Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9618/33**

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.

[Turn over

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 ....

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[3]

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

Mantissa							
0	0	0	1	1	1	1	0

Exponent							
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							
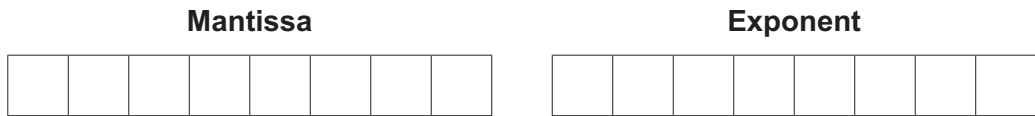
[2]

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**

```
                                    ┌─────────────────────────────────────┐
                                    │  minimising a program's execution    │
                                    │  time and memory requirement         │
                                    └─────────────────────────────────────┘

┌─────────────────────┐             ┌─────────────────────────────────────┐
│  Lexical analysis   │             │  converting an intermediate          │
│                     │             │  representation of source code into  │
└─────────────────────┘             │  an executable form                  │
                                    └─────────────────────────────────────┘

┌─────────────────────┐             ┌─────────────────────────────────────┐
│  Syntax analysis    │             │  converting a sequence of characters │
│                     │             │  into a sequence of tokens           │
└─────────────────────┘             └─────────────────────────────────────┘

┌─────────────────────┐             ┌─────────────────────────────────────┐
│  Code generation    │             │  directly executing instructions     │
│                     │             │  written in a scripting language     │
└─────────────────────┘             └─────────────────────────────────────┘

┌─────────────────────┐             ┌─────────────────────────────────────┐
│  Optimisation       │             │  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**.

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....

.... [2]

(b) Describe the process of asymmetric encryption.

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.... [2]

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

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.... [4]

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

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

[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.

....

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....

.... [2]

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.

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....

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.... [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.

....

....

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.... [2]

12

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