Candidate Name	Centre Number				Candidate Number				
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A LEVEL COMPUTER SCIENCE

UNIT 3

PROGRAMMING AND SYSTEM DEVELOPMENT

SPECIMEN PAPER

2 hours

ADDITIONAL MATERIALS

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

The use of a calculator is permitted in this examination.

INSTRUCTIONS TO CANDIDATES

Answer **ALL** question(s).
Write your answers in the separate answer book provided.

Write your name, centre number and candidate number in the spaces at the top of this page.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks available is 100.

Assessment will take into account the quality of written communication used in your answers.

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

Unit 3

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:

   Narberth, Cardiff, Pontypridd, Wrexham, Rhyl, Bangor, Denbigh   [2]

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

   (c) Make the following amendments to the original tree:

   (i)   Insert Pontardawe and Tonypandy into the tree;   [2]
   (ii)   Delete Cardiff and Pontypridd from the tree.   [3]

   (d) 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. (a) Explain what is meant by the term linked list. Describe one benefit and one drawback of using a linked list compared with using an array.   [4]

   (b) In a certain implementation, a linked list of integers is actually stored in a table form as shown below. The integers are to be accessed in ascending numerical order. A variable points to the address 752, which contains the lowest integer, 2312.

   Copy and complete the pointer column in the table below.

Address	Integer	Pointer
751	4811	
752	2312	
753	3599	
754	4166	
755	2567	
756	5218	
757	3100	

                                                                          [3]

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

State **six** reasons why programmers are required to follow rules under a professional Code of Conduct. Each reason must relate to a specific rule. [6]

4.   (a)   Using the laws of Boolean algebra, simplify the following Boolean expression. [3]

$$(A + B).(A + \bar{B})$$

(b)   Using the laws of Boolean algebra and De Morgan's theorem, simplify the following expression. [3]

$$C + \overline{BC}$$

(c)   Simplify the following Boolean expression. [3]

$$A + (A + \overline{B.C}) + \bar{C}$$

5.   Two 8 bit numbers are:

```
X      10011011₂
Y      11010111₂
```

Explain how the XOR operation can be used for encrypting data, using the two numbers above to illustrate your answer. You should also show how the original data can be recovered. [3]

6.   Write an algorithm that performs a binary search for SearchValue in an array of size `n` called SearchArray. Your algorithm should output the position of the SearchValue if found or an error message if the SearchValue is not found. [7]

7.   Name the the type of algorithm shown below. Give two features of this type of algorithm. Name a sort which uses this type of algorithm. [4]

```
function CalcF (Num: integer) :
integer
if Num = 1
then CalcF = 1
else CalcF = Num * CalcF(Num-1)
```

8.   (a)   Describe the purpose of Backus-Naur Form (BNF).   [1]

      (b)   A warehouse stores a large number of mobile phone components. Each
             component has a component code consisting of 6 digits and a description.
             The description is made up of upper case letters only and may be of any
             length.

             Examples of valid codes are:

             621402DIGITISER
             506742USBPORT

             (i)   Produce an appropriate BNF definition for a component code.   [4]
             (ii)   Produce an appropriate syntax diagram for a component code.   [3]

9.   Below is an algorithm that sorts data stored in an array.

```
Algorithm sort

Declare A(1 to n)

n = length(A)

for i = 1 to n
     for j = 1 to  n-1 inclusive do

          if A[i-1] > A[i] then
               swap( A[i-1], A[i] )
          end if

     next j
next i
```

      (a)   Determine how many comparisons are made when n is equal to:

             10
             100
             1000   [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
             comparisons performed by the algorithm.   [4]

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

10.   Describe the Waterfall and Agile approaches to systems analysis including their advantages and disadvantages. [6]

11.   A software development company specialises in developing computerised automatic car braking systems.

  (a)   When the company develops such a system, a design validation is carried out. Describe how a design validation should be carried out. [3]

  (b)   Explain why version control is important when developing computer programs. [1]

12.   (a)   Describe the purpose of compilers, interpreters and assemblers. [3]

  (b)   Describe and give examples of three common translation and execution errors.
  [9]

13.   Discuss the nature of different programming paradigms. [13]