Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4911392142

COMPUTER SCIENCE **9618/31**

Paper 3 Advanced Theory **October/November 2022**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must **not** be used in this paper.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].
- No marks will be awarded for using brand names of software packages or hardware.

This document has **12** pages. Any blank pages are indicated.

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1 Real numbers are stored in a computer system using floating-point representation with:

- 8 bits for the mantissa
- 8 bits for the exponent
- two's complement form for both mantissa and exponent.

(a) Write the normalised floating-point representation of +202 in this system.
Show your working.

Mantissa								Exponent							

Working .....

.....

.....

.....

.....

.....

[3]

(b) Write the normalised floating-point representation of –202 in this system.
Show your working.

Mantissa								Exponent							

Working .....

.....

.....

.....

.....

.....

[3]

(c) A binary number is stored in the computer system.

Mantissa								Exponent							
0	0	0	1	1	1	1	0	0	0	0	1	1	0	0	0

(i) State why the number is **not** normalised.

.....

..... [1]

(ii) Write the normalised floating-point representation of the number.

Mantissa								Exponent							

[2]

2 Outline the functions of the Transport and Internet layers of the TCP/IP protocol suite.

Transport layer .....

.....

.....

.....

Internet layer .....

.....

.....

.....

[5]

3 **(a)** State what is meant by the term **enumerated data type**.

.....

..... [1]

(b) State what is meant by the term **pointer data type**.

.....

..... [1]

(c) The months of the year are: January, February, March, April, May, June, July, August, September, October, November and December.

Write the **pseudocode** statement to define the data type `Quarter1`, to hold the names of the first three months of a year.

.....

.....

.....

..... [2]

(d) The composite data type `Pet` is used to store data about the various pets of a group of students. It uses these fields:

Field name	Data type
`PetName`	String
`AnimalType`	String
`PetAge`	Integer
`PetGender`	Char
`OwnerName`	String

(i) Write the **pseudocode** statement to set up a variable for one record of the composite data type `Pet`.

.....

..... [1]

(ii) Write **pseudocode** to store the details of the following pet, in the variable you set up in **part (d)(i)**.

PetName	AnimalType	PetAge	PetGender	OwnerName
Tibbles	Cat	8	M	Jasmine Smith

.....

.....

.....

.....

.....

..... [3]

4 Draw **one** line to connect each stage of compilation to its **most appropriate** description.

Stage of compilation	Description
Lexical analysis	minimising a program's execution time and memory requirement
Syntax analysis	converting an intermediate representation of source code into an executable form
Code generation	converting a sequence of characters into a sequence of tokens
Optimisation	directly executing instructions written in a scripting language
	using parsing algorithms to interpret the meaning of a sequence of tokens

[4]

5 **(a)** Write the infix expression in Reverse Polish Notation (RPN).

```
a * b + b - d + 15
```

.....

..... [1]

(b) **(i)** Write the RPN expression in infix form.

```
a b - c d + * a /
```

.....

..... [1]

(ii) Evaluate your infix expression from **part (b)(i)** when a = 5, b = 10, c = 27 and d = 12.

.....

..... [1]

6 A message is encrypted using a private key and sent to an individual using asymmetric encryption.

(a) State what is meant by a **private key**.

.....

.....

.....

..... [2]

(b) Describe the process of asymmetric encryption.

.....

.....

.....

..... [2]

(c) Explain how a digital signature is used to verify a message when it is received.

.....

.....

.....

.....

.....

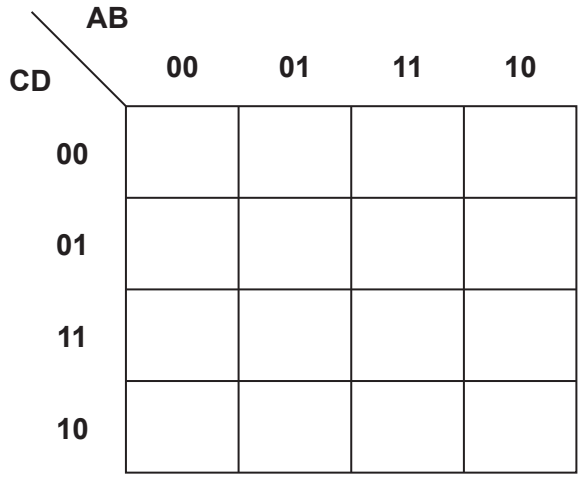
.....

.....

..... [4]

7 **(a)** Complete the Karnaugh map (K-map) for the Boolean expression.

$$Z = \overline{A}.B.\overline{C}.\overline{D} + \overline{A}.B.\overline{C}.D + A.B.\overline{C}.\overline{D} + A.B.\overline{C}.D + A.\overline{B}.\overline{C}.\overline{D} + A.\overline{B}.\overline{C}.D$$



[2]

(b) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]

(c) Write the Boolean expression from your answer to **part (b)** as a simplified sum-of-products. Use Boolean algebra to give your answer in its simplest form.

Simplified sum-of-products

Z = ...

Simplest form

Z = ...

[3]

8 Virtual memory, paging and segmentation are used in memory management.

(a) Explain what is meant by **virtual memory**.

.....

.....

.....

.....

.....

..... [3]

(b) State **one** difference between paging and segmentation in the way memory is divided.

.....

..... [1]

9 Deep learning is used in Artificial Intelligence (AI).

(a) Describe what is meant by **deep learning**.

.....

.....

.....

..... [2]

(b) Outline the reasons for using deep learning.

.....

.....

.....

..... [2]

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10 Reduced Instruction Set Computers (RISC) and Complex Instruction Set Computers (CISC) are two types of processor.

(a) Tick (✓) **one** box in each row to show if the statement applies to RISC or CISC processors.

Statement	RISC	CISC
uses a smaller instruction set		
uses single-cycle instructions and limited addressing modes		
uses fewer general-purpose registers		
uses both hardwired and micro-coded control unit		
uses a system where cache is split between data and instructions		

[2]

(b) Describe the process of pipelining during the fetch-execute cycle in RISC processors.

.....

.....

.....

.....

.....

.....

.....

..... [4]

11 (a) Define these Object-Oriented Programming (OOP) terms:

Instance .....

.....

Inheritance .....

.....

Polymorphism .....

.....

[3]

(b) In OOP, a class contains attributes and methods.

Complete the pseudocode for the class `Car` to enable objects to be created. The class needs to include:

- string attributes to store the make, model, body type and fuel type
- an integer attribute to store the number of cars of that type built.

The attributes must be available only through the methods of the class.

```
CLASS .....
    PRIVATE Make : STRING
    PRIVATE .....
    .....
    .....
    .....
    PUBLIC PROCEDURE New(CarMake : STRING, ..... ,
                        .....)
        Make ← .....
        Model ← .....
        BodyType ← CarBodyType
        Fuel ← ""
        NumberBuilt ← 0
    ENDPROCEDURE
    GetFuel()
    GetNumberBuilt()
.....
```

[5]

12 **(a)** The array `Names[0:99]` is in alphabetical order.

Complete this pseudocode binary search algorithm.

```
Lower ← 0

.....
Mid ← 0
Exit ← FALSE
OUTPUT "Enter the name to be found "
INPUT Target
REPEAT

  ..... THEN

     OUTPUT Target, " does not exist"
     Exit ← TRUE
  ENDIF
  Mid ← Lower + (Upper - Lower + 1) DIV 2
  IF Names[Mid] < Target THEN

     Lower ← .....
  ENDIF
  IF Names[Mid] > Target THEN

     .....
  ENDIF

  ..... THEN
     OUTPUT Target, " was found at location ", Mid
     Exit ← TRUE
  ENDIF

.....
```

[6]

(b) Big O notation is used to classify efficiency of algorithms.

The Big O notation for time complexity in a binary search is O(log n).

(i) State the Big O notation for time complexity of a linear search.

..... [1]

(ii) Describe the meaning of O(log n) as it applies to a binary search algorithm.

.....

.....

.....

..... [2]

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