



## Cambridge International AS & A Level

CANDIDATE  
NAME

CENTRE  
NUMBER

--	--	--	--	--

CANDIDATE  
NUMBER

--	--	--	--



**COMPUTER SCIENCE**

**9608/33**

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.

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	0	1	0
---	---	---	---

**Number B**

**Mantissa**

**Exponent**

0	1	1	1	0	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
<b>Application</b>	
	Handles forwarding of packets
<b>Internet/ Network</b>	
	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 .....

.....

.....

.....

.....

.....

[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.

		<b>PQ</b>			
		<b>00</b>	<b>01</b>	<b>11</b>	<b>10</b>
<b>RS</b>	<b>00</b>				
	<b>01</b>				
	<b>11</b>				
	<b>10</b>				

[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]

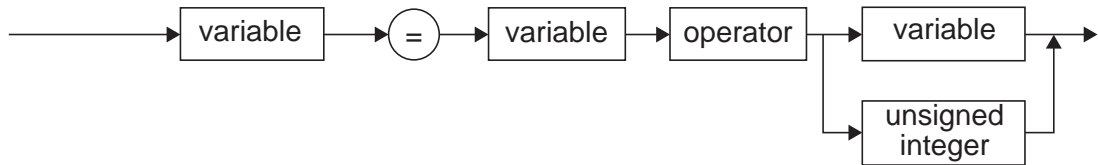
(b) Simplify your expression for **X** in **part (a)(i)** using Boolean algebra. Show your working.

.....  
.....  
..... [2]

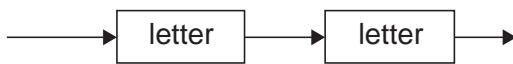
5 The following syntax diagrams for a programming language show the syntax of:

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

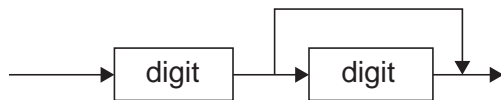
**assignment statement**



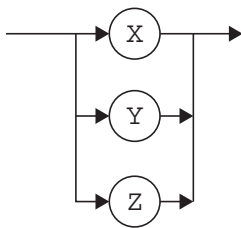
**variable**



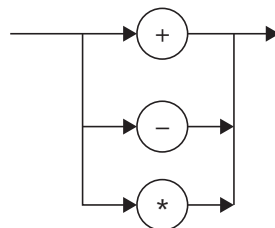
**unsigned integer**



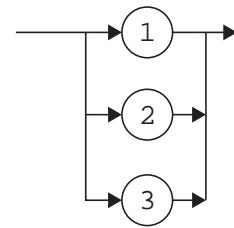
**letter**



**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.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [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.

		<b>Container number</b>							
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
300	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
		<b>Heater</b>				<b>Air conditioning</b>			

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

300									
-----	--	--	--	--	--	--	--	--	--

[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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

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

.....

.....

.....

.....

.....

.....

..... [3]

**BLANK PAGE**

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.