Work Sheet-Structured Programming 20191010

Q1

2 **(a)** **(i)** Procedures and functions are examples of subroutines.

State a reason for using subroutines in the construction of an algorithm.

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(ii) Give **three** advantages of using subroutines in a program.

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[3]

(iii) The following pseudocode uses the subroutine `DoSomething()`.

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Answer ← 23 + DoSomething("Yellow")
```

State whether the subroutine is a function or a procedure. Justify your answer.

Type of subroutine .....

Justification .....

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[2]

(b) Stepwise refinement is often used in the development of an algorithm.

Describe **stepwise refinement**.

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Q2

3 In a chemical factory, a procedure, `CheckSensor()` is required to allow an operator to monitor the temperature in different locations.

In the factory:

- the temperature is measured by 10 sensors, each at a different location
- each sensor has a unique ID (1 to 10).

The procedure `CheckSensor()` will compare the measured temperature against each of two constant values, `LowTemp` and `HighTemp`. It will perform the following actions depending on the result of the comparison.

Measured temperature	Action
below `LowTemp`	Output `"Cold"`
from `LowTemp` to `HighTemp`	Output `"Normal"`
above `HighTemp`	Call procedure `Alarm()`

A library function, `GetTemp()`, returns the temperature value from a given sensor.

The structured English representing the algorithm for the procedure `CheckSensor()` is as follows:

1. Prompt for the input of a sensor ID.
2. Input a sensor ID.
3. If the sensor ID is invalid, repeat from step 1.
4. Call the `GetTemp()` function with the sensor ID as the parameter, to obtain the relevant temperature.
5. Compare the temperature against the two constant values and take the appropriate action.

Draw a program flowchart on the next page to represent the algorithm for procedure `CheckSensor()`.

Variable declarations are not required in program flowcharts.

Q3

3 **(a)** A student is developing an algorithm to search through a 1D array of 100 elements. Each element of the array, `Result`, contains a `REAL` value.

The algorithm will output:

- the average value of all the elements
- the number of elements with a value of zero.

The structured English description of the algorithm is:

1. SET Total value to 0
2. SET Zero count to 0
3. SELECT the first element
4. ADD value of element to Total value
5. IF element value is 0 then INCREMENT Zero count
6. REPEAT from step 4 for next element, until element is last element
7. SET Average to Total / 100
8. OUTPUT a suitable message and Average
9. OUTPUT a suitable message and Zero count

Write **pseudocode** for this algorithm.

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(b) The student decides to change the algorithm and implement it as a procedure, `ScanArray()`, which will be called with three parameters.

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ScanArray(AverageValue, ZeroCount, ArrayName)
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`ScanArray()` will modify the first two parameters so that the new values are available to the calling program or module.

Write the **pseudocode** procedure header for `ScanArray()`.

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Q4

6 A text file, `StudentContact.txt`, contains a list of names and telephone numbers of students in a school. Not all students in the school have provided a contact telephone number. In this case, their name will not be in the file.

Each line of the file is stored as a string that contains a name and telephone number, separated by the asterisk character (`'*'`) as follows:

`<Name>'*'<TelNumber>`, for example:

`"Bill Smith*081234567"`

A 1D array, `ClassList`, contains the names of students in a particular class. The array consists of 40 elements of string data type. You can assume that student names are unique.
Unused elements contain the empty string `""`.

A program is to be written to produce a **new** text file, `ClassContact.txt`, containing student names and numbers for all students in a particular class.

For each name contained in the `ClassList` array, the program will:

- search the `StudentContact.txt` file
- copy the matching string into `ClassContact.txt` if the name is found
- write the name together with "*No number" into `ClassContact.txt` if the name is not found.

The program will be implemented as three modules. The description of these is as follows:

Module	Description

`ProcessArray()`	• Check each element of the array:
	  ○ Read the student name from the array
	  ○ Ignore unused elements
	  ○ Call `SearchFile()` with the student name
	  ○ If the student name is found, call `AddToFile()` to write the student details to the class file
	  ○ If the student name is not found, call `AddToFile()` to write a new string to the class file, formed as follows:
	  <Name>"*No number"
	• Return the number of students who have not provided a telephone number

`SearchFile()`	• Search for a given student name at the start of each line in the file `StudentContact.txt`:
	  ○ If the search string is found, return the text line from `StudentContact.txt`
	  ○ If the search string is not found, return an empty string

`AddToFile()`	• Append the given string to a specified file, for example, `AddToFile(StringName, FileName)`

(a) Write **program code** for the module `SearchFile()`.

Visual Basic and Pascal: You should include the declaration statements for variables.
Python: You should show a comment statement for each variable used with its data type.

Programming language .....

Program code

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(b) Write **pseudocode** for the module `ProcessArray()`.

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(c) `ProcessArray()` is modified to make it general purpose. It will now be called with two parameters as follows:

- an array
- a string representing the name of a class contact file

It will still return the number of students who have not provided a contact telephone number.

Write **program code** for the header (declaration) of the modified `ProcessArray()`.

Programming language .....

Program code

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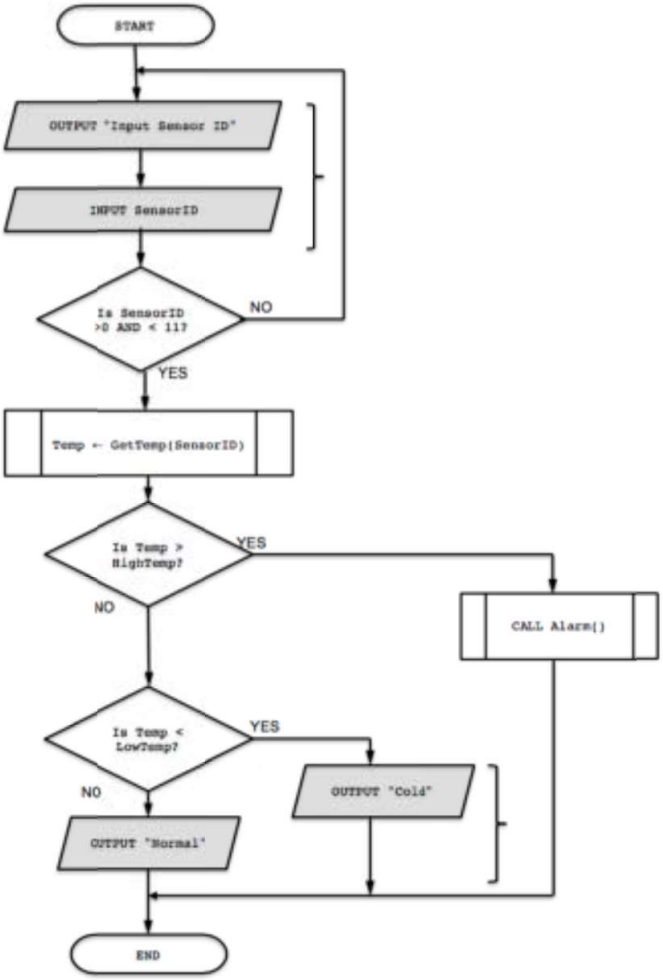
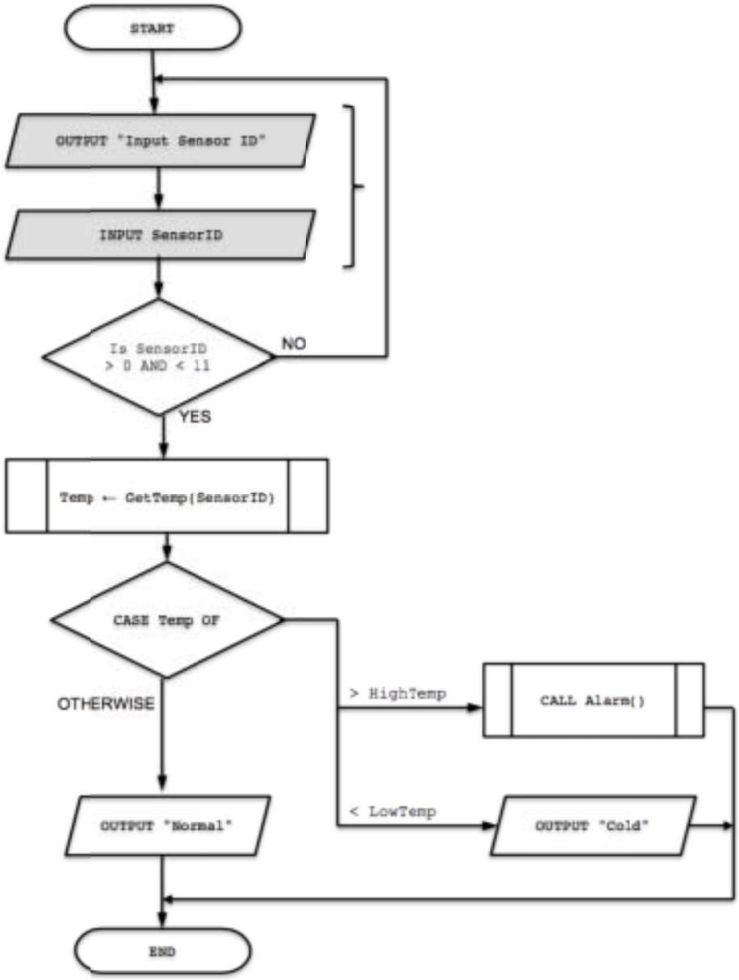
Mark Scheme

Q1

Question	Answer	Marks
2(a)(i)	• To make a more manageable / understandable solution • To support modular design	1
2(a)(ii)	• Allows the subroutine to be called from many / multiple places • Subroutine may be (independently) tested and debugged • If the task changes the change needs to be made only once • Reduces unnecessary duplication / program lines • Allows teams to work on different parts of the solution	3
2(a)(iii)	**Type of subroutine**: Function **Justification**: It returns a value // assigns a value to variable `Answer` One mark for type One mark for justification	2
3(b)	Key points: • to increase the level of detail of the algorithm // break the problem into smaller steps • until steps are easier to solve // to be directly translated into lines of code	2

Q2

Question	Answer	Marks
3	 One mark for: 1 START and END / STOP 2 prompt and input of `SensorID` (allow alt name) 3 decision box checking that `SensorID` is between 1 & 10 4 calling `GetTemp` with `SensorID` as parameter 5 decision box comparing `Temp` > `HighTemp` 6 calling `Alarm()` 7 decision box comparing `Temp` < `LowTemp` 8 both output messages	**8**

Question	Answer	Marks
3	ALTERNATIVE SOLUTION USING 'CASE'  Mark as follows: 1 One mark for START and END / STOP 2 One mark for prompt and input of `SensorID` (allow alt name) 3 One mark for decision box checking that `SensorID` is between 1 & 10 4 One mark for calling `GetTemp` with `SensorID` as parameter 5 One mark for decision box `CASE Temp` 6 One mark for calling `Alarm()` 7 One mark for two correct `CASE` conditions 8 One mark for both output messages	8

Q3

Question	Answer	Marks

3(a)	`TotalValue ← 0`
	`ZeroCount ← 0`
	
	`FOR Index ← 1 TO 100`
	`  TotalValue ← TotalValue + Result[Index]`
	`  IF Result[Index] = 0.0`
	`  THEN`
	`  ZeroCount ← ZeroCount + 1`
	`  ENDIF`
	`ENDFOR`
	
	`OUTPUT "The average is ", (TotalValue / 100)`
	`OUTPUT "The number of elements with a zero value is ",`
	`  ZeroCount`
	
	One mark for each of the following:
	
	1 Both initialisations
	2 Loop 100 times
	3 Adding individual element to TotalValue **in a loop**
	4 Check if element value is zero **in a loop**
	5 If so increment ZeroCount **in a loop**
	6 Average is calculated after the loop
	7 Both OUTPUT statements, including message and variables
		7

3(b)	`PROCEDURE ScanArray (BYREF AverageValue: REAL, _`
	`BYREF ZeroCount: INTEGER, ArrayName : ARRAY)`
	
	One mark for each underlined part
	
	Names unimportant but first two parameters must be `BYREF`
		4

Question	Answer	Marks

6(a)	'Pseudocode' solution included here for development and clarification of mark scheme.
	
	Programming language example solutions appear in the Appendix.
	
	`FUNCTION SearchFile (SearchString : STRING) RETURNS STRING`
	
	`  DECLARE FileData : STRING`
	`  DECLARE Found : BOOLEAN`
	`  DECLARE SearchLength : INTEGER`
	
	`  Found ← FALSE`
	`  SearchLength ← LENGTH(SearchString)`
	
	`  OPENFILE "StudentContact.txt" FOR READ`
	
	`  WHILE NOT EOF("StudentContact.txt") AND NOT Found`
	`  READFILE "StudentContact.txt", FileData`
	`  IF SearchString = LEFT(FileData, SearchLength)`
	`  THEN`
	`  Found ← TRUE`
	`  ENDIF`
	`  ENDWHILE`
	
	`  CLOSEFILE "StudentContact.txt"`
	
	`  IF NOT FOUND`
	`  THEN`
	`  RETURN ""`
	`  ELSE`
	`  RETURN FileData`
	`  ENDIF`
	
	`ENDFUNCTION`
	
	One mark for each of the following:
	
	1. Function header and end (where appropriate). Parameter optional but if present must be of type `STRING`
	2. Calculate length of string from parameter // extract substring from file line
	3. File `OPEN()` in `READ` mode **and** subsequent `CLOSE()`
	4. `WHILE` loop repeating until `EOF()`
	5. read a line from the file **in a loop**
	6. compare name from file with `SearchString` **in a loop**
	7. exit loop if `SearchString` found
	8. Return the line from the file if `SearchString` found **or** an empty string if not found
		8

Question	Answer	Marks

6(b)	
	`FUNCTION ProcessArray() RETURNS INTEGER`
	
	`  DECLARE NoTelNumber : INTEGER`
	`  DECLARE Index : INTEGER`
	`  DECLARE ThisName : STRING`
	`  DECLARE StudentData : STRING`
	
	`  NoTelNumber ← 0`
	
	`  FOR Index ← 1 to 40`
	`  ThisName ← ClassList[Index]`
	`  IF ThisName <> "" //Skip blanks`
	`  THEN`
	`  StudentData ← SearchFile(ThisName)`
	`  IF StudentData = "" //Student not found`
	`  THEN`
	`  StudentData ← ThisName & "*No number"`
	`  NoTelNumber ← NoTelNumber + 1`
	`  ENDIF`
	`  CALL AddToFile(StudentData, "ClassContact.txt")`
	`  ENDIF`
	
	`  ENDFOR`
	
	`  RETURN NoTelNumber`
	
	`ENDFUNCTION`
	
	One mark for each of the following:
	
	1. Function header and end, including return parameter
	2. Declaration and initialisation of local count variable (`NoTelNumber`)
	3. `FOR` loop for 40 array elements …
	4. skip empty elements **in a loop**
	5. use `SearchFile(ThisName)` and save return value **in a loop**
	6. if `Searchfile()` returns an empty string, add "*No number" to `SearchString` …
	7. ... and increment count
	8. call `AddToFile` with both parameters as above **in a loop**
	9. Return count **outside the loop**
		9

6(c)	'Pseudocode' solution included here for development and clarification of mark scheme.
	
	Programming language example solutions appear in the Appendix.
	
	`FUNCTION ProcessArray (ClassList : ARRAY, ClassContact : STRING)`
	`RETURNS : INTEGER`
	
	One mark per underlined section.
		3