UNIVERSITY OF EAST ANGLIA

School of Computing Sciences

Main Series UG Examination 2014/15

PROGRAMMING 2

CMP-5015Y

Time allowed: 2 hours

Answer four questions.

All questions carry *equal weight*.

Notes are not permitted in this examination.

Do not turn over until you are told to do so by the Invigilator.

1. (a) A class can be threaded by extending `Thread` or implementing `Runnable`. Which is better, and why? Describe with code segment examples how you define a class that can be threaded (using either `Thread` or `Runnable`) and how an object of that class could be run in its own thread. [6 marks]

   (b) What is the output of the following code? [3 marks]

```
public static class Player extends Thread{
        int id;
        Player op;
        public Player(int n){id=n;}
        public void connect(Player other){ op=other;}
        public void run(){
            if(op!=null){
                try {
                    op.join();
                } catch (InterruptedException ex) {
                     System.out.println(" INTERRUPTED");
                }
            }
            System.out.println("PLAYER ID ="+id);
        }
        public static void main(String[] args) {
            Player p1=new Player(1);
            Player p2=new Player(2);
            p1.connect(p2);
            p1.start();
            p2.start();
        }
}
```

(c) What is a monitor lock? [2 marks]

(d) Describe, with code examples, different ways of claiming a monitor lock in Java with the keyword `synchronized`. [10 marks]

(e) Describe, with examples, three common problems that can be encountered with concurrent programming and give scenarios where they are likely to occur. [9 marks]

2. (a) What is a nested class? [2 marks]

(b) How do nested classes differ in Java and C++? [2 marks]

(c) Describe the four types of nested class in Java. Give an indication of when you should use each type. [12 marks]

(d) Demonstrate the usage of each type of nested class by implementing `Comparator` nested classes for the `Person` class. Your solution should be a complete new version of the `Person` class. Include a static method that uses each type of `Comparator` nested class to sort an array of `Person` objects. Use a different attribute to sort with each nested class, and sort with `Arrays.sort`. [14 marks]

```
public class Person{
    String firstName;
    int age;
    double weight;
    char sex;
}
```

3. (a) What is an `enum` type in Java? Give an example of how to define one. [4 marks]

   (b) How do `enum` types in Java differ from `enum` types in C++? What are the benefits of Java `enum` types? [6 marks]

   (c) Explain how C++, Java and C# differ in relation to how they implement inheritance, including mechanisms for abstract methods/member function. [12 marks]

   (d) Explain the difference between C++ templates, Java generics and C# generics in terms of how the code is compiled. What are the benefits and problems of each approach? [8 marks]

4. (a) What is the output of the following program? [10 marks]

```
#include <stdio.h>
#include <stdlib.h>

#define PRINTX printf("x = %i\n", x);

int main(int argc, char **argv)
{
   int x = 2, y, z;

   x *= 3 + 2;      PRINTX;
   x *= y = z = 4;  PRINTX;
   x = y == z;      PRINTX;
   x == (y=z);      PRINTX;
   x = ++y - z--;   PRINTX;

   return EXIT_SUCCESS;
}
```

   (b) What type of variable is created in each of the following declarations? Where the declaration will not compile, or potentially cause an error, explain why this is the case. [5 marks]

(i) `const int a;`

(ii) `const double * const p = &d;`

(iii) `unsigned u = 042;`

(iv) `char s[] = {'h', 'e', 'l', 'l', 'o' };`

(v) `int (*compare)(int,int);`

(c) Write a C function, `range` that returns the difference between the largest and smallest values contained in array of `double` precision floating point values provided as an argument to the function. [10 marks]

(d) The following macro definition has two deficiencies; explain the deficiencies and give a revised macro definition that addresses both problems. [5 marks]

```
#define SQUARE(x) x*x
```

5. (a) A file, `data.txt`, contains an unknown number of integer values, one value being given on each line of the file. Write a C code fragment to compute the average (mean) of the numbers in the file. [10 marks]

(b) Explain what is meant by the "Rule of three" in C++ programming. [10 marks]

(c) What is the purpose of the following C++ code fragment?

```
int numbers[] = {-4, +3, -2, -3, 9, 42, 3};

int previous = 0;

for (int &current : numbers) {
   int temp = previous;
   previous = current;
   current  = current>temp?current-temp:temp-current;
}
```

What does the array contain after execution of the fragment? [10 marks]

6. (a) Explain the differences between pointers and references in the C++ and Java programming languages. [10 marks]

   (b) Write a C++ class definition describing a time of day, where the hour of the day and minute of the hour are represented as integers. The class should include appropriate constructors, accessor methods, overloaded operators supporting the use of stream I/O, and overloading of the subtraction operator to determine the difference between two `Time` objects, expressed in minutes. [20 marks]

END OF PAPER