Worksheet 2 Structured programming

Task 1

1. The following program is written as it would have been before the days of structured programming.
   It is designed to allow a user to input the times taken, to the nearest minute, by different people to complete a certain task. The program outputs the number of people who took
   - more than 60 minutes
   - between 30 and 59 minutes
   - less than 30 minutes

```
    slow = 0
    medium = 0
    fast = 0
INPUTDATA
    timeTaken = USERINPUT
    IF timeTaken = 0 GOTO PRINT
    IF timeTaken < 30 GOTO UNDER30
    IF timeTaken <60 GOTO UNDER60
    slow = slow + 1
    GOTO INPUTDATA
UNDER30
    fast = fast + 1
    GOTO INPUTDATA
UNDER60
    medium = medium + 1
    GOTO INPUTDATA
PRINT
    OUTPUT fast, medium, slow
```

   (i) Rewrite the programming using structured programming techniques.

   (ii) Flowcharts were invented in the days of GOTO statements. That is why they are not well-suited to representing iteration and selection structures. Can you draw a flowchart of the unstructured program?

   (iii) Which version of the program is
   - quicker to write?
   - easier to understand?
   - less likely to contain errors?

   (iv) Another feature of some early programming languages was that no identifier (e.g. variable name or label) could be more than 6 characters. How would this affect program readability, ease of debugging and maintenance?

2. (a) MOD is an arithmetic operator which returns the remainder from integer division.

e.g. x = 27 MOD 4 will put the value 3 in x.

DIV returns the integer result of the division.

e.g. y = 27 DIV 4 will put the value 6 in y.

Write pseudocode statements to allow the user to input a 3-digit number, and then output the individual digits in the number.

e.g. If the user enters 465, the output should be "The digits are 4 6 5"

(b) Devise a pseudocode algorithm which generates and prints all 3-digit numbers that equal the sum of the cubes of their individual digits.

e.g. 153 satisfies this condition because $153 = 1^3 + 5^3 + 3^3$

(In pseudocode, express this as 1**3 + 5**3 + 3**3)

Task 2

3. A hierarchy chart can be compared to an upside-down tree, with the root at the top and branches and leaves spreading downwards.

The "leaves" are the lowest level modules and all or most of the detailed program code will be in the "leaves".

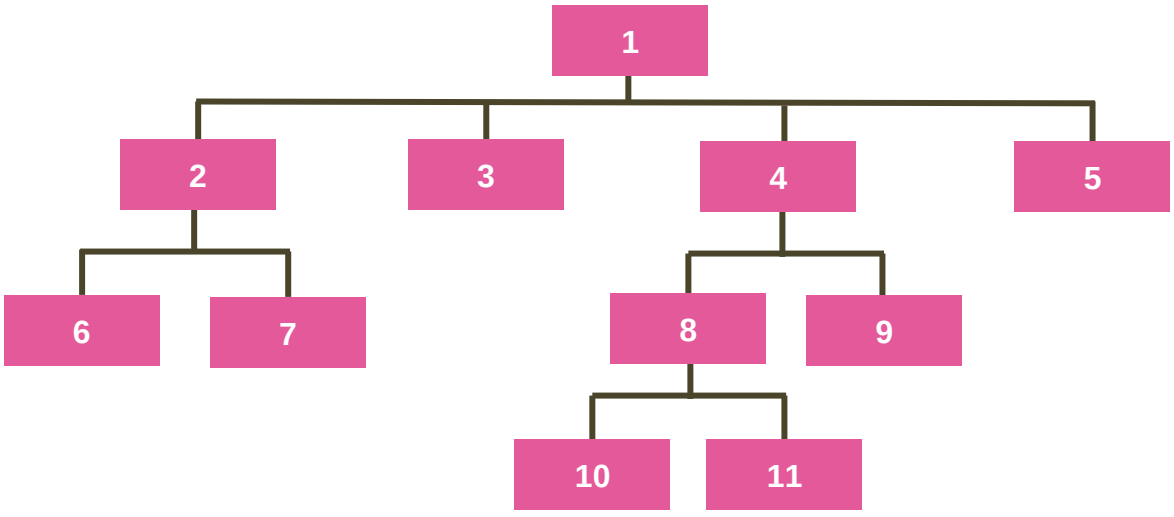
In the hierarchy chart below:

(a) Which are the Level 1 modules?

(b) Which are the Level 2 modules?

(c) Which are the Level 3 modules?

(d) Write down the order in which the modules are executed.



4. What are the advantages of structured programming?

5. The following pseudocode program is designed to allow the user to input a series of three numbers and for each set of numbers, find and output the maximum. The maximum is then added to a total. When the user enters 000 for the three numbers, the average of all the maximums is calculated and output.

```
SUB initialise
    OUTPUT “This program finds the maximums of sets of three numbers.
             Enter three zeroes when all numbers entered.
             Program then calculates and outputs the average of the maximums”
    total = 0
    n = 0
ENDSUB

SUB promptForNumbers
    OUTPUT"Please enter first number "
    num1 = USERINPUT
    OUTPUT ("Please enter second number "
    num2 = USERINPUT
   OUTPUT "Please enter third number "
    num3 = USERINPUT
ENDSUB

SUB findMax
    maxnum = num1
    IF num2>maxnum THEN
        maxnum = num2
   ELSE
     IF num3>maxnum THEN
        maxnum = num3
    ENDIF
    OUTPUT "Max of the three numbers is is ",maxnum
ENDSUB

SUB performCalculations
   total = total + maxnum
   n=n+1
ENDSUB

SUB processData
    promptForNumbers
    WHILE num1<>0 and num2<>0 and num3<>0
        findMax
        performCalculations
        promptForNumbers
    ENDWHILE
ENDSUB

SUB calculateAverage
    average = total/n
    OUTPUT "Average of maximums is ",average
ENDSUB

#Main program starts here
initialise
processData
calculateAverage
```

Draw a hierarchy chart representing this program. Show the different levels, i.e. Level 1 modules, Level 2 modules etc.