Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9618/31**

Paper 3 Advanced Theory **October/November 2023**

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.
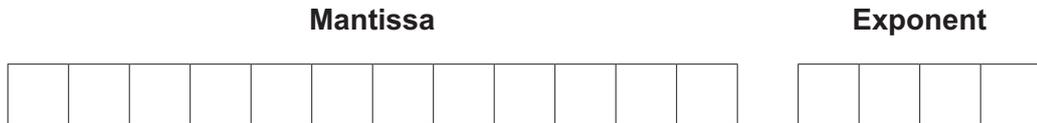
This document has **16** pages. Any blank pages are indicated.

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

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

(a) Write the normalised floating-point representation of +65.25 in this system.

Show your working.

Mantissa   **Exponent**

| | | | | | | | | | | | | | | | |

Working ....

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.... [3]

(b) Explain the problem that will occur in storing the normalised floating-point representation of +65.20 in this system.

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.... [2]

2 (a) Draw **one** line to connect **each** protocol to its most appropriate use.

Protocol

HTTP

BitTorrent

SMTP

IMAP

Use

to provide peer-to-peer file sharing

when retrieving email messages from a mail server over a TCP/IP connection

when transmitting hypertext documents

to map MAC addresses onto IP addresses

when sending email messages towards the intended destination

[4]

(b) Outline the purpose of the **Link layer** in the TCP/IP protocol suite.

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.... [2]

3 Describe what is meant by **enumerated** and **pointer** data types.

Enumerated ....

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....

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Pointer ....

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[4]

4 (a) Describe sequential and random methods of file organisation.

Sequential file organisation ....

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....

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Random file organisation ....

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[4]

(b) Outline the process of sequential access for serial and sequential files.

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.... [2]

5 Describe the features of SISD and MIMD computer architectures.

SISD ....

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MIMD ....

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[4]

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6 This diagram represents a logic circuit.
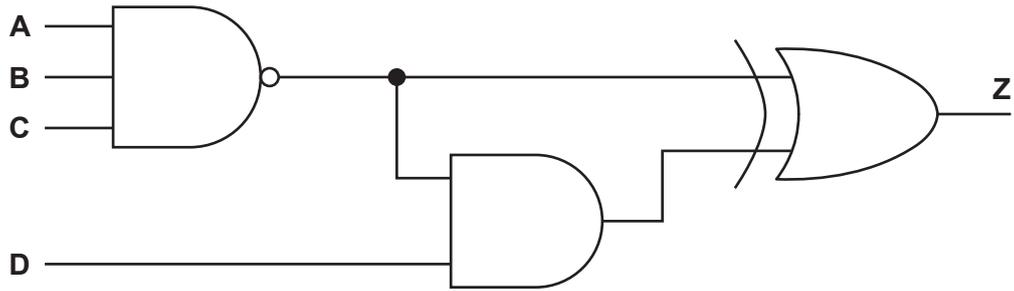
(a) Complete the truth table for the given logic circuit.

A	B	C	D	Working space	Z
0	0	0	0		1
0	0	0	1		0
0	0	1	0		1
0	0	1	1		0
0	1	0	0		1
0	1	0	1		0
0	1	1	0		1
0	1	1	1		0
1	0	0	0		1
1	0	0	1		0
1	0	1	0		1
1	0	1	1		0
1	1	0	0		1
1	1	0	1		0
1	1	1	0		0
1	1	1	1		0

[3]

(b) Simplify the given Boolean expression using Boolean algebra.
Show your working.

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

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....

.... [3]

7 (a) A student buys a new computer.

State **one** benefit to the student of a user interface **and** give an example.

Benefit ....

....

....

Example ....

....
[2]

(b) Two of the process states are the running state and the ready state.

Identify **one other** process state.

.... [1]

(c) Outline conditions under which a process could change from the running state to the ready state.

....

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.... [2]

8 (a) A pseudocode algorithm finds a customer account record in a random file and outputs it. The records are stored using the user-defined data type `TAccount`.

```
TYPE TAccount
    DECLARE AccountNumber : INTEGER
    DECLARE LastName : STRING
    DECLARE FirstName : STRING
    DECLARE Address : STRING
    DECLARE ContactNumber : STRING
ENDTYPE
```

Complete the file handling pseudocode.

The function `Hash()` takes the customer account number as a parameter, calculates and returns the hash value.

```
DECLARE Customer : TAccount
DECLARE Location : INTEGER
DECLARE AccountFile : STRING

...................................................................... ← "AccountRecords.dat"
.......................................... AccountFile ...........................................
OUTPUT "Please enter an account number"
INPUT Customer.AccountNumber

Location ← Hash(..................................................................................)
SEEK ..................................................................., Location
.......................................... AccountFile, ...........................................
OUTPUT Customer                 // output customer record
CLOSEFILE AccountFile
```
[5]

(b) Define the term **exception handling**.

....

.... [1]

(c) State **two** possible causes of an exception.

....

.... [2]

9 **(a)** **(i)** Write the infix expression for this Reverse Polish Notation (RPN) expression:

```
5 2 - 5 4 + * 9 /
```

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.... [2]

(ii) Show how the contents of the following stack will change as the RPN expression in part **(a)(i)** is evaluated.
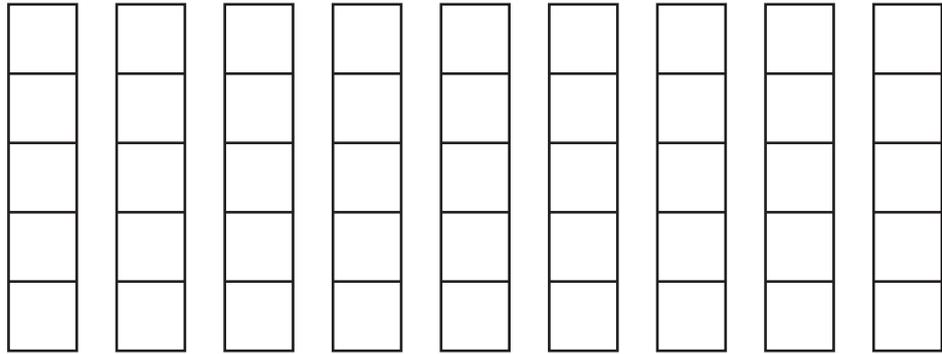
[4]

(b) Explain how a stack can be used to evaluate RPN expressions.

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.... [3]

10 A stack is to be set up using the information in the table.

Identifier	Data type	Description
BasePointer	INTEGER	points to the bottom of the stack
TopPointer	INTEGER	points to the top of the stack
Stack	REAL	1D array to implement the stack

A constant, with identifier Capacity, limits the size of the stack to 25 items.

(a) Write the **pseudocode** for the required declarations.

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.... [3]

(b) Complete the pseudocode function Pop() to pop an item from Stack.

```
// popping an item from the stack

FUNCTION Pop()......................................................................

    DECLARE Item : REAL

    Item ← 0

    ......................................................... BasePointer THEN

        Item ← ..............................................................

        TopPointer ← .........................................................
    ELSE
        OUTPUT "The stack is empty – error"
    ENDIF

    .........................................................

ENDFUNCTION
```

[5]

(c) Compare and contrast the queue and stack Abstract Data Types (ADT).

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.... [2]

11 A **declarative** programming language is used to represent subjects that students can choose to study.

Students must choose two subjects.

```
01  subject(mathematics).
02  subject(physics).
03  subject(chemistry).
04  subject(computer_science).
05  subject(geography).
06  subject(history).
07  subject(english).
08  subject(biology).
09  student(tomaz).
10  student(josephine).
11  student(elspeth).
12  student(nico).
13  student(teresa).
14  student(pietre).
15  choice1(tomaz, mathematics).
16  choice1(teresa, chemistry).
17  choice1(pietre, mathematics).
18  choice1(nico, mathematics).
19  choice1(elspeth, chemistry).
20  choice2(tomaz, computer_science).
21  choice2(nico, geography).
```

These clauses have the meanings:

Clause	Meaning
01	Mathematics is a subject.
09	Tomaz is a student.
15	Tomaz has chosen mathematics as his first choice.
20	Tomaz has chosen computer science as his second choice.

(a) Anthony is a student who would like to study history and geography.

Write additional clauses to represent this information.

22 ....

23 ....

24 ....

[3]

(b) Using the variable X, the goal:

```
choice1(X, chemistry)
```

returns

```
X = teresa, elspeth
```

Write the result returned by the goal:

```
choice1(X, mathematics)
```

X = ... [1]

(c) Students must choose two different subjects such that:

N may choose S, if N is a student and S is a subject and N has not chosen S as the first choice.

Write this as a rule.

```
may_choose_subject(N, S)
```

IF ....

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.... [4]

12 Artificial neural networks have played a significant role in the development of machine learning.

Explain what is meant by the term **artificial neural network**.

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.... [4]

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