Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6195603694

COMPUTER SCIENCE **9608/31**

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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1 In a particular 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**			
	1	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**

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

(a) (i) Identify whether each number is positive or negative. Justify your answer.

Number A .....

.....

Number B .....

.....

[2]

(ii) 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]

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

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	
	Handles forwarding of packets
Internet / Network	
	Handles how data is physically sent

[4]

(b) **(i)** Explain why communication protocols are necessary.

.....

.....

.....

..... [2]

(ii) Identify **and** describe **one other** communication protocol. State its purpose.

Protocol .....

Description .....

.....

Purpose .....

.....

[3]

3 Describe, with the aid of a diagram for each one, the bus and star network topologies.

Bus

Description .....

.....

.....

.....

.....

.....

Star

Description .....

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.....

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.....

[6]

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	1
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	1
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.

.....

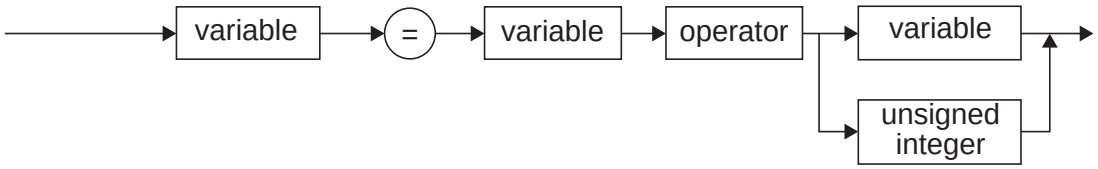
.....

..... [2]

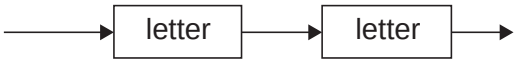
5 The following syntax diagrams for a programming language show the syntax of:

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

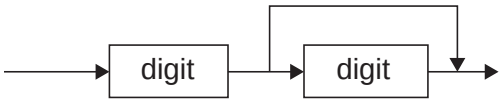
assignment statement



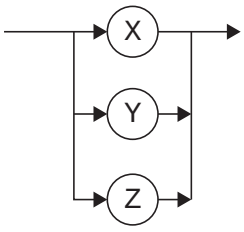
variable



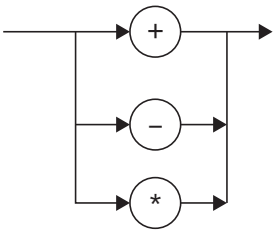
unsigned integer



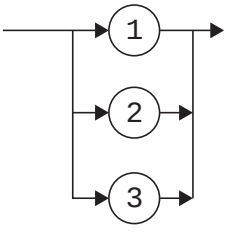
letter



operator



digit



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

```
X = XY + 21
```

.....

```
YZ := YZ * 3
```

.....

```
XY = XY - 5
```

.....

[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> ::=
```

.....

```
<digit> ::=
```

.....

```
<unsigned_integer> ::=
```

.....

```
<operator> ::=
```

.....

[5]

(c) The syntax of a **variable** is changed to allow one or two letters followed by zero, one or two digits.

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

[3]

(ii) Give the BNF for the revised **variable**.

.....

.....

.....

.....

..... [3]

6 Encryption is used to provide security when messages are transferred over a communication link.

(a) (i) Explain the way in which asymmetric key cryptography is used to encrypt a message being sent from one computer user to another over the Internet.

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.....

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.....

.....

.....

.....

..... [4]

(ii) State **two** benefits of using asymmetric key cryptography.

1 .....

.....

2 .....

.....

[2]

(b) (i) Explain the way in which Transport Layer Security (TLS) provides communication security over a computer network.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) State **two** situations where the use of TLS would be appropriate.

1 .....

.....

2 .....

.....

[2]

7 Four shipping containers are used to store goods on the dockside at a port. The temperature inside each container should be kept between 5 and 8 degrees Celsius inclusive.
Each container has a temperature sensor.

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

- turning on the heater and turning off the air conditioning unit when the temperature falls below 5 degrees
- turning off the heater and turning on the air conditioning unit when the temperature rises above 8 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 `301` to `304`.

`301`	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**Container 1**
`302`	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**Container 2**
`303`	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**Container 3**
`304`	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**Container 4**

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

.....

.....

.....

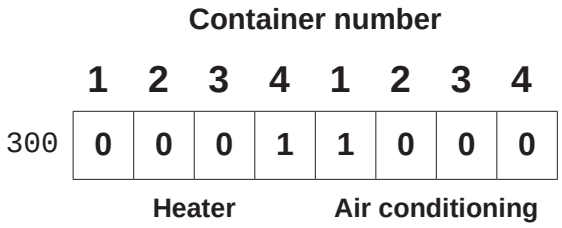
..... [2]

(c) The status of the heaters and the air conditioning units is shown at location `300`.

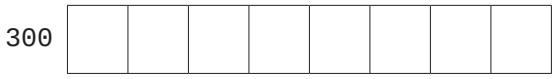
A value of 1 means that the device is on and a value of 0 (zero) means that the device is off.

The status of the heaters is shown in the most significant four bits; the status of the air conditioning units is shown in the least significant four bits.

The pattern of bits at location `300` shows that the heater for container 4 is on and the air conditioning unit for container 1 is on.



Show the pattern of bits when the heater is on for containers 1 and 2 and no air conditioning units are on.



[1]

(d) The following table shows assembly language instructions for the container 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

If the bit for a container's heater and the bit for the same container's air conditioning unit 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 container 1 system.

```
LDD 300
AND &88
CMP &88
JPE ERROR
```

Explain the purpose of each instruction.

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..... [4]

(ii) Write the assembly language instructions to check for an error in the container 4 system.

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..... [3]

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