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COMPUTER SCIENCE **9618/22**

Paper 2 Fundamental Problem-solving and Programming Skills **October/November 2022**

2 hours

You must answer on the question paper.

You will need: Insert (enclosed)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must **not** be used in this paper.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].
- No marks will be awarded for using brand names of software packages or hardware.
- The insert contains all the resources referred to in the questions.

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Refer to the **insert** for the list of pseudocode functions and operators.

1 **(a)** A programmer is developing an algorithm to solve a problem. Part of the algorithm would be appropriate to implement as a subroutine (a procedure or a function).

(i) State **two** reasons why the programmer may decide to use a subroutine.

1 It reduce the complexity of the program.

2 maintainence is easier.

[2]

(ii) A procedure header is shown in pseudocode:

```
PROCEDURE MyProc(Count : INTEGER, Message : STRING)
```

Give the correct term for the identifiers `Count` and `Message` **and** explain their use.

Term Parameter

Use To pass the values

[2]

(b) The algorithm in **part (a)** is part of a program that will be sold to the public.
All the software errors that were identified during in-house testing have been corrected.

Identify **and** describe the additional test stage that may be carried out before the program is sold to the public.

Test stage Beta testing

Description The users will check that the software works as required without containing any errors. Testing carrier out by a small group of users. Suggestions for improvement and the problems before the program is sold.

[4]

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(c) Part of an identifier table is shown:

Variable	Type	Example value
FlagDay	DATE	23/04/2004
CharList	STRING	"ABCDEF"
Count	INTEGER	29

Complete the table by evaluating each expression using the example values.

Expression	Evaluation
MID(CharList, MONTH(FlagDay), 1)	'D'
INT(Count / LENGTH(CharList))	4
(Count >= 29) AND (DAY(FlagDay) > 23)	FALSE

[3]

2 **(a)** An algorithm will process data from a test taken by a group of students. The algorithm will prompt and input the name and test mark for each of the 35 students.

The algorithm will add the names of all the students with a test mark of less than 20 to an existing text file `Support_List.txt`, which already contains data from other group tests.

(i) Describe the steps that the algorithm should perform.

Do **not** include pseudocode statements in your answer.

1. Open the file in APPEND mode
2. Prompt and input a Student Name and Mark.
3. If mark is less than 20 → jump to step 4
   If mak is greater than or equal to 20 jump to step 5
4. Write only name of file
5. Repeat from step 2 (35 times)

[5]

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(ii) Explain why it may be better to store the names of the students in a file rather than in an array.

Data stored is permanently.

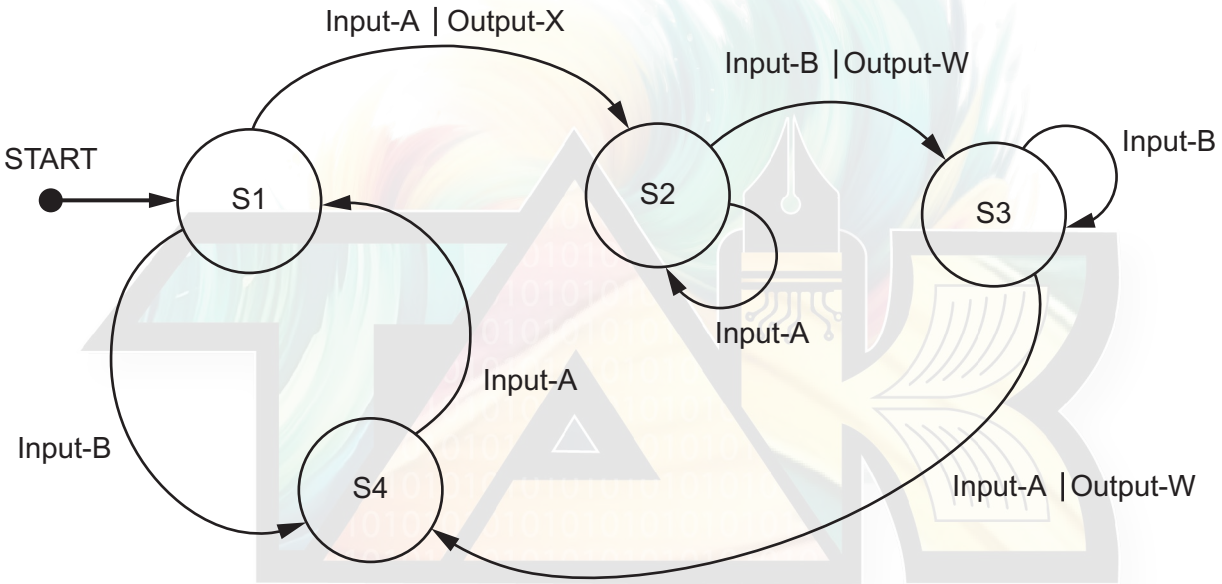
[1]

(iii) Explain why `WRITE` mode cannot be used in the answer to **part 2(a)(i)**.

write will over write the data into text file. Append will store data at end of file, will not over write.

[1]

(b) Examine the following state-transition diagram.



Complete the table to show the inputs, outputs and next states.

Input	Output	Next state
		S1
Input-A	output X	S2
Input A	none	S2
Input B	Output-W	S3
Input A	Output-W	S4

[4]

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3 A stack is used in a program to store string data which needs to be accessed in several modules.

(a) A stack is an example of an Abstract Data Type (ADT).

Identify **one other** example of an ADT **and** describe its main features.

Example Queue

Features In Queue it contain one element The principle is FIFO. Queue may be Linear Queue or Circular. Two pointers are used FOQ and fOQ.

[3]

(b) Explain how the stack can be implemented using an array.

Declare 1D Array of data type string.
Define the size of the Array.
Declare the stack pointer as integer
Declare the Array with lower bound and Upper bound.
Use stackpointer as index of Array.
Push and Pop routines need to check for full or empty conditions.

[5]

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(c) A second stack is used in the program. The diagram below shows the initial state of this stack. Value X is at the top of the stack and was the last item added.

Upper-case letters are used to represent different data values.

Stack operations are performed in three groups as follows:

Group 1:

```
PUSH D
PUSH E
```

Group 2:

```
POP
POP
POP
```

Group 3:

```
PUSH A
PUSH B
POP
PUSH C
```

Complete the diagram to show the state of the stack **after** each group of operations has been performed.

Include the current stack pointer (SP) **after** each group.

Memory location	Initial state	After Group 1	After Group 2	After Group 3
957				
956				
955		E → SP	~~E~~	
954		D	~~D~~	C → SP
953	X ←SP	X	~~X~~	A
952	Y	Y	Y → SP	y
951	Z	Z	Z	Z
950	P	P	P	P

[5]

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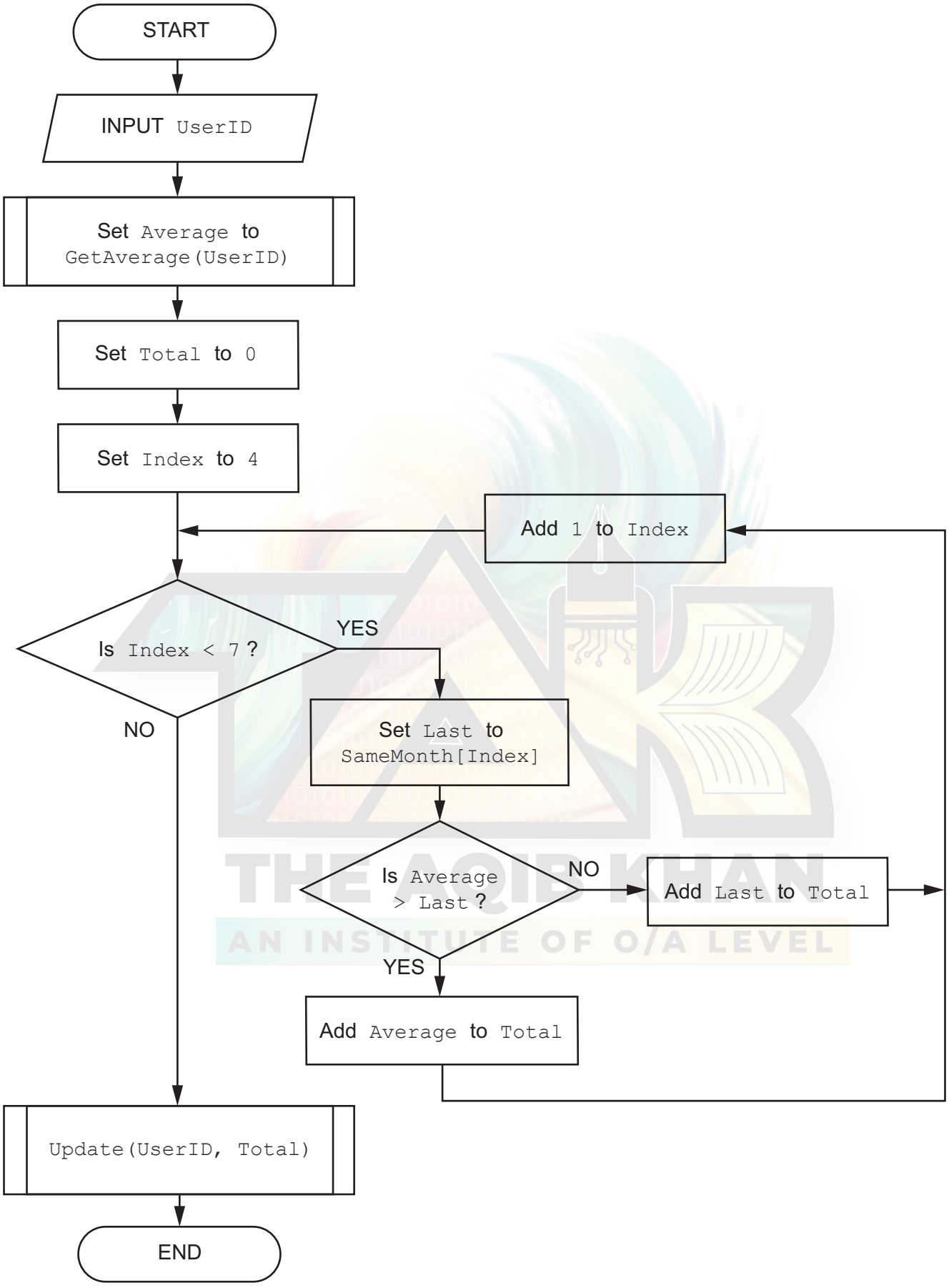
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4 The program flowchart represents a simple algorithm.



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(a) Write the equivalent pseudocode for the algorithm represented by the flowchart.

```
INPUT User ID
Average ← Get Average (User ID)
Total ← 0
Index ← 4
REPEAT
    Last ← SameMonth [Index]
    IF Average > last THEN
        Total ← Total + Average
    ELSE
        Total ← Total + last
    ENDIF
    Index ← Index + 1
UNTIL Index = 7
CALL Update ( User ID, Total)
```

[6]

(b) Give the name of the iterative construct in the flowchart.

Pre condition loop. [1]

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5 Examine the following pseudocode.

```
IF A = TRUE THEN
   IF B = TRUE THEN
      IF C = TRUE THEN
         CALL Sub1()
      ELSE
         CALL Sub2()
      ENDIF
   ENDIF
ELSE
   IF B = TRUE THEN
      IF C = TRUE THEN
        CALL Sub4()
      ELSE
        CALL Sub3()
      ENDIF
   ELSE
      IF C = FALSE THEN
        CALL Sub3()
      ELSE
        CALL Sub4()
      ENDIF
   ENDIF
ENDIF
```

A programmer wants to re-write the pseudocode as **four** separate `IF...THEN...ENDIF` statements, each containing a single `CALL` statement. This involves writing a single, simplified logic expression as the condition in each statement.

Write the amended pseudocode.

1 If A and B and C
THEN CALL SUB1()
End If

2 IF (A AND B) AND NOTC
Then call SUB2() ENDIF

3 If(NOT A) AND (NOTC)
THEN Call SUB3()
ENDIF

4 IF-(NOT A) ANDC
CALL SUB4()
ENDIF

[4]

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6 **(a)** The factorial of an integer number is the product of all the integers from that number down to 1.

In general, the factorial of n is $n \times (n-1) \times \ldots \times 2 \times 1$

For example, the factorial of 5 is $5 \times 4 \times 3 \times 2 \times 1 = 120$

In this question, n will be referred to as the `BaseNumber`.

A function `FindBaseNumber()` will:

- be called with a positive, non-zero integer value as a parameter
- return `BaseNumber` if the parameter value is the factorial of the `BaseNumber`
- return −1 if the parameter value **is not** a factorial.

For example:

Parameter value	Value returned
120	5
12	−1
6	3
1	1

`FindBaseNumber(12)` will return -1 because 12 is not a factorial.

You may use the rest of this page for rough working.

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Write pseudocode for the function `FindBaseNumber()`.

```
FUNCTION FindBaseNumber(Value : integer) RETURNS integer
    DECLARE Num, Try : INTEGER
    DECLARE Found : BOOLEAN
    Num = 0
    Found = FALSE
    Try = 1
    WHILE Try <= Value AND Found = FALSE
        Num = Num + 1
        Try = Try * Num
        IF Try = Value
            THEN Found = TRUE
        ENDIF
    ENDWHILE
    IF found = TRUE RETURN Num
        ELSE
            RETURN -1
    ENDIF
ENDFUNCTION
```

[7]

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(b) A program is written to allow a user to input a sequence of values to be checked using the function `FindBaseNumber()`.

The user will input one value at a time. The variable used to store the user input has to be of type string because the user will input 'End' to end the program.

Valid input will be converted to an integer and passed to `FindBaseNumber()` and the return value will be output.

Complete the table by giving **four** invalid strings that may be used to test distinct aspects of the required validation. Give the reason for your choice in each case.

Input	Reason for choice
"27.3"	It is numeric but not integer
-3	A non positive integer
""	empty string
"Adravk"	Non numeric string value that is not "End"

[4]

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7 A teacher is designing a program to perform simple syntax checks on programs written by students.

Two global 1D arrays are used to store the syntax error data. Both arrays contain 500 elements.

- Array `ErrCode` contains integer values that represent an error number in the range 1 to 800.
- Array `ErrText` contains string values that represent an error description.

The following diagram shows an example of the arrays.

Index	ErrCode	ErrText
1	10	"Invalid identifier name"
2	20	"Bracket mismatch"
3	50	"Undeclared variable"
4	60	"Type mismatch in assignment"
...		
500	999	<Undefined>

Note:

- There may be less than 500 error numbers so corresponding elements in both arrays may be unused. Unused elements in `ErrCode` have the value `999`. The value of unused elements in `ErrText` is undefined.
- Values in the `ErrCode` array are stored in ascending order but not all values may be present, for example, there may be no error code `31`.

The teacher has defined two program modules as follows:

Module	Description

`OutputError()`	• takes two parameters as integers:
	○ a line number in the student's program
	○ an error number
	• searches for the error number in the `ErrCode` array:
	○ if found, outputs the corresponding error description and the line number, for example:
	`"Bracket mismatch on line 34"`
	○ if not found, outputs the line number and a warning, for example:
	`"Unknown error on line 34"`

`SortArrays()`	sorts the arrays into ascending order of `ErrCode`

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(a) Write **efficient** pseudocode for module `OutputError()`.

```
Procedure OutputError(LineNum, ERRNum: Integer)
  Declare Index : Integer
  Index ← 0
  REPEAT
    Index = Index + 1
  UNTIL (ERRCode[Index] >= ERRNum) OR (Index = 500)
  IF ERRCode[Index] = ERRNum THEN
    Output ERR[Text],
    Output "On line" LineNum
  ELSE
    Output "Unknown error on line", LineNum
  ENDIF
ENDPROCEDURE
```

[6]

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(b) Write an **efficient** bubble sort algorithm in pseudocode for module `SortArrays()`.

```
Procedure SortArrays()
  Declare i, Boundary : Integer
  Declare TempInt : Integer
  Declare TempString : String
  Declare NoSwap : Boolean
  Boundary ← 499
  REPEAT
    NoSwap ← TRUE
    FOR i = 1 TO Boundary
      IF ErrCode[i] > ErrCode[i+1]
      THEN
        TempInt ← ErrCode[i]
        ErrCode[i] ← ErrCode[i+1]
        ErrCode[i+1] ← TempInt
        TempString ← ErrText[i]
        ErrText[i] ← ErrText[i+1]
        ErrText[i+1] ← TempString
        NoSwap ← FALSE
      ENDIF
    Next i
    Boundary = Boundary - 1
  UNTIL (NoSwap = TRUE)
ENDProcedure
```

[8]

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(c) Two 1D arrays were described at the beginning of the question. Both arrays contain 500 elements.

- Array `ErrCode` contains integer values that represent an error number in the range 1 to 800.
- Array `ErrText` contains string values that represent an error description.

The two arrays will be replaced by a single array. A user-defined data type (record structure) has been declared as follows:

```
TYPE ErrorRec
   DECLARE ErrCode : STRING
   DECLARE ErrText : STRING
ENDTYPE
```

int

(i) State the error in the record declaration.

ErrCode should be an integer

[1]

(ii) State **two** benefits of using the single array of the user-defined data type.

1 Program is easier to write and debug.

2 Array of records can store mixed data type

[2]

(iii) Write the declaration for the single array in pseudocode.

DECLARE Error : ARRAY[1:500] OF ErrorRec [1]

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