Diploma Programme
Programme du diplôme
Programa del Diploma

Computer science
Higher level
Paper 1

Friday 28 October 2022 (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]**.

8822–7011

Section A

Answer **all** questions.

1. Outline the need for a translation process from a higher level language to a lower level language. [2]

2. A company is using a prototyping approach as part of their software development process.

(a) Outline **one** advantage of prototyping. [2]

(b) Outline **one** situation in which the use of a prototype is not the best approach. [2]

3. Define the Boolean operator XOR. [2]

4. A student posts images and videos on a public website of her friends at a party.

(a) Outline **one** ethical issue with the student posting these images and videos. [2]

(b) Outline **one** technical issue that may prevent the images and videos from being viewed. [2]

5. Each pixel on a computer screen has three colour values associated with it: red, green and blue. The range for each of the three colour values is from $0_{(10)}$ to $255_{(10)}$.

Colour values can also be represented in hexadecimal. For example, the colour blue can be represented in hexadecimal as 0000FF.

(a) State the binary representation of the colour blue. [1]

(b) State the number of colours that can be represented in each pixel on the computer screen. [1]

6. Define the term *variable*. [1]

7. Explain how increasing the size of the central processing unit (CPU) cache improves the performance of a computer. [3]

8. A computer science student is coding and running a program while several documents, such as essays, lab reports and homework, are being printed out.

(a) Define the term *queue* as a data structure. [1]

(b) Identify **two** different queues that are used in this scenario. [2]

9. Given the one-dimensional array NAMES:

[0]	Zixan
[1]	Murali
[2]	Eli
[3]	Kim

and the following recursive algorithm:

```
mystery(A, N)     // A is a one-dimensional array, N is an integer
    if N>0 then
        mystery(A, N-1)
    end if
    output(A[3-N])
end mystery
```

determine the output produced after execution of the following statement:

```
mystery(NAMES, 3)
```

Show all your working. [4]

Section B

Answer **all** questions.

10. A company has a local area network (LAN). Ethernet (a wired network) and WiFi (a wireless network) are the two ways to enable LAN connections.

The LAN is accessible to all employees through their personal accounts. At the office, employees can use either desktop computers for wired access to the LAN or personal laptops to connect wirelessly.

(a) Identify **one** additional hardware component in a wireless LAN. [1]

(b) Distinguish between a wired network and a wireless network in terms of reliability of transmission. [4]

(c) Outline why a wireless network may be less secure than a wired network. [2]

Employees who are not in the office can access the company's resources over the internet using a virtual private network (VPN).

(d) Outline **two** features of a VPN that make it secure. [4]

Packet switching is used for transmitting data.

(e) Explain how data is transmitted by packet switching. [4]

11. An international organization is moving its offices from Africa to Europe. All of its data will need to be moved to a new system.

(a) (i) Define the term *data migration*. [1]

(ii) Outline **two** issues that could arise concerning data migration. [4]

(b) Outline **two** aspects of change management that need to be considered, **other than** data migration. [4]

The organization will continue to maintain the legacy system.

(c) Explain **one** problem of maintaining legacy systems. [3]

(d) Explain why parallel running is an expensive changeover method. [3]

12. A company is planning to transform its office building into a smart building. Among other things, a smart building can control the opening and closing of its doors.

(a) Outline **two** other operations that can be controlled by a smart building. [4]

Sensors, processors and output transducers are vital components of a smart building. They play an important role in the collection and management of data.

(b) Explain how a smart building can control the opening and closing of all its doors. You should refer to sensors, processors and output transducers. [4]

An operating system has a significant role in a smart building system.

(c) (i) Identify **two** functions of this operating system. [2]

(ii) Suggest **one** technique this operating system might use to determine when a hardware device needs attention. [2]

(d) Explain why transforming the building into a smart building will be beneficial for the company. [3]

13. A list of students' names and test scores are written in a teacher's notebook in alphabetical order. The teacher uses an application that allows her to input all of the names and scores in the order they appear in her notebook. The application orders the scores from highest to lowest and then outputs all the names and scores (see **Figure 1**).

Figure 1: An example of the input and output of the application

Input:	**Output:**
Anna 56	Zara 90
Ava 47	Emma 87
Baker 24	Nolan 63
Emma 87	Anna 56
Nolan 63	Ava 47
Zara 90	Baker 24

The application:
- inputs the names and scores
- stores the input data in two arrays: `NAMES` and `SCORES` (see **Figure 2**)

Figure 2: The `NAMES` and `SCORES` arrays

`NAMES`	Anna	Ava	Baker	Emma	Nolan	Zara
	`[0]`	`[1]`	`[2]`	`[3]`	`[4]`	`[5]`
`SCORES`	56	47	24	87	63	90

For example, `NAMES[3]` holds the student's name (Emma), and her score (87) can be found in `SCORES[3]`.

The application also:
- sorts the input data in order of scores from the highest to the lowest by using a bubble sort algorithm.
- outputs the sorted data.

(a) (i) Describe the steps in the bubble sort algorithm that sorts the input data stored in the `SCORES` and `NAMES` arrays in order of scores. [5]

(ii) Identify **one** alternative sorting algorithm. [1]

A decision has been made to create a new application. It will use a binary tree as an alternative to the two arrays.

(b) Identify the components of a node in a binary tree. [3]

The input data will be inserted into the binary tree so that an inorder traversal of the binary tree would output all the students' names and scores, sorted from the highest to the lowest score.

(c) Describe the steps in this insertion process. [6]

14. An integer divisor of an integer, `N(N>0)`, is an integer greater than zero that divides `N` without leaving a remainder. The proper divisors of `N` are divisors of `N` other than `N` itself.

For example:

- The divisors of 10 are 1, 2, 5 and 10.
- The proper divisors of 10 are 1, 2 and 5.

`X(X>0)` and `Y(Y>0)` are two integers.

(a) Construct a logic expression that evaluates to `True` if `X` is a proper divisor of `Y` and to `False` otherwise. [2]

The subprogram `sumPD(N)` accepts an integer, `N(N>1)`, and returns the sum of all proper divisors of `N`. For example, `sumPD(16)` returns 15 (1 + 2 + 4 + 8 = 15).

(b) Construct an algorithm in pseudocode for the subprogram `sumPD(N)`. [3]

Every number can be classified as abundant, deficient, or perfect according to the following definitions:

A number is an **abundant number** if it is less than the sum of its proper divisors.
For example, 12 is an abundant number because 1 + 2 + 3 + 4 + 6 = 16, and 16 > 12.

A number is a **deficient number** if it is greater than the sum of its proper divisors.
For example, 9 is a deficient number because 1 + 3 = 4, and 4 < 9.

A number is a **perfect number** if it is equal to the sum of its proper divisors. For example, 28 is a perfect number because 1 + 2 + 4 + 7 + 14 = 28, and 28 = 28.

Assume that the two-dimensional array `MAT` holds positive integers.

An algorithm should be written that creates **three** one-dimensional arrays, named `ABUNDANT`, `DEFICIENT` and `PERFECT`, so that

- the array `ABUNDANT` holds all the abundant numbers of the two-dimensional array `MAT`
- the array `DEFICIENT` holds all the deficient numbers of the two-dimensional array `MAT`
- the array `PERFECT` holds all the perfect numbers of the two-dimensional array `MAT`.

(This question continues on the following page)

(Question 14 continued)

For example, if the 4 × 6 two-dimensional array MAT holds 24 positive integers, as follows:

	[0]	[1]	[2]	[3]	[4]	[5]
[0]	6	12	20	42	3	48
[1]	78	28	70	80	2	16
[2]	60	72	10	56	9	54
[3]	30	13	7	11	15	17

then the three arrays should be:

PERFECT

[0]	[1]
6	28

ABUNDANT

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
12	20	42	48	78	70	80	60	72	56	54	30

DEFICIENT

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
3	2	16	10	9	13	7	11	15	17

(c) Construct an algorithm in pseudocode to create the **three** one-dimensional arrays, ABUNDANT, DEFICIENT **and** PERFECT, as described.

You may assume that the two-dimensional array MAT is inputted and three one-dimensional arrays of sufficient size are initialized.

You should call the sumPD() subprogram in your algorithm. [10]