Diploma Programme
Programme du diplôme
Programa del Diploma

Computer science
Higher level
Paper 1

Wednesday 4 May 2016 (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]**.

2216 – 7011

Section A

Answer **all** questions.

1. Outline **one** problem of maintaining legacy systems. [2]

2. Outline the use of a failover system. [2]

3. Describe the function of the control unit (CU) in the central processing unit (CPU). [2]

4. Construct the truth table for the following expression.

A XOR (B OR C) [3]

5. In an 8-bit register, state the binary representation of the hexadecimal number 3B. [2]

6. The following list of numbers needs to be put into ascending order.

9 , 11 , 3 , 4 , 5 , 7 , 1 , 2

State the list that would be obtained after **two** iterations of a bubble sort. [1]

7. Outline why a virtual machine is an example of abstraction that is particularly useful when testing software on different platforms. [3]

8. Explain, in terms of resources, how Voice over IP provides a collaborative working environment for a company with multiple locations nationwide. [3]

9. Explain **two** functions that an operating system needs to perform in relation to multitasking. [4]

10. Discuss **one** ethical consideration of using CCTV in a workplace. [3]

Section B

Answer **all** questions.

11. An examination office of a university must securely store students' examination papers and their grades. The office keeps the documentation of past students for two years. After two years the office only stores the student grades. All documentation of current students is frequently accessed for other operations and the volume of the data increases quickly.

To better support its operations, the office is creating a new system to provide this storage.

(a) Identify **two** aspects of the data that need to be taken into account during the planning of the new system. [2]

(b) Describe how direct observations on the current system may provide information to help propose a suitable new system. [3]

A prototype of the new system is created to present to the examination office.

(c) Describe the purpose of this prototype. [3]

The examination office needs to upgrade the computing resources for their operations, and this will require data migration.

(d) Discuss **two** possible problems that may occur during data migration. [4]

(e) Outline **one** economic aspect that the examination office needs to take into account to support parallel running. [3]

12. A college has a high-speed network. The network is accessible to all students and staff through their personal accounts.

The network may be accessed by using desktop computers available in the college. When in the college, users can also use personal laptops to connect wirelessly or dock with an Ethernet cable. When not in the college, users can connect via a virtual private network (VPN) over the internet.

(a) In the given context, distinguish between Ethernet and wireless in terms of **reliability** of transmission. [4]

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

(c) State **one** technology that is necessary for a VPN. [1]

The college is devising a policy for the use of its IT resources and services. They are considering prohibiting the use of external services such as cloud storage and blogs.

(d) In relation to the specific activities that may be carried out by students, discuss **two** advantages and **two** disadvantages of the use of external services. [6]

13. A car park has two barriers. One barrier is at the entrance, where tickets are **issued**, and one barrier is at the exit, where paid tickets are **checked** when cars leave. A display at the entrance, showing the current availability of spaces in the car park, is updated as tickets are **issued** and **checked**.

The actions of issuing, paying and checking a ticket operate on the collection of objects, `TICKETS`, that is organized as a linked list. Each object holds the following information:

`Nr`: ticket number (a progressive unique identifier)
`Date`: date of issue
`Arrival`: time of issue (in 24-hour format)
`PaidOn`: date of payment
`PaidAt`: time of payment (in 24-hour format).

(a) Describe how a linked list is a suitable data structure for the given scenario. [2]

When a car arrives and the car park is not full, a ticket is issued, the entrance barrier is raised and the display is updated.

Payment of a ticket at a machine updates both the ticket and its object representation held in the linked list. The car must exit the car park within 10 minutes.

At the exit barrier the ticket is checked, and this makes the barrier rise and updates the display.

(b) For the given scenario, identify:

(i) **one** example of two processes that could occur concurrently [1]

(ii) **one** example of two processes that could **not** occur concurrently. [1]

(c) State the condition that needs to be checked on the ticket when a car leaves the car park. [1]

A car arrives at the entrance barrier while another car is at the exit barrier.

(d) Explain the order in which the operations for raising the barriers and updating the display should be performed, to ensure a correct and efficient management of the car park. [3]

Upon payment, the `PaidOn` and `PaidAt` fields are populated in the corresponding object, without removing it from the linked list.

(e) Outline **one** implication of this choice of design in terms of efficiency. [2]

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(Question 13 continued)

The car park rules enforce a short-stay policy. Staying in the car park for up to 2 hours is allowed, and is subject to two possible **fees**. Staying in the car park for durations longer than two hours is subject to three possible **fines**, in addition to the original fee, up to a maximum price for each day. Tickets are paid in Euros (EUR).

The possible fees and fines are stored in a two-dimensional (2D) array, `RULES`.

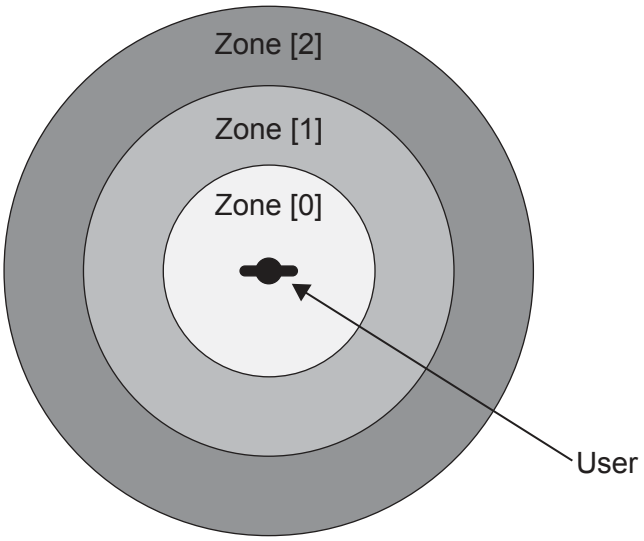
RULES		*Up to 30 minutes* ↓	*Up to 2 hours* ↓	*Maximum daily price* ↓
		[0]	[1]	[2]
Fees →	[0]	0.50 EUR	3.00 EUR	-------
Fines →	[1]	5.00 EUR	15.00 EUR	30.00 EUR

For example:

- staying in the car park for 40 minutes costs 3.00 EUR
- staying in the car park for 3 hours costs 3.00 + 15.00 = 18.00 EUR
- any stay in the car park that exceeds 4 hours costs 30.00 EUR
- a stay that spans two consecutive days, regardless of duration, costs 60.00 EUR.

(f) Construct the steps of an algorithm that calculates the amount that a ticket is to be charged. [5]

14. *LookUpLunch* is an app for a Smartphone that can be used to search for restaurants located in zones of increasing distance from the user's current position. The diagram shows the user and zones as they would appear on a map of the area.



A search in Norway produced the following table, `RESULTS`, which shows the number of restaurants in each zone. `RESULTS` also displays the average price for a meal, expressed in the local currency (Norwegian Krone, NOK).

RESULTS

	NOK 90	NOK 200	NOK 400
Zone [0]	3	10	7
Zone [1]	4	6	3
Zone [2]	2	3	1

(a) Using the table, state the total number of restaurants in the zone furthest from the user. [1]

(b) Suggest how the zones are calculated and displayed on the map using GPS based technology. [4]

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(Question 14 continued)

Another Smartphone app that is linked to *LookUpLunch* collects customers' reviews for restaurants.

A review consists of whether a customer *likes* the restaurant, and a rating of cheap (`C`), medium (`M`) or expensive (`E`). The app combines all of the reviews to produce a single letter rating (`C`, `M` or `E`) and a total number of *likes* for the restaurant.

As part of the internal representation of the app, the collection `LIKES` is used. Some of the data items contained in `LIKES` are shown below. Each individual data item is separated by a comma.

```
0,26,TomHus,M,1,14,GladLaks,E,2,1,MerPoteter,C,1,15,Linie,E,0,2,Mezze,M...
```

The restaurant GladLaks, underlined as an example, is located within zone [1]. Based on the reviews, this restaurant has 14 *likes* and is expensive.

(c) Construct an algorithm that outputs the name of the restaurant with the most *likes* in zone [1]. [5]

(d) By making use of binary trees and the collection `LIKES`, explain how a list could be produced that shows the restaurants in order of zone and then, within each zone, in order of popularity. [3]

Individual restaurants are able to use this app to see reviews from their customers.

(e) Describe **one** disadvantage of the use of feedback from social networking in relation to business. [2]

15. The letters F_0, F_1, F_2, …, F_N, …, where $N \geq 0$, are used to identify the Nth term of the sequence of Fibonacci numbers that starts as follows.

0 , 1 , 1 , 2 , 3 , 5 , 8 , 13 , …

With the exception of the leading 0 and 1 (the zeroth term and 1st term), the terms in the sequence are the sum of the two preceding terms. For example, F_5 is the 5th term of the sequence, which is 5, and is the sum of the 3rd and 4th terms, which are 2 and 3 respectively.

(a) State the value of the 8th term in the sequence. [1]

The following method, `fibo(N)`, generates the `N`th term in the sequence. The `return` statement returns the value that the method generates.

```
fibo(N)
  if (N=0 OR N=1) then
    return N
  else
    return (fibo(N-1) + fibo(N-2))
  end if
```

(b) Trace `fibo(4)`, showing the different levels of recursion. [3]

(c) Construct a non-recursive algorithm to generate Fibonacci numbers. [6]

(d) Construct an algorithm that will **output** the first `N` terms of the sequence. You should use `fibo()`, the method defined above. [3]

Recursive programs written in high level languages require the use of particular structures to support their execution.

(e) Describe how a stack is usually employed in the running of a recursive algorithm. [2]