Diploma Programme
Programme du diplôme
Programa del Diploma

Computer science
Standard level
Paper 1

Wednesday 4 May 2016 (afternoon)

1 hour 30 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 **[70 marks]**.

2216 – 7014

Section A

Answer **all** questions.

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

2. Explain what is meant by user acceptance testing. [2]

3. Discuss **one** advantage and **one** disadvantage of printed material, when compared to online support, as a method to provide user documentation. [4]

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

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

6. Describe how the cache memory can speed up the functioning of a processor. [2]

7. Outline **one** feature of the operating system that needs to be considered when running a game application. [2]

8. Construct the truth table for the following expression.

A XOR (B OR C) [3]

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

10. Trace the following fragment, for `N=139` and `L=3`, by **copying** and completing the trace table given below.

```
D = N div L
Z = 1
B = false

loop while Z<L
  D = D div L
  Z = Z+1
  B = NOT B
end loop
if (D ≠ 0 AND B) then
  output(D, B)
else
  output(Z, NOT B)
end if
```

D	Z	B	Z<L ?	output
…	…	…	…	…

[4]

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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 local charity organizes a half-marathon to raise money. The rules to participate in the half-marathon are as follows:

- The organizers limit the total number of participants to 450
- Participants belong to a team and each team must have at least three and at most five participants
- Each participant registers for the event independently from the other members of their team, and they all declare their team name when registering
- For scoring, the team's final time is the sum of the times of its three fastest participants. Participants that do not cross the finishing line within 2 hours after the start, are assigned a default time of 1000 minutes. The **winning team** is the team with the smallest sum total.

During registration, an array, `PARTICIPANTS`, with 450 positions is used to hold the abbreviated team names that are declared by each participant. Simultaneously, a collection `TNAMES` is generated: any **new** team name that is declared is added to the collection.

(a) State the minimum size of `TNAMES` to ensure the names of all potential teams can be stored. [1]

Part of the array `PARTICIPANTS` is shown below, where, for example, the first participant declared that they are part of team `TK`. The initial part of the collection `TNAMES` is also shown, with arrows indicating the direction of growth.

PARTICIPANTS

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	...
TK	W	AC	TK	W	TK	AC	W	TK	TK	AC	QA	AC	W	AC	...

TNAMES

Both `PARTICIPANTS` and `TNAMES` are used to construct the array, `TEAM`, that groups all participants who belong to the same team. Part of the array `TEAM` is shown below.

TEAM

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	...
3	4	6	5	7	8	10	13	9	0	12	73	14	15	2	...

In `TEAM`, each **element** is related to one other **index** in the array, shown by the arrows on the above diagram. This relation will eventually form a closed path (for this example 0, 3, 5, 8, 9 and back to 0). The relation reflects the information in `PARTICIPANTS`, by grouping people who declared the same team name during registration.

Hence, participants 0, 3, 5, 8 and 9 are on the same team and, from `PARTICIPANTS`, that team is `TK`.

(This question continues on the following page)

(Question 13 continued)

(b) Identify the position in PARTICIPANTS of the second participant that registered for team QA. [1]

Part of the algorithm that generates the TEAM array is shown below, in pseudocode.

```
//Input PARTICIPANTS array, TNAMES collection
TEAM    // array with 450 positions, initialized to '999'
CURRENT // variable to store current name of team;
T, P    // variables to store the indexes of TEAM and PARTICIPANTS,
        // respectively;
MINP    // stores the first index P of members of the CURRENT team;

TNAMES.resetNext()
loop while TNAMES.hasNext()
       CURRENT = TNAME.getNext()
       T = 0; P = 0; MINP = 0    // variables' initialization
       //*
       //* Code to be completed in part (c)(i)
       //*
       //* Code to be completed in part (c)(ii)
       //*
end loop
output TEAM
```

(c) In order to complete this code, and return the correct TEAM array,

(i) construct pseudocode to find MINP, the first index in PARTICIPANTS of the CURRENT team, and use it to start the construction of TEAM [3]

(ii) construct pseudocode to find the other participants belonging to the CURRENT team, implementing the idea of the closed paths in the TEAM array. [4]

As part of the program to determine the winning team, an array, TIMING, is maintained in parallel to PARTICIPANTS. For example, TIMING[5] and PARTICIPANTS[5] relate to the same participant.

TIMING is initialized to zero before the race starts, and updated with the finishing times for each participant. The algorithm sum3best is able to output the sum of the three fastest times from any group of times that are passed to the algorithm.

(d) Describe the steps of an algorithm that will find the **winning team**, as defined by the marathon rules on page 6. Clearly mention the use of existing or of new data structures. [6]