Cambridge International AS & A Level

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CANDIDATE NAME

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2326710888

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2019**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **13** printed pages and **3** blank pages.

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1 Real numbers are stored using floating-point representation in a computer system.

This representation uses:

- 8 bits for the mantissa, followed by
- 4 bits for the exponent.

Two's complement form is used for both the mantissa and the exponent.

(a) (i) A real number is stored as a 12-bit normalised binary number as follows:

Mantissa								Exponent			
0	1	0	1	0	0	1	0	0	0	1	0

Calculate the denary value for this binary number. Show your working.

Working .....

.....

.....

Denary value .....

[3]

(ii) Calculate the normalised binary number for –3.75. Show your working.

Mantissa								Exponent			

Working .....

.....

.....

.....

[3]

(b) The number of bits available to represent a real number is increased to 16.

State the effect of increasing the size of the exponent by 4 bits.

.....

..... [1]

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(c) State why some binary representations can lead to rounding errors.

.....

..... [1]

(d) Complete the following descriptions by inserting the **two** missing terms.

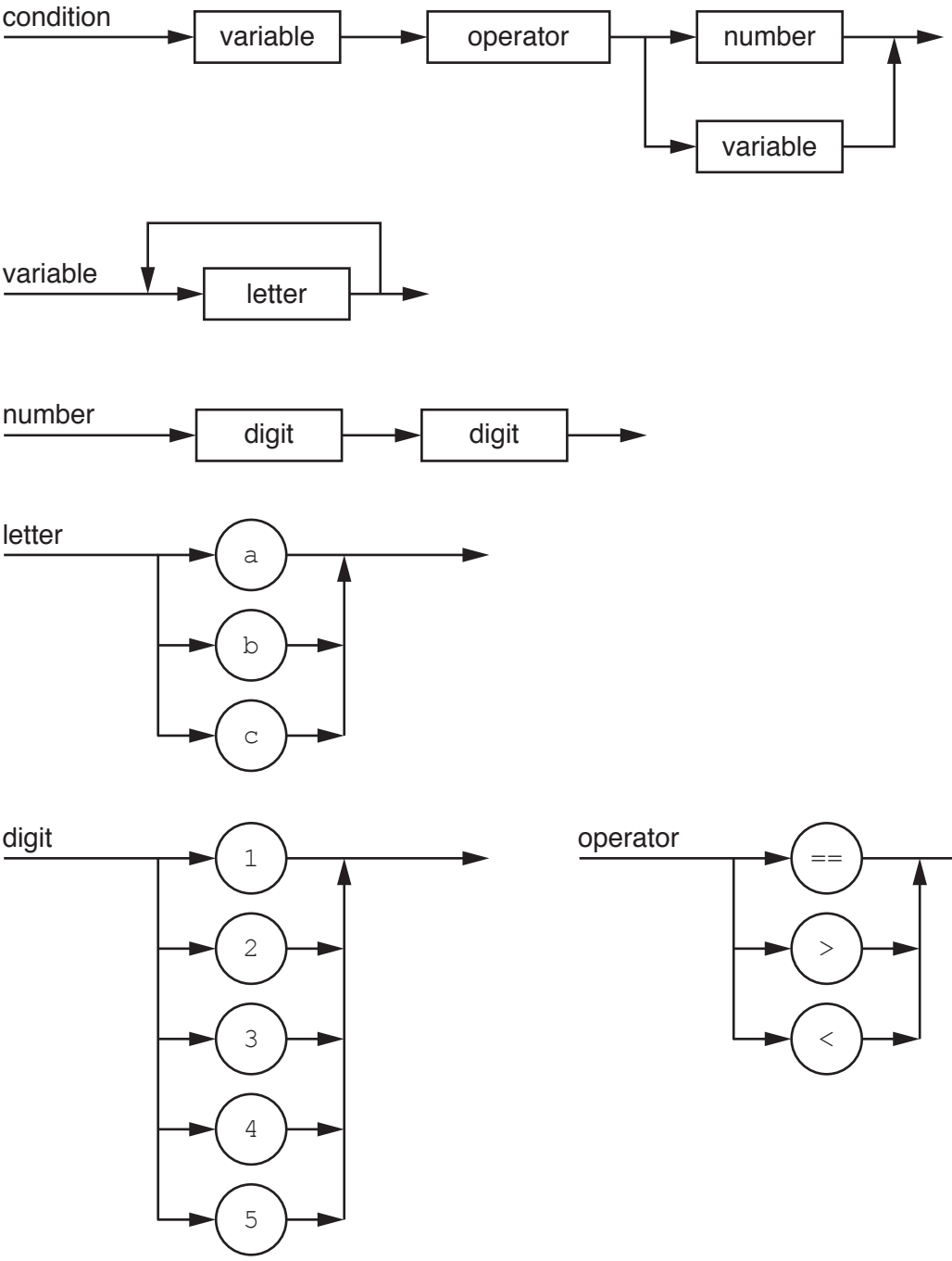
..... can occur in the exponent of a floating-point number, when the exponent has become too large to be represented using the number of bits available.

A calculation results in a number so small that it cannot be represented by the number of bits available. This is called ..... .

[2]

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

- a condition
- a variable
- a number
- a letter
- a digit
- an operator



(a) The following conditions are invalid.

Give the reason in each case.

(i) `35 > 24`

Reason .....

..... [1]

(ii) `abc := cba`

Reason .....

..... [1]

(iii) `bc < 49`

Reason .....

..... [1]

(b) Complete the Backus-Naur Form (BNF) for the syntax diagram.

<operator> ::= .....

.....

<number> ::= .....

.....

<variable> ::= .....

.....

<condition> ::= .....

.....

[6]

3 Protocols are essential for communication between computers.

(a) Explain why protocols are essential for communication between computers.

.....

.....

.....

.....

..... [2]

(b) A protocol used in bus networks is CSMA/CD.

Explain what is meant by **CSMA/CD**.

.....

.....

.....

.....

.....

.....

.....

..... [4]

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4 A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

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

X = ... [2]

(b) Complete the Karnaugh Map (K-map) for the truth table above.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

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

(c) Draw loops around appropriate groups in the K-map in **part (b)** to produce an optimal sum-of-products. [2]

(d) Write, using your answer to **part (c)**, a simplified sum-of-products expression for the truth table.

X = ... [2]

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5 **(a)** Explain why user-defined data types are necessary.

.....

.....

.....

..... [2]

(b) An organisation stores data about its employees.

- Employee ID is a five-digit number, for example, 01234.
- Employee name is a string, for example, 'Kiri Moana'.
- Department is one of three values: Sales, Technical, Customer services.
- Salary is an integer value in the range 25 000 to 150 000.

(i) Complete the following **pseudocode** definition of a user-defined data type to store the employee data.

```
TYPE Employee

  DECLARE EmployeeID   :  .....
  DECLARE EmployeeName :  STRING
  DECLARE Department   :  ( .....
                             .....)
  DECLARE Salary       :  25000..150000
```

.....

[4]

(ii) Write a **pseudocode** statement to declare a variable, `NewEmployee` of data type `Employee`.

.....

..... [1]

(iii) Write a **pseudocode** statement that assigns `02244` to the `EmployeeID` of `NewEmployee`.

.....

..... [1]

(iv) `Employee` is an example of a record that is a composite data type.

State **two** other composite data types.

1 .....

2 .....

[2]

6 **(a)** An operating system (OS) uses a memory management technique called paging.

Explain what is meant by the following terms.

Page .....

.....

.....

Page frame .....

.....

.....

Page table .....

.....

..... [3]

(b) Explain why an operating system needs to use scheduling algorithms.

.....

.....

.....

.....

.....

..... [3]

(c) State what is meant by an **interrupt**.

.....

..... [1]

(d) For a computer system using multi-programming, the low-level scheduler decides which process will get next use of the processor.

One algorithm could be a round-robin, which means every process gets use of the processor in sequence for a fixed amount of time (time-slice).

For a round-robin algorithm, five processes are currently loaded and get the use of the processor in the sequence:

JOB21 – JOBSS – JOBPT – JOB32 – JOB42, then return to JOB21

Process JOB32 has just completed its time-slice.

The following paragraph describes what happens next. Complete the paragraph by inserting the missing processes.

Interrupt received from the low-level scheduler. Save all register contents for

..... .

Copy the saved registers for ..... to the CPU.

The processor will now process ..... .

[3]

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7 **(a)** Identify the **four** layers of the TCP/IP protocol suite.

1 .....

2 .....

3 .....

4 .....

[4]

(b) The TCP/IP protocol suite is responsible for transmitting data across the Internet using packet switching.

(i) Explain why packet switching is used when sending data across the Internet.

.....

.....

.....

..... [2]

(ii) Each packet requires a header.

Describe the purpose of a packet header.

.....

.....

.....

..... [2]

(iii) Identify **three** items that should be contained in a packet header.

Item 1 .....

.....

Item 2 .....

.....

Item 3 .....

.....

[3]

8 Digital certificates are used in internet communications. A Certificate Authority (CA) is responsible for issuing a digital certificate.

(a) Identify **two** data items present in a digital certificate.

1 .....

2 .....

[2]

(b) The following paragraph describes how a digital signature is produced. Complete the paragraph by inserting an appropriate term in each space.

A ..... algorithm is used to generate a message digest from the plain text message. The message digest is ..... with the sender's ..... .

[3]

9 **(a)** The following incomplete table shows descriptions relating to computer architectures.

Complete the table by inserting the appropriate terms.

	Description	Term
A	• There are several processors. • Each processor executes different sets of instructions on one set of data at the same time.	.....
B	• The processor has several ALUs. • Each ALU executes the same set of instructions on different sets of data at the same time.	.....
C	• There is only one processor. • The processor executes one set of instructions on one set of data.	.....
D	• There are several processors. • Each processor executes a different set of instructions. • Each processor operates on different sets of data.	.....

[4]

(b) State **three** characteristics of massively parallel computers.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

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