

**UNIVERSITY OF EAST ANGLIA**

School of Computing Sciences

UG Main Series Examination 2012/13

**PROGRAMMING 2**

CMPC2M13

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) Describe, with the aid of diagrams, the three types of structure commonly employed in parallel computing systems. [6 marks]
- (b) Describe, with the aid of code segment examples, how you define a class that can be threaded and how an object of that class could be run in its own thread. [8 marks]
- (c) What are the differences between `wait/notify` and `sleep/interrupt` mechanisms of thread communication? [7 marks]
- (d) Describe 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 in Java? Describe, with code segment examples, the four types of nested class. [10 marks]
- (b) In Java, what are **generics**? Describe, with code segment examples, the advantages of using generics. [8 marks]
- (c) Explain how generics work through the process of type erasure and compare this to how templates work in C++. [6 marks]
- (d) In the context of Java, what is meant by Reflection? Explain, with code segment examples, how it can be used. [6 marks]
3. (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 fraction, consisting of an integer numerator and denominator. The class should include appropriate constructors, error checking, accessor methods and overloaded operators supporting the use of stream I/O and the addition of fractions and addition of integer values and fractions. [20 marks]

4. (a) Explain the function of the following C++ code fragment. [5 marks]

```
int numbers[] = {8, 9, 10, 3, 2, 2, 4, 9};

for (int &n : numbers)
{
    if (n%2 == 1)
    {
        n++;
    }
}
```

- (b) The following C++ code fragment does not function as the programmer apparently intended. Identify and explain the error in the code and suggest how it could be modified to function correctly.

Could this type of error occur in a Java program?

[10 marks]

```
int a = 7, b = 6, c = 5;

if (a > b > c)
    std::cout << "a, b & c are in descending order"
               << std::endl;
else
    std::cout << "a, b & c are not in descending order"
               << std::endl;
```

- (c) What kind of variable is created in each of these declarations?

Where the declaration will not compile, explain why this is the case. [5 marks]

(i) `int *p;`

(ii) `string &s;`

(iii) `char *s[] = {"hello", "Jupiter", "!"}`

(iv) `Fraction f();`

(v) `unsigned *a[6];`

- (d) According to the “Rule of Three”, if a class contains an explicit implementation of a destructor, name two other facilities the class should probably provide, giving reasons for your answer. [10 marks]

5. (a) Describe, giving a simple example, how object oriented programming is implemented in MATLAB.

[10 marks]

- (b) Write a MATLAB function with two input parameters, `BOX` which describes a rectangular region in a two-dimensional space, and `X`, an  $M \times 2$  matrix, describing  $M$  points within that space. `BOX` should be a four element row vector, where the first two elements specify the co-ordinates of the bottom left hand corner of the rectangle, and the remaining two elements represent the width and height of the rectangle respectively. The function should return a logical column vector, `Y`, with  $M$  rows, which indicates whether the corresponding row of `X` represents a point within the rectangle described by `BOX`. Figure 1 shows example input and output for this function. The function should check that all elements of `BOX` and `X` are real-valued and a valid numeric value, and that the correct number of arguments, of the appropriate dimensions have been provided.

[20 marks]

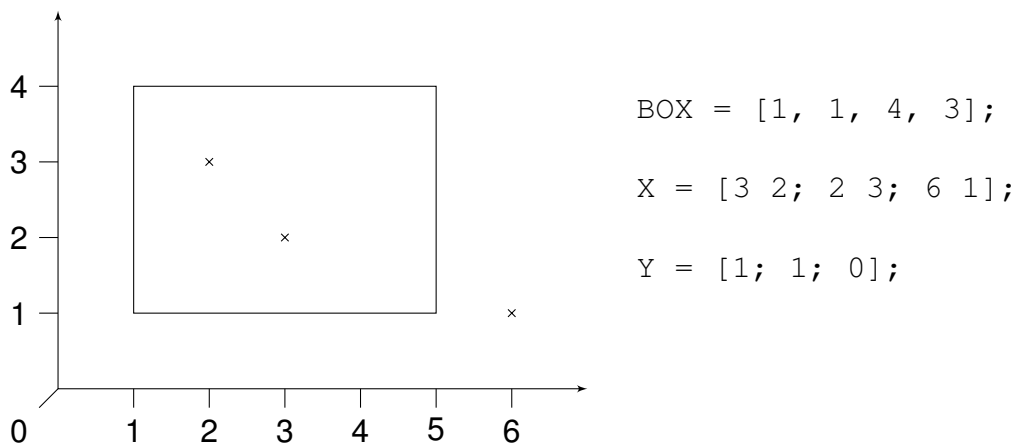


Figure 1: Example input and output for question 5b.

6. (a) Given the MATLAB array:  $M = \begin{bmatrix} 6 & 2 & 3 \\ 9 & 7 & 6 \\ 2 & 8 & 2 \end{bmatrix}$ ; what would be the result of the following operations?

(i) `size(M,1)` [1 mark]

(ii) `size(M')` [1 mark]

(iii) `M(:,2)` [1 mark]

(iv) `M(1,[1 3])` [1 mark]

(v) `M([2 end],[end 1])` [1 mark]

(b) Given the following operations in MATLAB:

```
>> vec = [3 5 1 4 2 6];
>> idx1 = [0 0 1 1 0 0];
>> idx2 = idx1 == 1;
```

(i) Write the values contained in `idx2`. [3 marks]

(ii) What is the difference between `idx1` and `idx2`? [3 marks]

(iii) What is the result of the following assignments? Explain your reasoning.

(A) `>> vec(idx1) = 42` [2 marks]

(B) `>> vec(idx2) = 42` [2 marks]

(c) A MATLAB function requires that an error be generated if an input vector, named `v`, contains any element with a non-finite value.

Implement this check as compactly as possible. You may assume that the input has already been checked to determine if it is a vector and that it is of a numeric type. [8 marks]

(d) Outline the main differences between a *script* and a *function* in MATLAB. [7 marks]

**END OF PAPER**