A LEVEL COMPUTER SCIENCE

COMPONENT 1

Programming and System Development

SPECIMEN PAPER

2 hours 45 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a 16 page answer book.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the separate answer book provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question; you are advised to divide your time accordingly.

The total number of marks is 100.

You are reminded of the need for good English and orderly, clear presentation in your answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

*Answer **all** questions*

1. A binary tree can be constructed using the following rules:

   Rule 1. The first item becomes the root node;
   Rule 2. Items earlier or at the same position in the alphabet follow the left pointer;
   Rule 3. Items later in the alphabet follow the right pointer.

   (a) Draw a representation of a dynamic binary tree with pointers using the following data:

   Newport, Canterbury, Oswestry, Warrington, Rugby, Bath, Derby [2]

   (b) Show how the above tree could be represented using a two dimensional array. [3]

   (c) Make the following amendments to the tree represented as a two dimensional array:

   (i) Insert *Newquay* into the tree; [3]
   (ii) Delete *Warrington* from the tree. [1]

   (d) Give one advantage and one disadvantage of using a binary tree to store data compared with a linked list. [2]

   (e) Giving examples, compare a balanced and an un-balanced binary tree and evaluate their effectiveness to solve problems by comparing the maximum number of comparisons to locate an item in each of these trees. [4]

2. In the programming industry, professional Codes of Conduct are used extensively and they set rules that should be followed by programmers.

   State **five** reasons why programmers are required to follow rules under a professional Code of Conduct. Each reason must relate to a specific rule. [5]

3. Below is a segment of code from a high level language.

```
Total = Total + NumInput;
print(Total);
Count = Count + 1;
print(Count);
```

Give an example of a reserved word table used by a compiler and construct a user identifier table that could be used by a compiler to translate the segment of code above into a stream of Hex tokens. [4]

Use the tables to translate the following line of code into a stream of Hex tokens

Total = Total + NumInput [1]

4. (a) Clearly showing each step, simplify the following Boolean expression using De Morgan's Laws and Boolean identities:

$$\overline{A \cdot B} + A \qquad [3]$$

(b) Clearly showing each step, simplify the following Boolean expression:

$$A + B \cdot (A + B) + A \cdot (\bar{A} + B) \qquad [5]$$

5. Below is an algorithm.

```
Algorithm CalculateArea

        declare subprocedure FindArea( R, A ) {procedure to calculate area of a circle}

        Pi = 3.142

        startproc
            set A = Pi * R * R
        endproc

        declare subprocedure MainProg

        Area is real
        Radius is real

        startproc
            output "Type in the radius"
            input Radius
            call FindArea (Radius, Area)
            output "The area is ",Area
        endproc


start
        call MainProg
end
```

(a) Explain why it is good programming practice to use constants, meaningful names for variables and annotation in computer programs. [3]

(b) From the above algorithm, identify a value and a reference parameter. [1]

(c) Explain the difference between a value and a reference parameter giving an advantage of using a value parameter. [3]

6. Explain the facilities available in a typical IDE that would assist when debugging a computer program. [4]

7. The email addresses of staff at National Bank are made up of a first name, followed by a full stop, followed by a surname, followed by a single digit, followed by the @ sign, followed by nb.co.uk

   All first names and surnames consist of lower case letters only, and can be of any length.

   (a) Produce appropriate syntax diagrams to define an email address at National Bank. [5]

   (b) Produce an appropriate Backus-Naur Form (BNF) definition for an email address at National Bank. [4]

   (c) Explain why programmers find both syntax diagrams and BNF notation preferable methods for describing the syntax of programming languages compared to natural English. [3]

8. A software company has produced a stock control system for a small retailer. Using examples, describe different types of maintenance that should be carried out on the stock control system.

   [6]

9. Below is a section of a program that makes use of a recursive algorithm.

```
declare subprocedure RecursionAlgo(IN Num)
NewNum is integer
startproc
        if Num = 0 then
                output "Num is zero"
        else
                output "Num is ", Num
                set NewNum = Num - 1
                call RecursionAlgo(NewNum)
        endif
endproc
startmainprog
        input NumInput
        output "Starting recursion"
        call RecursionAlgo(NumInput)
        output "Recursion ended"
endmainprog
```

(a) Identify the main features of a recursive algorithm. [2]

(b) Describe, giving reasons, two problems that a programmer might encounter when using a recursive algorithm. [4]

10. Explain the terms class and inheritance in object-oriented programming. [3]

11. Write algorithms in pseudo-code that will:

(a) input 10 integers into an array;
search the array of 10 integers for the largest value;
output the largest value. [3]

(b) input 10 integers into an array;
sort the array of 10 integers into ascending order;
output the 10 integers in ascending order. [6]

12. Below is an algorithm that calculates the product of two square matrices A and B.

Both matrices have dimensions N by N where N is the number of rows and columns in each matrix.

```
for i = 1 To N
   for j = 1 To N
      for k = 1 To N
         set Answer( i, j ) = Answer( i, j ) + A( i, k ) * B( k, j )
      next k
   next j
next i
```

(a) Determine how many multiplication calculations will be carried out when N is equal to:

10
100

[1]

(b) Evaluate the efficiency of the algorithm and, using Big O notation, determine the growth rate for the time performance. Your answer should refer to the addition and multiplication calculations performed by the algorithm. [5]

(c) Using Big O notation, determine the growth rate of memory space used by this algorithm. [2]

13. A software company encourages their programming teams to write programs using modules.

Discuss implications of writing programs in modules.

You should draw on your knowledge, skills and understanding from a number of areas across your Computer Science course when answering this question. [12]

End of Paper