Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3303447885

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2021**

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.

1 Data types can be defined using pseudocode.

The data type, `ComputerRecord`, is defined by the following pseudocode:

```
TYPE ComputerRecord

   DECLARE ComputerID       : INTEGER

   DECLARE ComputerType     : (Laptop, Desktop, Tablet)

   DECLARE ComputerLocation : (Lab1, Lab2, Lab3, Mobile)

   DECLARE DateTested       : DATE

ENDTYPE
```

A variable, `SchoolComputer`, is declared in pseudocode as:

```
DECLARE SchoolComputer : ComputerRecord
```

(a) Write **pseudocode** statements to assign `1234` to the `ComputerID` of `SchoolComputer` **and** `Lab2` to the `ComputerLocation` of `SchoolComputer`.

.....

..... [2]

(b) The type definition for `ComputerRecord` is changed.

(i) The definition has been extended to include the student identification numbers, `StudentID`, for up to 20 students who can use that computer. Each student identification number is an integer.

Write the extra line of **pseudocode** needed in the type definition for `ComputerRecord`.

.....

..... [1]

(ii) The values for the field `ComputerID` must be between `1000` and `1999` inclusive.

Rewrite **one pseudocode** line from the type definition of `ComputerRecord` to implement the change.

.....

..... [1]

(c) Data about all the computers are stored in a file that uses random file organisation.

`ComputerID` is used as the key field.

Explain how a program could search for a record stored in this file.

.....

.....

.....

.....

.....

..... [3]

2 The TCP/IP protocol suite can be viewed as a stack with four layers.

(a) Complete the diagram by writing the names of the **three** missing layers.

Layer
Transport

[3]

(b) State the purpose of each of the following protocols.

HTTP .....

.....

.....

FTP .....

.....

.....

POP3 .....

.....

.....

SMTP .....

.....

.....

[4]

3 Hamish is constructing a Local Area Network (LAN) using Ethernet with CSMA/CD.

(a) Identify **and** draw a diagram of the most appropriate topology for this LAN.

Topology .....

Diagram:

[3]

(b) Explain how devices on the LAN use CSMA/CD.

.....

.....

.....

.....

.....

.....

.....

..... [4]

4 **(a)** The truth table for a logic circuit with four inputs is shown.

INPUT				OUTPUT
P	**Q**	**R**	**S**	**X**
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

(i) Write the Boolean algebraic expression for the truth table as a sum-of-products.

X = ... [2]

(ii) Complete the following Karnaugh Map (K-map) for the truth table.

		PQ			
		00	**01**	**11**	**10**
RS	**00**				
	01				
	11				
	10				

[2]

(iii) The K-map can be used to simplify the expression in **part (a)(i)**.

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

(iv) Write the simplified sum-of-products from the K-map.

X = ... [2]

(b) Simplify the expression for **X**, as represented by the truth table in **part (a)**, using Boolean Algebra.

.....

.....

.....

..... [2]

5 **(a)** Flora has written a program that uses the variables `a`, `b`, `c` and `d`.

Part of the program contains the following calculations:

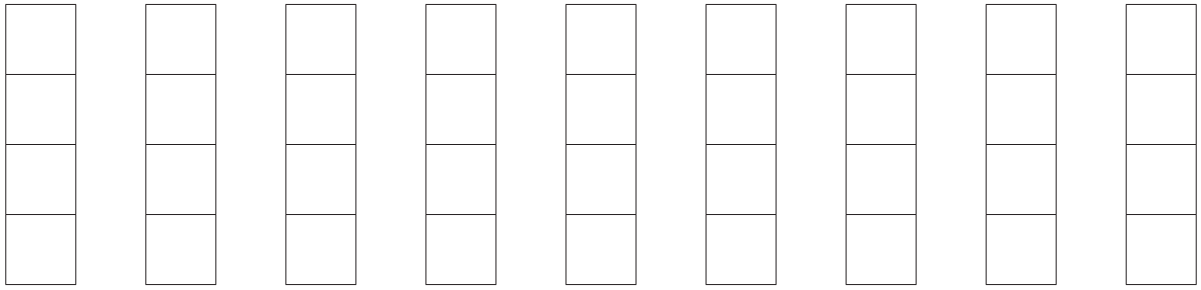
```
a = 2
b = 5
c = 7
d = a * b - (a + b + c)
```

(i) Write the Reverse Polish Notation (RPN) for the expression:

```
a * b - (a + b + c)
```

..... [2]

(ii) Show the changing contents of the stack as the value for variable `d` is calculated from the RPN expression.



[4]

(b) Convert the following RPN expression back to its original infix form.

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

.....

.....

.....

.....

..... [3]

(c) Explain why expressions are evaluated using RPN.

.....

.....

.....

.....

.....

..... [3]

6 Mohammad is working away from his company's head office. He wants to send a secure message over a computer network to the head office.

(a) (i) Explain the way in which a digital signature for the message would be produced.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) State **two** reasons why a digital signature for the message is required.

1 .....

.....

2 .....

.....

[2]

(b) The message is encrypted using asymmetric key cryptography before it is sent and decrypted when it arrives at the head office.

(i) Describe this process of encrypting and decrypting the message.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(ii) State **one** reason for using asymmetric key cryptography.

.....

..... [1]

7 A large apartment block has 20 floors. On each floor there is one security camera and four sensors.

The image from each security camera is output to a display screen for that floor.

- There are 20 display screens in the reception area on the lowest floor.
- The data from the sensors are read and processed by a computer system.
- Warning messages can also be displayed on each display screen.

(a) (i) Identify the type of system described.

..... [1]

(ii) Justify your answer to **part (a)(i)**.

.....

.....

.....

..... [2]

(iii) Identify **two** types of sensor that could be used by this system.
State a reason for the use of each sensor.

Sensor 1 .....

Reason .....

.....

Sensor 2 .....

Reason .....

.....
[4]

(b) A program regularly checks each sensor's readings. If the value of the reading is out of range, a warning message is displayed on the screen for that floor.

A pseudocode algorithm to output the warnings has been written using these identifiers.

Identifier	Data type	Description
`FloorNumber`	`INTEGER`	Floor number
`SensorNumber`	`INTEGER`	Sensor number
`Always`	`BOOLEAN`	Value to ensure continuous loop

The pseudocode algorithm uses:

- the function `CheckSensor(Floor, Sensor)` that returns `TRUE` if the sensor reading is out of range and `FALSE` otherwise
- the procedure `ScreenOut(Floor, Sensor)` that outputs the warning message `"Problem on Floor"` to the appropriate screen.

(i) Complete the **pseudocode** algorithm.

```
01  Always ← .....
02  REPEAT
03    FOR FloorNumber ← 1 TO .....
04      FOR SensorNumber ← 1 TO .....
05         IF CheckSensor(FloorNumber, SensorNumber)
06           THEN
07              ScreenOut(FloorNumber, SensorNumber)
08         ENDIF
09      ENDFOR
10    ENDFOR
11
12  // delay loop
13  // delay loop
14  UNTIL .....
```

[4]

(ii) Write a delay loop in **pseudocode** for lines `12` and `13` of the pseudocode algorithm.

.....

.....

..... [2]

(c) If a sensor reading is out of range, a bit is set in a memory location allocated to that floor. The addresses for the memory locations are `401` to `420`.
For example, memory location `401` is used to store the status of the sensors 1 to 4 on floor 1, memory location `402` is used to store the status of the sensors 1 to 4 on floor 2.

The table shows data for some of the floors, with sensor 1 on floor 1 set, sensor 2 on floor 2 set and sensors 3 and 4 on floor 20 set.

Memory location	Bits								
					Sensor number				
					1	2	3	4	Floor
401	0	0	0	0	1	0	0	0	1
402	0	0	0	0	0	1	0	0	2
…	…	…	…	…	…	…	…	…	…
420	0	0	0	0	0	0	1	1	20

(i) The data in memory location `410` is shown.

410	0	0	0	0	0	1	0	1

State what this data represents.

.....

..... [2]

(ii) Explain the way in which the data from sensor 3 on floor 7 can be checked.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]