



COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Friday 10 November 2000 (morning)

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

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

1. A programmer wants to save space on a disk by removing the comments from the source code of a programming language. In the language, comments start with two forward slashes //, and can be on a new line or after a programming statement (an "inline" comment).

An example is given below where comments are shown in bold. (All other statements are part of the programming language.)

```
<R>//Header
//Start of program

start
procedure foo//inline comment
//a comment that is on one line
:
:
```

The following is a procedure to find the comments in a program stored in a file, OLDFILE.

```
procedure FINDCOMMENT
  declare OLDFILE is string file
  declare LINE string
  declare POSITION integer
  declare COMMENT boolean

  open(OLDFILE)
  while not eof(OLDFILE) do
    input(OLDFILE) LINE
    POSITION <-- 1
    COMMENT <-- false
    while (POSITION < length(LINE)) and (not(COMMENT)) do
      if LINE[POSITION] = "/" then
        COMMENT <-- LINE[POSITION+1] = "/"
      endif
      POSITION <-- POSITION+1
    endwhile

    if COMMENT then
      output "Comment found"
    endif
  endwhile
  close(OLDFILE)
endprocedure FINDCOMMENT
```

(Recall that the function **length(S)** returns the length of characters in a string S. For example **length("this string")** would return 11.)

(This question continues on the following page)

(Question 1 continued)

- (a) Explain what the following lines in the algorithm do:

```

if LINE[POSITION] = "/" then
    COMMENT <-- LINE[POSITION+1] = "/"

```

[3 marks]

- (b) Construct the additional statements to copy the program from OLDFILE to another file, NEWFILE, without the comments, or any blank lines. For the example program, NEWFILE would start:

```

<R>
start
procedure foo
:
:

```

(You may find it useful to use the function `copy(S, START, COUNT)`, which extracts a substring from S. For example, `copy("healing", 4, 2)` would return "li".)

[7 marks]

- (c) Another procedure in the program stores the comments and their line numbers in a file, STYLE, in the format:

```

NNNNcomment

```

For example, the first four records for the example program would be:

```

0001Header
0002Start of program
0005inline comment
0006a comment that is on one line

```

Construct an algorithm which reads from STYLE and builds a linked list of line numbers and comments, by adding each record to the head of the list as it is read. The following record structure is used for each node in the list:

```

newtype NODE record
    NUMBER integer
    TEXT string
    NEXT pointer->NODE
endrecord

```

so that if there was a variable TEMP declared of the type `pointer->NODE`, `output TEMP->TEXT` would display the comment.

(You may assume that there is a function, CONVERT, which takes a four-character string of digits as a parameter, and returns the integer value. For example, `CONVERT("0005")` would return 5.)

[14 marks]

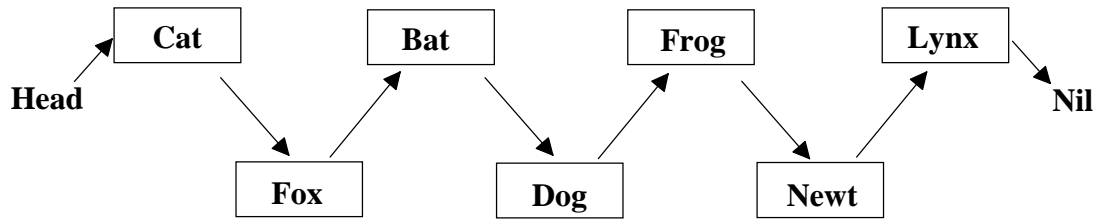
- (d) Construct the recursive algorithm to output the list created in (c) with the comments in the order that they were stored in STYLE.

[6 marks]

This question requires the use of the Case Study.

2. (a) (i) State why the PIN might be stored on the user’s card, rather than in a central database. *[1 mark]*
- (ii) Outline how the encrypted PIN on the card is used by the ATM. *[3 marks]*
- (b) Describe **one** advantage of using a graphical user interface rather than a command line interface at an ATM. *[2 marks]*
- (c) At the Bank “staff are consulted before the process of change is initiated”. Explain why some staff might view the consultation in a negative way. *[2 marks]*
- (d) State why a smartcard is used to store the details of a customer’s “eye-print”, rather than a magnetic stripe. *[1 mark]*
- (e) Suggest **two** reasons why some people may not like having extra information (such as medical information) along with their banking details on a smartcard. *[4 marks]*
- (f) Describe why the cheque transaction file is sorted. (As part of your answer describe the merge process.) *[5 marks]*
- (g) A customer requests a full statement from an ATM. The statement will be posted from Head Office. Draw the systems flowchart, including what data is required, for this option. *[6 marks]*
- (h) (i) Describe the connection of ATMs to the central mainframe by a polling method. *[2 marks]*
- (ii) Describe the connection of ATMs to the central mainframe by an interrupt method. *[2 marks]*
- (iii) Explain why the Bank uses the polling method to connect to ATMs from the central mainframe. *[2 marks]*

3. A linked list of data items can be implemented using two arrays. Consider the following linked list:



This list might be represented in two arrays as follows:

DATA	"Fox "	"Dog "	"Cat "	" "	"Bat "	"Lynx "	"Newt "	"Frog "
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
PTR	5	8	1		2	-1	6	7

The list also uses a variable, HEAD, that indicates the start of the list:

HEAD 3

- (a) Outline how the new item "Lion" could be inserted between "Dog" and "Frog". (You need not produce any pseudocode.) [4 marks]

- (b) Construct the algorithm called REMOVE that removes an item from the above list. The algorithm uses two parameters, the head of the list and the data item which is to be removed. (An example call is REMOVE (HEAD, "Dog") .

(You may assume that the data item passed for deletion is in the list, and that there is always more than one item in the list.) [7 marks]

- (c) Identify the limitations of implementing a linked list in this way, rather than using a dynamic data structure. [4 marks]

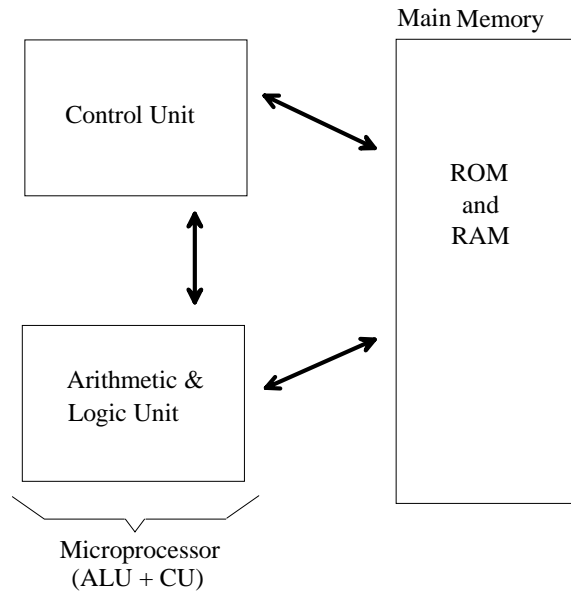
4. In a bank, the main file of customers' details uses a hash algorithm based on the account number to store and retrieve records. Transactions (for example, a customer paying in a cheque) are stored in a serial file. A backup of the transaction file is made by the bank.
- (a) Explain **one** method of updating the main file using the data in the transaction file at the end of each day. *[6 marks]*

 - (b) (i) State **one** situation when the backup file would be needed and describe how it would be used in this situation. *[3 marks]*

 - (ii) Describe how the backup file is maintained so that it can be used in the situation given in (b) (i). *[2 marks]*

 - (c) Explain how the main file can be used to print out all the customers' details in ascending order of account number. *[4 marks]*

5. The following is a simple diagram of a Central Processing Unit, which is part of a heating control system using 8 bits to store temperatures in two's complement form:



- (a) Explain why a processor with cache memory will execute a program faster than the same processor with no cache memory. *[4 marks]*
- (b) Outline the function of the ALU with reference to **one** arithmetic instruction and **one** logic instruction. As part of your answer, explain the role of the accumulator. *[6 marks]*
- (c) Outline **one** limitation (and its implication) of storing the heating control software in ROM. *[2 marks]*
- (d) State **one** purpose for RAM in the heating control system (assuming that all required software is in ROM). *[1 mark]*
- (e) Describe a method that will allow temperatures to be stored to two decimal places (for example, 17.27) rather than as integers. *[2 marks]*
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