Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1055919570 3

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **May/June 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 **16** pages. Any blank pages are indicated.

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[Turn over

1 In a computer system, two real numbers, **A** and **B**, are stored using floating-point representation with:

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

Number A	**Mantissa**											**Exponent**			
	0	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**

Number B	**Mantissa**											**Exponent**			
	1	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**

(a) (i) Convert the binary values of the **mantissa** and the **exponent** for each number to their separate denary values.

A mantissa .....

.....

A exponent .....

.....

B mantissa .....

.....

B exponent .....

.....

[4]

(ii) Calculate the denary value of each floating-point number using your values from **part (a)(i)**.

Number A .....

.....

.....

Number B .....

.....

.....

[2]

(b) State which number, **A** or **B**, is stored in normalised floating-point form. Justify your answer.

Number .....

Justification .....

.....

.....

.....

[3]

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

(a) Write the correct descriptions for the **two** layers **and** the correct layers for the **two** descriptions given in the following table.

Layer	Description
Application	
Transport	
	Handles transmission of data
	Handles how data is physically sent

[4]

(b) Identify **and** state the purpose of **two** communication protocols other than TCP/IP.

Protocol 1 .....

Purpose .....

.....

.....

Protocol 2 .....

Purpose .....

.....

.....

[4]

3 **(a)** Describe, with the aid of a diagram, a bus topology network.

Description .....

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..... [3]

(b) Describe the way in which a bus network uses Ethernet technology for communication.

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..... [4]

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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	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
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	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

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

X = ... [2]

(ii) Complete the 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 loops around appropriate groups of 1s in the table in **part (a)(ii)** to produce an optimal sum-of-products. [2]

(iv) Write the simplified sum-of-products expression for your answer to **part (a)(iii)**.

X = ... [2]

(b) Simplify your expression for **X** in **part (a)(i)** using Boolean algebra. Show your working.

.....

.....

.....

..... [2]

5 Flip-flops are used in computer construction.

(a) Describe the role of flip-flops in a computer.

.....

.....

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.....

.....

..... [3]

(b) Describe the difference between an SR flip-flop and a JK flip-flop.

.....

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.....

..... [2]

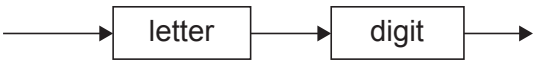
6 The syntax diagrams for a programming language show the syntax of:

- an assignment statement
- a variable
- an unsigned integer
- a letter
- an operator
- a digit

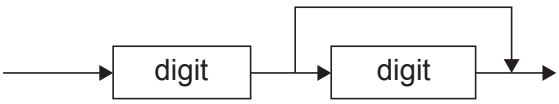
assignment statement



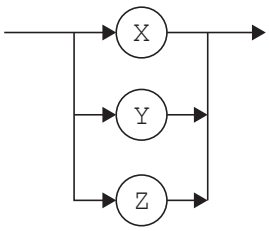
variable



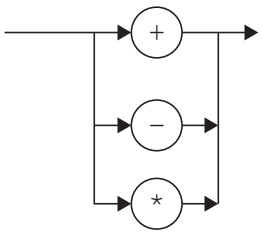
unsigned integer



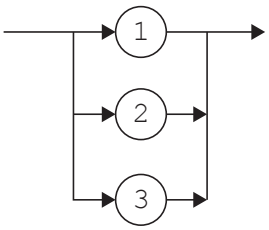
letter



operator



digit



(a) Give reasons why each of these statements is **invalid**.

```
X1 = Y - 21
```

.....

```
Y3 := Y3 + 1
```

.....

```
X1 = X2 * 7
```

.....

[3]

(b) Complete the Backus-Naur Form (BNF) for the syntax diagrams shown.
<letter> has been completed for you.

<letter> ::= X|Y|Z

<assignment_statement> ::=

.....

<variable> ::=

.....

<unsigned_integer> ::=

.....

<operator> ::=

.....

<digit> ::=

.....
[5]

(c) The syntax of an **assignment statement** is changed to allow for a variable or an unsigned integer before and after the operator.

(i) Draw an updated syntax diagram for the **assignment statement**.

[2]

(ii) Give the BNF for the revised **assignment statement** syntax.

.....

.....

.....

.....

..... [2]

7 **(a)** A digital certificate and a digital signature are used to ensure that a message is not changed during transmission.

Write an appropriate term in each space to complete the descriptions.

A digital certificate contains the ..... key of the owner. A digital certificate is obtained from the ..... .

Before a private message is sent to the owner of the digital certificate, this key is used to ..... the message.

A digital signature is also sent. The message is hashed to produce a ..... , which is then encrypted with the sender's ..... key to obtain the digital signature. [5]

(b) State **two** encryption protocols used in data transmission.

1 .....

2 .....
[2]

(c) Malware can harm computer systems.

Describe **two** methods that can be used to restrict the effect of malware.

.....

.....

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.....

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.....

.....

..... [4]

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8 Four greenhouses are used to grow tomatoes. The temperature inside each greenhouse should be kept between 10 and 20 degrees Celsius inclusive.
Each greenhouse has a temperature sensor.

A computer system is programmed to control each greenhouse's temperature by:

- turning on the heater and closing the ventilation when the temperature falls below 10 degrees
- turning off the heater and opening the ventilation when the temperature rises above 20 degrees.

(a) (i) State the name given to the type of system described.

..... [1]

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

.....

.....

.....

..... [2]

(b) The computer system stores the temperature readings for the four sensors in two's complement form and in four eight-bit memory locations with addresses `701` to `704`.

`701`	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**Greenhouse 1**
`702`	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**Greenhouse 2**
`703`	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**Greenhouse 3**
`704`	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**Greenhouse 4**

State the greenhouse number(s) where the temperature is out of range **and** give the value(s) of these temperature(s) in denary.

.....

.....

.....

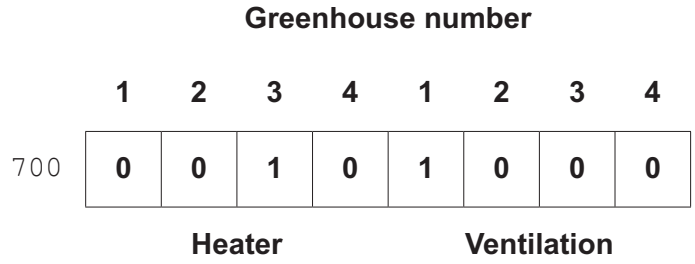
..... [2]

(c) The status of the heaters and the ventilation is shown at location `700`.

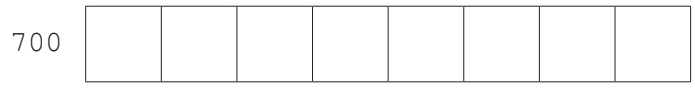
- A value of 1 means that the heater is on.
- A value of 0 (zero) means that the heater is off.
- A value of 1 means that the ventilation is open.
- A value of 0 (zero) means that the ventilation is closed.

The status of the heaters is shown in the most significant four bits; the status of the ventilation is shown in the least significant four bits.

The pattern of bits at location `700` shows that the heater for greenhouse 3 is on and the ventilation for greenhouse 1 is open.



Show the pattern of bits when the heater is on for greenhouses 1 and 2 only and no ventilation is open.



[1]

(d) The table shows assembly language instructions for the greenhouse computer system that has one general purpose register, the accumulator (ACC).

Instruction			Explanation
Label	**Op code**	**Operand**	
	`LDM`	`&n`	Load the hexadecimal number n to ACC
	`LDD`	`<address>`	Load the contents of the location at the given address to ACC
	`STO`	`<address>`	Store the contents of ACC at the given address
	`AND`	`&n`	Bitwise AND operation of the contents of ACC with the hexadecimal number n
	`LSL`	`#n`	Bits in ACC are shifted denary number n places to the left. Zeros are introduced at the right hand end
	`CMP`	`&n`	Compare the contents of ACC with the hexadecimal number n
	`JPE`	`<address>`	Following a compare instruction, jump to <address> or <label> if the compare was True
`<label>:`	`<op code>`	`<operand>`	Labels an instruction

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If the bit for a greenhouse's heater and the bit for the same greenhouse's ventilation are both set to 1, a routine at label `ERROR` is executed. This routine has not been provided.

(i) These assembly language instructions check for an error in the greenhouse 1 system.

```
LDD   700
AND   &88
CMP   &88
JPE   ERROR
```

Explain the purpose of each instruction.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Write the assembly language instructions to check for an error in the greenhouse 2 system.

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.....

..... [3]

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