. Explain why the indentations are not appropriate. (2 marks)

Answer: The reserved word else is associated with the second if statement, but the indentations suggest that it is associated with the first if statement. Two marks.

c) Radiation dosage is measured in millisieverts. The upper limits on radiation dosage in one year are as follows.

   Employees aged 18 years or over: 20 millisieverts.
   Trainees: 6 millisieverts.
   All others: 1 millisievert.

The category of a person is specified by a variable c of type int. For employees aged 18 years or over, c has the value 1, for trainees, c has the value 2, for all others, c has the value 3. The radiation dose in millisieverts is given as the value of a variable d of type int. Write a public static method with the name doseExceeded that takes c, d as parameters and that returns a boolean value true if the upper limit on radiation dosage is strictly exceeded and returns a boolean value false otherwise. (6 marks)

Answer:

    public static boolean doseExceeded(int c, int d)
    {
        if(c == 1 && d > 20)return true;
        if(c == 2 && d > 6)return true;
        if(c == 3 && d > 1)return true;
        return false;
    }

Six marks. Full marks for any reasonable correct answer. Subtract one mark for each mistake.
9. a) The numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and the letters are ordered in Java in the following way. The numbers are ordered by magnitude. Lower case letters are ordered alphabetically. Upper case letters are ordered alphabetically. Numbers precede all letters and upper case letters precede lower case letters. Explain how this ordering of letters and numbers is extended to give a lexicographic ordering of strings. (4 marks)

Answer: Let s1, s2 be two distinct strings. Suppose first that s2 is obtained by adding one or more characters to s1, on the right. Then s1 < s2. Similarly, if s1 is obtained from s2 by adding one or more characters on the right then s2 < s1. If neither of the above two cases applies, then s1 contains a character that is different from the character in the corresponding position in s2. Let c1 be the leftmost character in s1 with this property. Let c2 be the corresponding character in s2. If c1 < c2 in the ordering of the characters then s1 < s2. Similarly, if c2 < c1, then s2 < s1. Four marks.

b) Place the following four strings in lexicographic order.

i) "1079"
ii) "10794"
iii) "Zebra"
iv) "Zeb2ra"

(2 marks)

Answer: 1079 < 10794 < Zeb2ra < Zebra. Two marks. One mark if the given answer differs from the correct answer by a single transposition.

c) Write a method f that takes a string as an argument and returns true if every character in the string strictly precedes the character 'a' in the ordering of the characters. Otherwise f returns false. The header for the method is

public static boolean f(String str)

The method string1.compareTo(string2) is noted, but the use of this method is not obligatory. (4 marks)

Answer:

public static boolean f(String str)
{
    for(int i = 0; i < str.length(); i++)
    {
        String str1 = str.substring(i, i+1);
        if(str1.compareTo("a") > 0)
        {
            return false;
        }
    }
}
return true;
}

Four marks for any reasonable answer. Subtract one mark for each error.

10. a) Define the terms index and element as they apply to one dimensional arrays. Let \( ar \) be the array \( \{1, 2, 3\} \). What is the value of the largest correct index for \( ar \)? What is the length of \( ar \)? (2 marks)

Answer: an index to an array is an integer that identifies an element in the array. An element is an item of data stored in the array. The length of \( ar \) is 3 and the largest correct index for \( ar \) is two. Two marks. Half a mark for each part, with any non-integer total rounded up.

b) A partially filled array is by definition an array accompanied by a companion variable that records the number of array elements that are being used, i.e. that have meaningful values. Let \( a \) be an array and let \( currentSize \) be a companion variable for \( a \). The array \( a \) and the companion variable \( currentSize \) are defined by

\[
\begin{align*}
double[] a &= new double[10]; \\
int currentSize &= 0;
\end{align*}
\]

Consider the following method with the name update.

\[
\begin{align*}
public static int update(double[] b, int c, double r) \\
\{ \\
\quad b[c] &= r; \\
\quad c &= c+1; \\
\quad return c;
\}
\end{align*}
\]

State with reasons the value of \( currentSize \) and the values of the relevant elements of \( a \) after the following two instructions have been executed in a correct Java program.

\[
\begin{align*}
currentSize &= update(a, currentSize, 2); \\
currentSize &= update(a, currentSize, 3);
\end{align*}
\]

(4 marks)

Answer: The value of \( currentSize \) is 2, the element \( a[0] \) of \( a \) is equal to 2 and the element \( a[1] \) of \( a \) is equal to 3. No other elements of \( a \) are meaningful. Each call to update adds a new element to \( a \) and increases \( currentSize \) by 1 to yield the new number of array elements that are being used. Four marks for any reasonable answer. Two marks for a correct answer without reasons.

c) The method update in part (b) of this question returns an integer of type int. Explain why it is not necessary for update to return any further information about the array specified by the parameter \( b \). (4 marks)
Answer: The parameter b of update is in effect the address where the array is stored in memory. This address does not change, even though the values of the elements of b do change. It is thus not necessary for update to return b. Four marks.