INTERNATIONAL BACCALAUREATE
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M01/650/H(2)

COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Thursday 3 May 2001 (morning)

2 hours 30 minutes

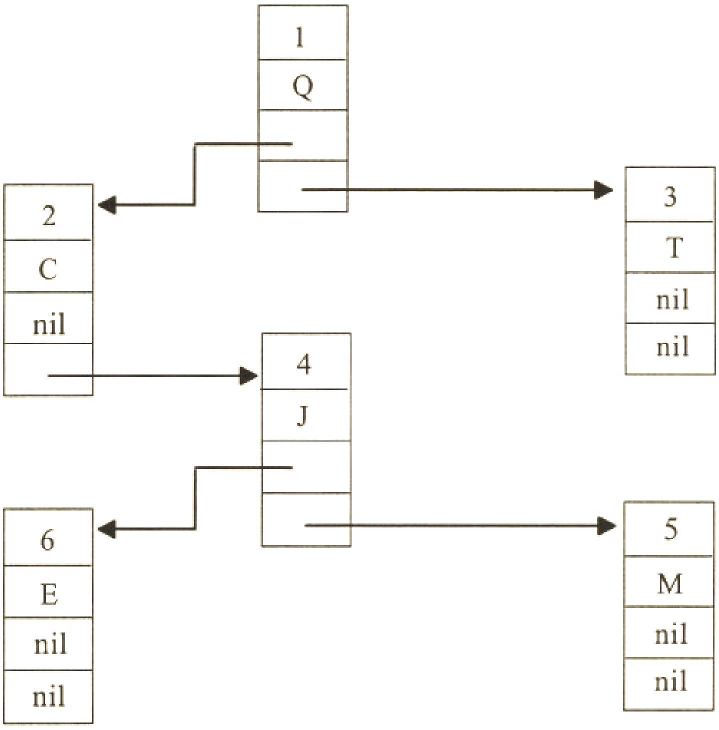
INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.

7 pages

1. Data is stored in a binary tree such that the first data item read is stored as the root, and subsequent data is added as a left link to a node if it is smaller than the node's data, or as a right link if it is not smaller.

For example, if the input data is Q, C, T, J, M and E; the following tree would be stored:



Where a record contains:

node number
data
left pointer
right pointer

that is:

```
newtype NODE record
                    NUMBER integer
                    DATA character
                    LEFT pointer->NODE
                    RIGHT pointer->NODE
            endrecord
```

(a) Draw the binary tree (using the same data type definition as above) for the data entered in the order of S, F, D then A. *[2 marks]*

(b) (i) Construct the algorithm to search for a data value (input by the user) and to output the node number if it is in the tree, or an error message otherwise. Assume that `ROOT` is a variable of type **pointer**->`NODE` and points to node 1. *[10 marks]*

(ii) State the Big-O efficiency of searching a fully balanced tree (equal number of right and left sub-trees) **and** a totally unbalanced tree (only right **or** left sub-trees). *[2 marks]*

(This question continues on the following page)

(Question 1 continued)

(c) The following algorithm traverses the tree using a stack to store pointers and data:

```
procedure TRAVERSE (val ROOT pointer->NODE)
    declare CURRENT pointer->NODE

    CURRENT<-ROOT
    INITIALISE /*Make stack empty*/

    repeat
      output CURRENT->DATA
      if CURRENT->RIGHT # nil then
         PUSH(CURRENT->RIGHT)
      endif

      if CURRENT->LEFT # nil then
         CURRENT<-(CURRENT->LEFT)
      else
         CURRENT<-POP
      endif

    until CURRENT = nil
endprocedure TRAVERSE
```

where `PUSH(DATA)` is a procedure to push the parameter onto the stack and `POP` is a function that pops (and returns) the top item from the stack.

(i) Trace the call `TRAVERSE(ROOT)` for the example data given at the start of the question, assuming that `ROOT` points to node 1, by copying and completing the following trace table:

output	STACK	CURRENT->NUMBER	CURRENT->DATA
	nil	1	Q
Q	3T,nil		

[9 marks]

(ii) State the traversal carried out by `TRAVERSE`. *[1 mark]*

(iii) Construct the recursive algorithm for `TRAVERSE`. *[6 marks]*

This question requires the use of the Case Study.

2. (a) Outline **one** example of how more powerful computers improve weather forecasting. *[2 marks]*

(b) State what archive data is and describe **one** purpose of keeping such data. *[3 marks]*

(c) Evaluate the use of modelling in weather forecasting. (Remember to include implications and limitations.) *[5 marks]*

(d) (i) State **one** situation in the Case Study where data is sent over a WAN. *[1 mark]*

(ii) Outline why data integrity is important in the sending of this data. *[2 marks]*

(e) Explain why computers are limited in their ability to predict the weather with absolute accuracy. *[4 marks]*

(f) Describe a specific fail-critical situation in weather forecasting, and describe how predicting such situations can be further improved. *[4 marks]*

(g) Identify **one** use of a standard protocol within the Case Study, and explain why standardisation is important. *[3 marks]*

(h) Identify and explain **two** reasons why the archived data is expected to be transferred to a new storage medium in the future. *[6 marks]*

3. A computer game uses a lot of graphics and the CPU needs to spend time to process this data without continually being interrupted by input from the user. Because the user's input is much slower than the computer's processor, input is queued and retrieved when the CPU is ready.

(a) Describe the data structures required to implement a queue using each of the following methods:

(i) linear implementation. *[2 marks]*

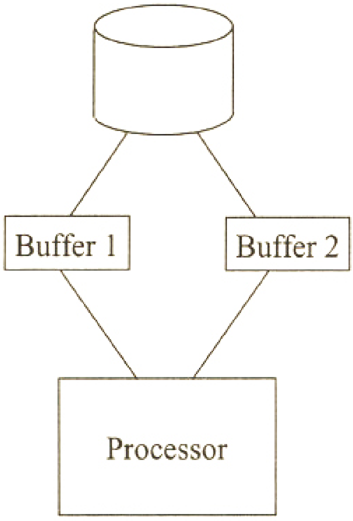
(ii) circular implementation. *[2 marks]*

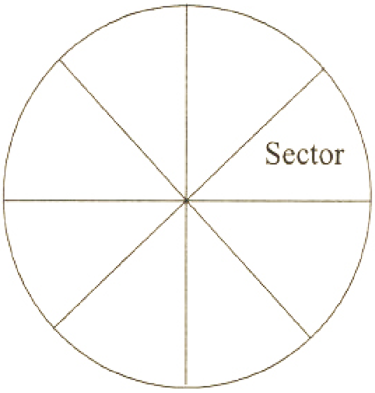
(iii) dynamic implementation. *[3 marks]*

(b) Compare the implementation of a queue using methods (a) (i) and (a) (ii). *[4 marks]*

(c) Explain **one** advantage of the implementation using (a) (ii) over (a) (iii) **and one** advantage of using (a) (iii) over (a) (ii). *[4 marks]*

4. When data is read from a disk, buffers are used:





When data is requested from a file on disk, the required block address is found using a fully-indexed organisation. The heads are moved to the required cylinder and sector.

If many blocks are read, a buffer cannot be emptied in the time it takes the end of one sector to pass under the head and the start of the next sector. Therefore, the next sector's data is transferred to a second buffer to reduce latency (rotational delay).

(a) Define the term *cylinder*. *[2 marks]*

(b) Outline why buffers are used in the transfer of data in a computer system. *[2 marks]*

(c) Explain how latency is reduced by using two buffers. *[3 marks]*

(d) Explain how, and why, DMA (Direct Memory Access) would be used in the situation above. *[6 marks]*

(e) State **two** differences between storing a file using a fully-indexed organisation and a file using a partially-indexed organisation. *[2 marks]*

5. In order to improve weather forecasting, software is continually being developed. A group of 50 software engineers are divided into teams to work on different projects. Each team consists of about 10 people.

(a) Describe how a manager makes sure that the work of all the teams fits together to create the required solution. *[3 marks]*

(b) (i) Explain why the test data would be prepared before any programs are completed. *[3 marks]*

(ii) Identify who would generate the test data. *[1 mark]*

(c) Discuss the implications of a changeover to a new implementation with regard to:

(i) installation. *[2 marks]*

(ii) training. *[2 marks]*

(iii) method of changeover. *[4 marks]*