

Computer science
Higher level
Paper 1

Friday 4 November 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]**.

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.

```

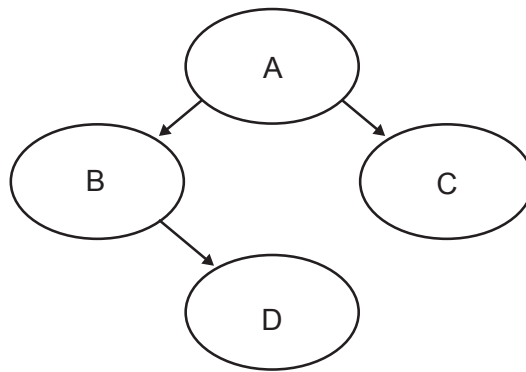
FUN(X, N)
if N<=0 then
  return 1
else
  return X*FUN(X, N-1)
end if

```

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 $N \leq 0$ it outputs -1 , otherwise it outputs the sum of the first N odd numbers.

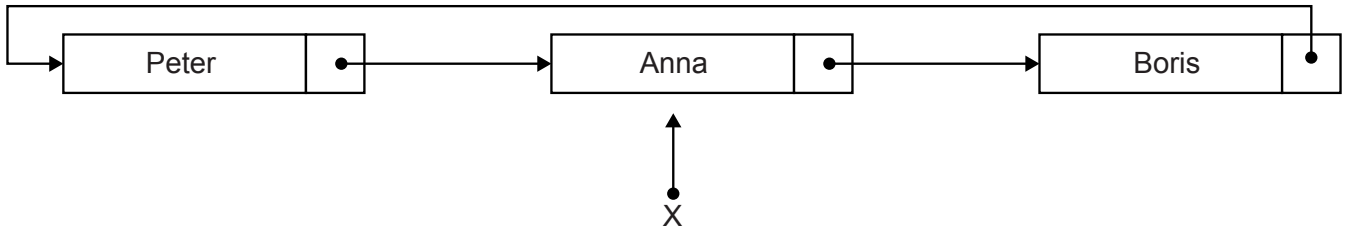
For example:

`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, ..., N².

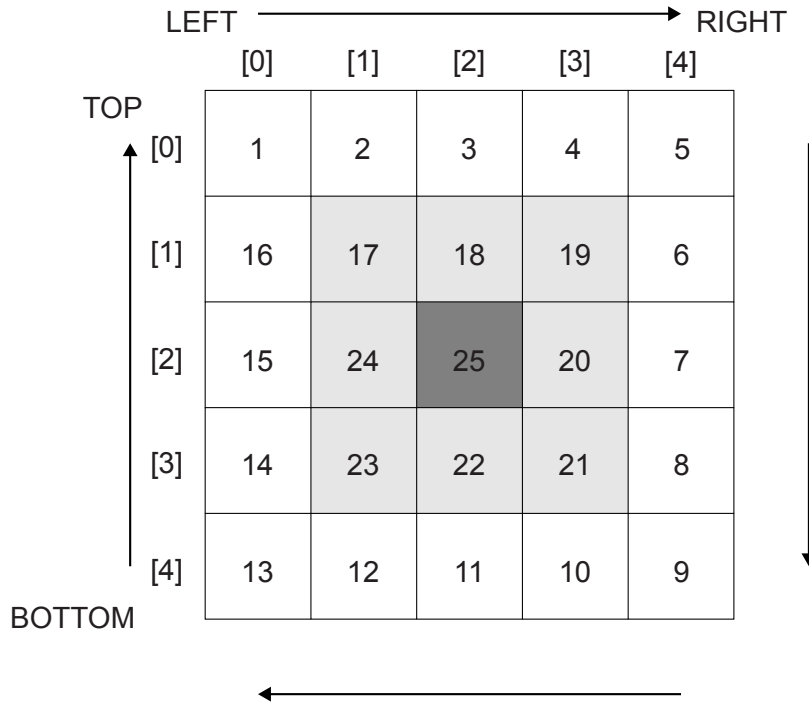
```
N=input('Enter an integer greater than zero')
K=N*N
loop for ROW=0 to N-1
  loop for COLUMN=0 to N-1
    A[ROW][COLUMN]=K
    K=K-1
  end loop
end loop
```

(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 5×5 has been filled in a circular (spiral) pattern with numbers 1 to 5^2 .



The general process of filling an $N \times N$ 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 $N \times N$ two-dimensional array, in a circular (spiral) pattern, with numbers from 1 to N^2 as described above. [9]