Diploma Programme
Programme du diplôme
Programa del Diploma

# Computer science
# Higher level
# Paper 1

Friday 4 November 2016 (afternoon)

2 hours 10 minutes

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**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]**.



8816 – 7011

## Section A

Answer **all** questions.

**1.** State **three** potential usability issues with cell phones. [3]

**2.** (a) State the purpose of cache memory. [1]

(b) Draw a diagram to show the relationship between random access memory (RAM), the processor and cache memory. [1]

**3.** Outline **one** advantage and **one** disadvantage of wireless networks. [4]

**4.** Construct a truth table for the Boolean expression NOT (A XOR B) AND C.
Use the following headings in your table.

| A | B | C | A XOR B | NOT (A XOR B) | NOT (A XOR B) AND C |
|---|---|---|---|---|---|
| | | | | | |

[4]

**5.** Many different people and organizations upload scientific materials to the internet. A student uses data from the internet in a science project.

Outline **two** ethical issues concerning this use of the internet. [4]

**6.** Consider the following recursive algorithm `FUN(X, N)`, where `X` and `N` are two integers.

```
FUN(X, N)
if N<=0 then
  return 1
else
  return X*FUN(X, N-1)
end if
```

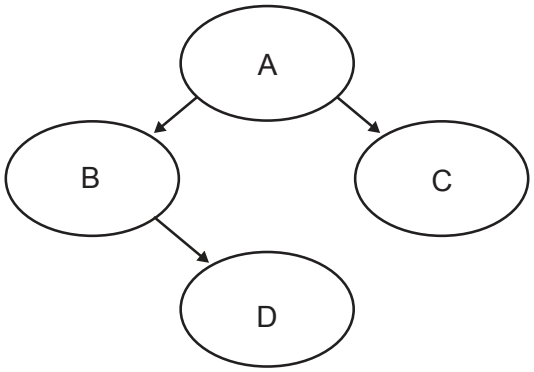
The `return` statement gives the value that the algorithm generates.

(a) Determine how many times multiplication is performed when this algorithm is executed. [1]

(b) Determine the value of `FUN(2,3)`, showing all of your working. [3]

(c) State the purpose of this recursive algorithm. [1]

**7.** Consider the following binary tree.




(a) Identify all leaf nodes in this binary tree. [1]

(b) For this binary tree, state the result of:

(i) inorder tree traversal, [1]

(ii) postorder tree traversal. [1]

## Section B

Answer **all** questions.

**8.** A book shop has a computer at each point of sale, and also a central computer.

When a customer buys a book in the book shop, the salesperson at the point of sale uses a scanning device to input a barcode from the book.

The barcode is sent to the central computer where the barcode of each book and the corresponding price are held in a database on a disk.

When the price is found, it is sent to the point of sale computer where all necessary calculations are performed, details of the transaction are stored on a local disk and a receipt is printed out.

(a) Construct a system flow chart for the system described above. [5]

At the point of sale there are peripheral devices other than the scanning device and printer.

(b) Outline the purpose of **one** other possible peripheral device in this scenario. [2]

The customers can also buy books online. A customer can select a book, and then enter their name, address and credit card number. This data is stored on the book shop's central computer in a database of customer orders.

(c) Outline the purpose of protocols in transferring this data. [2]

(d) (i) Identify **two** sources of risk to personal data in this online system. [2]

(ii) State **two** measures that the book shop can take to address the risks identified in part (d)(i). [2]

(iii) Outline the consequences to the customer if their data is not adequately protected. [2]

**9.** A new higher level programming language is being developed.

(a) Identify **two** reasons why consistent grammar and syntax should be essential features of a higher level programming language. [2]

(b) Identify **two** features of a user interface that will allow application programmers to interact more easily with the programming language. [2]

(c) State **one** method of providing user documentation. [1]

Application programmers who use this programming language will be able to choose to use either an interpreter or a compiler.

(d) (i) Outline the need for an interpreter or a compiler. [2]

(ii) Describe **one** advantage to application programmers of having both an interpreter and a compiler available. [2]

One of the predefined sub-programs in the new language is `sumOdd()`. It accepts an integer `N` as input. If `N<=0` it outputs `-1`, otherwise it outputs the sum of the first `N` odd numbers.

For example:
`sumOdd(4)` outputs `16`, because 4 is not less than 0, and $1 + 3 + 5 + 7 = 16$.
`sumOdd(−3)` outputs `−1`, because −3 is less than 0.

(e) Construct, in pseudocode, the algorithm for `sumOdd()`. [4]

(f) Outline the need for predefined sub-programs and collections. [2]

**10.** The temperature, humidity, light levels and automatic watering of plants inside the greenhouses (glasshouses) of a garden centre are centrally monitored and controlled.

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

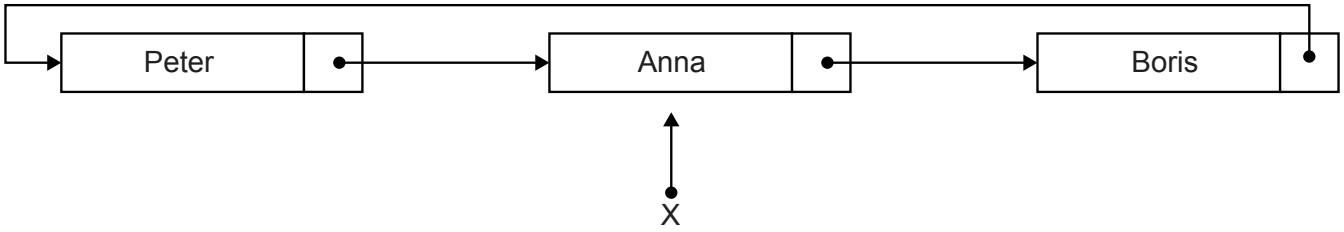
(b) With reference to sensors, transducers and the processor, explain the control process that takes place in the greenhouse (glasshouses). [5]

(c) Outline the role of the operating system specific to this scenario. [4]

(d) Describe the difference between polling and interrupt in the event that some of the sensors malfunction. [3]

(e) Compare a centrally controlled system with a distributed system. [2]

**11.** The diagram shows a list of names held in a circular linked list. The end of the list is pointed to by an external pointer, X.




(a) State the first name in this circular list. [1]

Two operations are performed on the list in the following order:
1. A node containing the name Sarah is inserted at the beginning of the list.
2. A node containing the name Ken is inserted at the end of the list.

(b) Sketch a diagram showing the resulting circular linked list. [3]

(c) Describe how the number of names held in this list could be determined. [4]

(d) Explain how a stack could be used to output, in reverse order, all names held in the linked list. [4]

(e) Compare the use of static and dynamic data structures. [3]

**12.** A two-dimensional array, `A`, has `N` rows and `N` columns, where `N` is a positive integer. The following algorithm is written to fill array `A` with the numbers 1, 2, 3,…, $N^2$.

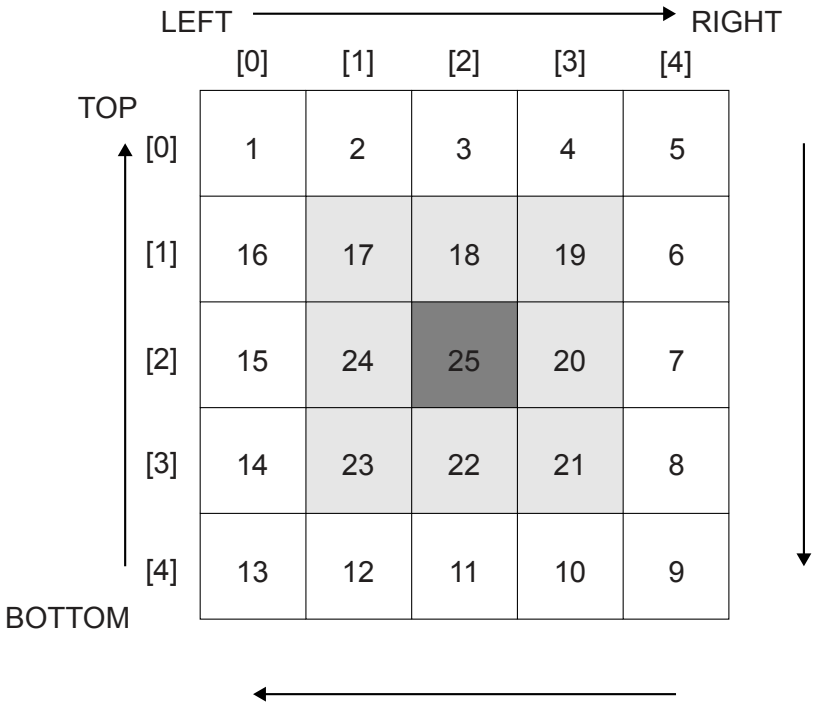
```
N=input('Enter an integer greater than zero')
K=N*N
loop for ROW=0 to N-1
  loop for COLUMN=0 to N-1
       A[ROW][COLUMN]=K
       K=K-1
    end loop
end loop
```

(a) Trace the algorithm, with an input of `N=3`, to show the contents of array `A` after the algorithm has been executed. [3]

**(This question continues on the following page)**

**(Question 12 continued)**

There are many different ways of placing the numbers 1 to $N^2$ into an $N \times N$ two-dimensional array. The following two-dimensional array, with dimensions $5 \times 5$ has been filled in a circular (spiral) pattern with numbers 1 to $5^2$.




The general process of filling an `N` × `N` two-dimensional array, in a circular (spiral) pattern, with numbers from 1 to $N^2$ could be described as follows:

- initialize `Z=1`,
- initialize `TOP`, `BOTTOM`, `LEFT` and `RIGHT`,
- iterate until the whole array is filled,
- each time `Z` is placed correctly increase the value of `Z` by `1`,
- fill the elements of the `TOP` row starting from `LEFT` to `RIGHT`,
- increase `TOP` by `1` before filling the elements of the `RIGHT` column,
- fill the elements of the `RIGHT` column starting from `TOP` to `BOTTOM`,
- decrease `RIGHT` by `1` before filling the elements of the `BOTTOM` row,
- and continue filling the `BOTTOM` row and `LEFT` column in a similar way, adjusting `TOP`, `RIGHT`, `BOTTOM` and `LEFT` accordingly.

(b) (i) State the initial values for `TOP`, `BOTTOM`, `LEFT` and `RIGHT`. [1]

(ii) State the consequence of not increasing `TOP` by `1` before starting to fill the elements of the `RIGHT` column. [1]

(iii) In the algorithm described above, state the indices (subscripts) of the first and the last element to be filled in the `BOTTOM` row. [1]

(c) Construct, in pseudocode, an algorithm to fill an `N` × `N` two-dimensional array, in a circular (spiral) pattern, with numbers from 1 to $N^2$ as described above. [9]