Diploma Programme
Programme du diplôme
Programa del Diploma

Computer science
Higher level
Paper 1

2 May 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours 10 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer all questions.
- The maximum mark for this examination paper is **[100 marks]**.

9 pages

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Section A

Answer **all** questions.

1. Identify **two** features of an application interface. [2]

2. (a) Outline the purpose of secondary memory. [2]

   (b) Describe a situation when secondary memory would be used as an extension of primary memory. [2]

3. Outline **two** possible hardware upgrades to improve a desktop computer's performance. [4]

4. Describe **two** advantages of using surveys to determine user requirements for updating a computer system. [4]

5. Construct a truth table for the following expression:

   X = NOT A OR B AND C OR NOT B [4]

6. Identify **two** methods of implementing a new computer system. [2]

7. Describe the role of a DNS server. [2]

8. Explain **one** reason why a virtual private network (VPN) might be used. [3]

Section B

Answer **all** questions.

9. An architect uses a single computer for her business. She uses hand-drawn sketches to present her ideas to clients and computer-aided design (CAD) software to create construction projects, alterations, and redevelopments.

(a) (i) State what is meant by CAD software. [1]

(ii) Outline **two** benefits for the architect of using CAD software. [4]

The architect often creates large graphic files that are sent via the internet.

(b) Explain the need for data compression software in storing and transferring these large graphic files. [3]

Data loss can cause downtime, which can force the architect to pause business operations.

The impact on productivity depends on the amount of data lost as well as the time it takes for data recovery.

(c) (i) Describe how the architect could minimize downtime if the disk system on her computer fails. [3]

(ii) Outline **two** causes of data loss **other than** hardware failure. [4]

10. A school has a local area network (LAN) with a central server that stores many files containing personal, health, and financial information.

The LAN is used by the following types of user: network administrators, teachers, students and guests.

(a) Explain how the different levels of access for the users of this LAN could be implemented. [6]

(b) (i) Suggest **one** communications link that would provide high-speed internet access for the school. [2]

(ii) Suggest **two** measures to protect the school's LAN from external network security threats. [4]

The school gives students and teachers their own school email account.

(c) List **three** problems that might result from providing email access to all students and teachers. [3]

11. Each set of traffic lights in a city is controlled by a separate embedded system.

(a) (i) Describe what is meant by an embedded system. [2]

(ii) State **two** other examples of embedded systems in daily life. [2]

It has been proposed that all the traffic lights in the city should be controlled from a central computer.

(b) Discuss the advantages **and** disadvantages of using one central computer to manage the city's traffic light system. [4]

Vehicle counts provide the city's traffic control centre with information regarding the number of vehicles on the city's roads.

(c) List **two** types of sensor that could be used to collect data on the number of vehicles. [2]

(d) Describe **one** difference between interrupts and polling. [2]

The data about traffic and road conditions will be shared with application (app) developers. Their apps can provide real-time information about traffic conditions.

(e) Explain the benefit for drivers of having access to real-time information about traffic and road conditions. [3]

12. (a) Consider the following recursive function:

```
recfn(N)
    if N <= 0
        then
            return 0
        else
            if N mod 2 = 0
                then
                    return recfn(N-1) - N
                else
                    return recfn(N-1) + N
                endif
    endif
end recfn
```

Determine the value of variable X after execution of the following program statement:

```
X = recfn(5)
```

Show all your working. [5]

(This question continues on the following page)

(Question 12 continued)

(b) Describe **two** basic stack operations. [4]

The NUMBERS stack stores real numbers. An algorithm should be constructed that will find the smallest number and the largest number stored in the NUMBERS stack. After execution of the algorithm, **only** these two numbers should be stored in the NUMBERS stack (see **Figure 1**).

Figure 1: Example data stored in the NUMBERS stack before and after execution of the requested algorithm

The content in the NUMBERS stack **before** execution of the algorithm.

The number **23.0** is on the top of the NUMBERS stack.

23.0
–54.9
–12.4
67.0
15.2

The content in the NUMBERS stack **after** execution of the algorithm.

The smallest number, **–54.9**, is on the top of the NUMBERS stack.

–54.9
67.0

(c) Construct this algorithm in pseudocode.

You may assume that the NUMBERS stack already contains real numbers.

You must use the access methods of a stack. [6]

13. A team of four high-school students decided to create a computer program for younger students to help them learn to count and recognize whole numbers from 1 to 25.

A table partially completed with numbers from 1 to 25 is given to a younger student. The table consists of five rows and five columns (see **Figure 2**). The younger student must enter the remaining numbers. Each number from 1 to 25 should be entered only once.

Figure 2: Example table partially filled with numbers

	24	1		
		7	14	
4	6			22
10			21	3
11		25		9

Each of the four students is responsible for creating several sub-programs that will be included in the program.

(a) List **three** advantages of using sub-programs in this situation. [3]

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(Question 13 continued)

The sub-program `inputInRange()` should return a valid input number.

This will ensure that the younger student's input is a number in the range 1–25 inclusive. If the input number is not in this range, an appropriate message is output. The process will be repeated until a valid number is input.

For example:

For the sub-program call `N = inputInRange()`, if the following appears on the screen:

```
Enter a number:
32
The number is not in the range from 1 to 25. Please try again.
Enter a number:
0
The number is not in the range from 1 to 25. Please try again.
Enter a number:
15
Your number is valid.
```

Then the value of `N` would be 15 after execution.

(b) Construct an algorithm in pseudocode for the sub-program `inputInRange()`. [4]

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(Question 13 continued)

In the program, the table is stored as a static two-dimensional array.

Figure 3: Two examples of data

Figure 3a: The two-dimensional array is correctly completed because each of the numbers from 1 to 25 appears only once.

	[0]	[1]	[2]	[3]	[4]
[0]	2	24	1	8	15
[1]	23	5	7	14	16
[2]	4	6	13	20	22
[3]	10	12	19	21	3
[4]	11	18	25	17	9

Figure 3b: The two-dimensional array is not correctly completed because the number 17 is missing and the number 12 appears twice.

	[0]	[1]	[2]	[3]	[4]
[0]	**12**	24	1	8	15
[1]	23	5	7	14	16
[2]	4	6	13	20	22
[3]	10	**12**	19	21	3
[4]	11	18	25	2	9

The sub-program `isCorrectlyCompleted(MAT)` accepts the two-dimensional array `MAT` and outputs an appropriate message to indicate if it has been correctly filled.

For example:

If `MAT` is the two-dimensional array shown in **Figure 3a**, then `isCorrectlyCompleted(MAT)` should output that the table has been correctly completed.

If `MAT` is the two-dimensional array shown in **Figure 3b** then `isCorrectlyCompleted(MAT)` should output that the table has **not** been correctly completed.

(This question continues on the following page)

(Question 13 continued)

The description of the algorithm for the `isCorrectlyCompleted(MAT)` sub-program is as follows:

- Initialize a one-dimensional array, `FLAGS`, with zero (0) values.
- Visit all elements of the `MAT` array.
  - Use the number stored in the `MAT` array to match up the index in the `FLAGS` array.
  - Assign one (1) to the `FLAGS` array at that index.
- Inspect elements of the `FLAGS` array.
  - If all the elements in the `FLAGS` array are one (1), output a message saying that the table has been completed correctly; otherwise, output a message saying that the table has not been completed correctly.

For example, the `FLAGS` array for the `MAT` array shown in **Figure 3a** is:

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

And the `FLAGS` array for the `MAT` array shown in **Figure 3b** is:

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**0**	1	1	1	1	1	1	1	1

(c) Construct the algorithm in pseudocode for the `isCorrectlyCompleted(MAT)` sub-program as described. [8]