L-Università
ta' Malta

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	24th May 2022
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

· Answer **ALL** questions.
· Good English and orderly presentation are important.
· All answers are to be written on the booklet provided.
· The use of flowchart templates is permitted but calculators may **not** be used

1. Consider the following snippet of Java code:

```
1   public static int recUrs(int num) {
2       if (num == 0)
3           return 1;
4       else
5           return recUrs(num – 1) + 3;
6   }
```

   a. In which line is the base case found and what is its purpose?   (2)
   b. What will the method return when the parameter is set as 5 (i.e. `recUrs(5)`)? Show your working.   (2)
   c. In terms of how a method is accessed, how does a static method differ from a non-static method?   (1)

   (Total: 5 marks)

   Please turn the page.

2. Consider the following snippet of Java code:

```java
1    public abstract class Toy {
2      public double price;
3      Toy (double newPrice) {
4        this.price = newPrice;
5      }
6      public double getPrice() {
7        return price;
8      }
9    }
10
11   public class Car extends Toy {
12     public boolean hasRemote;
13     Car (double newPrice, boolean hasRemote) {
14       super(newPrice);
15       this.hasRemote = hasRemote;
16     }
17   }
```

   a. Referring to line 3, what is the purpose of the method Toy()? (1)
   b. State why a programmer who tries to instantiate the Toy class, is presented with an error by the compiler. (1)
   c. Give an example of how method overriding could be used in the code above. (1)
   d. The same programmer would like to add another method to the Toy class with the signature Car (double price). Is it possible for the programmer to do so? Explain. (2)

   (Total: 5 marks)

3. Wil is configuring a fibre optic LAN for an office.
   a. Mention **TWO** differences between fibre optic wires which Wil is using and twisted pair wires. (2)
   b. On such a LAN data can be transmitted in either serial or parallel. Differentiate between serial and parallel data communication. (2)
   c. Different fibre optic cables can support simplex or full duplex communication. How does simplex data communication differ from full duplex communication? (1)

   (Total: 5 marks)

4. Priya is an engineer setting up a DNS server and an email server for her company.
   a. Outline **TWO** reasons why having such DNS servers readily available is so important for the rest of the Internet. (2)
   b. Briefly describe any **THREE** email-related network protocols. (3)

   (Total: 5 marks)

5. Alice is in the process of designing and implementing a simple computer system on a breadboard.
   a. Briefly describe any **FOUR** registers that Alice's CPU must have to complete a typical fetch-execute cycle. (4)

b. If Alice's computer has an address bus that is 8 bits wide and the memory being addressed is byte-addressable, what is the maximum size of addressable memory in MB? (1)

(Total: 5 marks)

6. When designing a CPU, a RISC or a CISC (or a combination of both) architecture can be followed.
   a. What do RISC and CISC stand for? (1)
   b. Name **ONE** difference between RISC and CISC. (1)
   c. A system's architecture can also include the use of different types of memory. For the following statements state whether it is referring to Static RAM or Dynamic RAM:
      i. This type of memory is typically used to make up the cache/s of CPUs. (1)
      ii. The cells of this type of memory are more complex and contain relatively more components in the form of transistors and capacitors. (1)
      iii. In a typical home computer, the total size of this memory is relatively much larger. (1)

(Total: 5 marks)

7. The following BNF statements, describe how an organisation plans to create codes for boxes of different sizes.

```
<box_code> ::= <alphanum> | <alphanum> <box_code>

<alphanum> ::= <letter><digit><letter>

<letter> ::= 'K'|'J'|'M'

<digit> ::= '5'|'6'|'2'|'0'
```

   a. State with reason whether the box code KM56J is valid or not. (2)
   b. Write down **TWO** batch codes which are considered as valid (according to the grammar defined above). (1)
   c. Outline the difference between terminal and non-terminal symbols and identify **ONE** terminal symbol and **ONE** non-terminal symbol from the example above. (2)

(Total: 5 marks)

8. The translation of formal languages is an essential part of programming. This task is carried out by programs such as compilers.
   a. Briefly describe the difference between formal languages and natural languages. (2)
   b. Outline **TWO** tasks the compiler would carry out during lexical analysis. (2)
   c. Name **TWO** types of compilers. (1)

(Total: 5 marks)

Please turn the page.

9. Howard is creating an application which must search through a list of saved items and return the required data as quickly as possible. A hash table is one data structure Howard could use to save his data.
   a. Describe how Howard could implement a hash table using a simple hashing function. (2)
   b. Name a solution Howard could implement should a collision occur in the hash table. (1)
   c. Howard eventually finds out that the linear search algorithm makes his application slow. Briefly suggest and describe an alternative algorithm which he could implement to search for an item in an array. (2)

(Total: 5 marks)

10. Look at the following tree and then answer the questions below it.
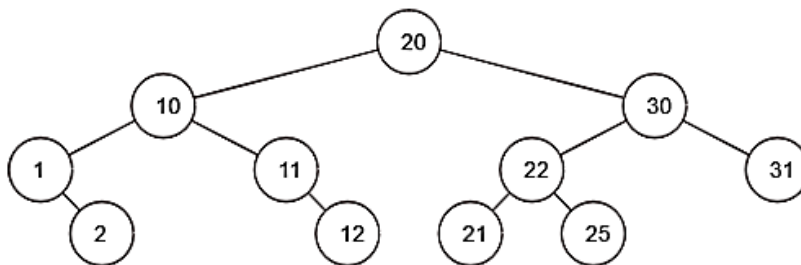
   a. Traverse the following tree in Pre-order, In-order, and Post-order. (3)
   b. Re-draw the tree to show how it would be re-ordered after the node with the number 30 is deleted. (2)

(Total: 5 marks)

11. Penny's Aeronautical Resources and Technologies B.V. is a company in the process of upgrading its raw materials procurement software.
   a. Name **FOUR** feasibility aspects which must be taken in consideration before potentially proceeding with the development of the new system. (2)
   b. Provide **ONE** reason why the company should create both a Use Case Diagram and a Data Flow Diagram during Systems Analysis. (1)
   c. Suggest **ONE** changeover technique this company could use to implement the new system. Give a reason for your answer. (2)

(Total: 5 marks)

12. Several testing methods can be employed to check whether a software solution such as a gaming application targeting mobile devices is ready for release.
   a. Differentiate between black box and white box testing. (2)
   b. Provide **TWO** reasons why beta testing should be carried out before attempting release of the game. (2)
   c. Briefly describe **ONE** type of maintenance the game is expected to undergo after release. (1)

(Total: 5 marks)

13. A startup company is considering different types of Operating System (OS) to control the operation of self-driving cars.
    a. Compare and contrast a batch OS with a real-time OS. (2)
    b. Name a type of OS which can be used on a self-driving car's computer system. (1)
    c. Outline how the use of DMA helps improve the overall performance of the car's computer system. (2)

(Total: 5 marks)

14. Stuart is programming his own custom OS and someone suggested he use contiguous memory partitioning.
    a. Briefly describe to Stuart contiguous memory partitioning. (2)
    b. After several processes are successfully executed and the corresponding memory is deallocated, Stuart notices a lot of memory fragmentation. Briefly describe how Stuart could reduce memory fragmentation. (2)
    c. Name any **ONE** file management system which he may implement to organise blocks on disk. (1)

(Total: 5 marks)

15. Alice is testing on her breadboard to program the CPU chip. She has to refer to the chip's manual, specifically the CPU's instruction set. The instruction set and Alice's programs are written in assembly.
    a. Briefly explain why the instruction set is important for Alice. (1)
    b. Briefly explain what opcodes and operands are and how these are related to the instruction set. (3)
    c. Describe how Alice might need to use a cross assembler. (1)

(Total: 5 marks)

16. The following is part of an assembly program. By showing your working (writing the values of registers AX, CX and EX):
    a. Determine the contents of the register AX after execution. (3)
    b. Name any **ONE** addressing mode and provide an example using the program below. (2)

```
Start:  MOV AX, 1      ; set AX = 1
        MOV EX, 1      ; set EX = 1
        MOV CX, 0      ; set CX = 0
Loop:   ADD AX, EX     ; set AX = AX + EX
        INC EX         ; increment EX
        INC CX         ; increment CX
        CMP CX, 4      ; compare CX with 4
        JE, end        ; jump if CX = 4
  end:  HLT            ; end program
```

(Total: 5 marks)

Please turn the page.

17. Leonard is a Database Administrator (DBA) and as part of his job he is expected to have a good knowledge of Data Manipulation Language (DML) commands and Data Description Language (DDL) commands.
    a. Briefly describe the role of a DBA within an organisation. (2)
    b. How do DML commands differ from DDL commands? (2)
    c. Why is it important that Leonard creates and maintains different user views of the database? (1)

    (Total: 5 marks)

18. Look at the following table called Deer_Expenses:

Client ID	Client Email	Product Ordered	Price	Date Delivered
1	rudolph@santa.net	Red Nose	9.00	1/12/2021
2	blitzen@santa.net	Yellow Nose	5.00	1/12/2021
3	prancer@sclaus.com	Pink Nose	5.00	2/12/2021
4	comet@sclaus.com	Green Nose	5.00	4/12/2021

    a. Is the table normalised to the first, second or third normal form? Give **ONE** reason for your answer. (2)
    b. Write down the output for the following queries:
        i.

            SELECT *
            FROM Deer_Expenses
            WHERE Client_ID > 2; (1)

        ii.

            SELECT Count(Price)
            FROM Deer_Expenses
            GROUP BY Price
            ORDER BY Count(Price) **DESC;** (2)

    (Total: 5 marks)

19. Use the laws of Boolean algebra to show that $(AB' + ABC')' = A' + BC$. State the laws used in each step. (5)

    (Total: 5 marks)

20. a.   Obtain a minimised Boolean expression for the output G through the exclusive use of a Karnaugh map. Outputs denoted by an X represent don't care values.   (4)

A	B	C	D	G
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	X
1	1	1	0	0
1	1	1	1	X

   b.   Draw the truth table showing the output for a 2-input XOR gate.   (1)

(Total: 5 marks)

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ADVANCED MATRICULATION LEVEL
2022 FIRST SESSION

|	
SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	25th May 2022
TIME:	4:00 p.m. to 7:05 p.m.

Directions to Candidates

· Answer **any FIVE** questions.
· Good English and orderly presentation are important.
· All answers are to be written on the booklet provided.
· The use of flowchart templates is permitted but calculators may **not** be used.

1. You have been tasked with creating the software for the self-checkout machines that will be installed at Percy's Supermarket. Using a touchscreen monitor, a shopper can press the checkout function after scanning the items using QR code.

    The shopper can be a 'Premium shopper' or a 'Guest shopper'. A premium shopper gets a 5% discount with every purchase. If a shopper is not a 'Premium shopper' they also have the option to register by entering their name, e-mail address and contact number. This registration is subject to approval by a retail manager which then instructs the system to issue a welcome email with the 'shopper ID' which can be used for future purchases at which point the discount applies. All shopper details are stored in the 'Shoppers' file.

    Finally, the shopper must pay using a card to complete the transaction subject to approval by the customer's bank. Details of the transaction are stored in the 'Transactions' file and a receipt is sent by e-mail to the shopper.

    a. Draw a level 0 diagram for the above scenario (Assume that a context-level diagram is the same as a level 0 diagram). The following partially completed diagram can be used as help.
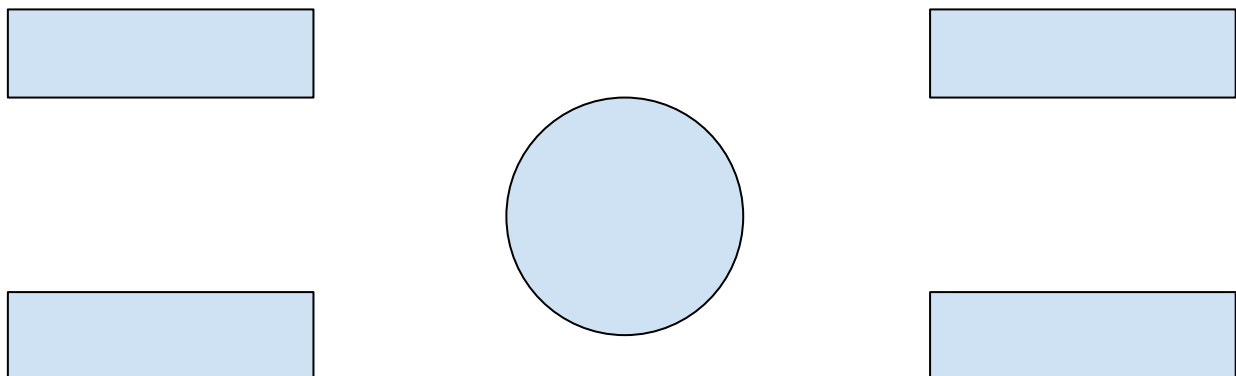
(6)

Question continues on next page.

b. Draw the level 1 diagram for the above scenario. (12)

c. Provide **TWO** reasons why a system should be designed as a set of modules rather than following a monolithic design. (2)

(Total: 20 marks)

2. Emily is tasked with coding and testing a school management information system. She is given the design plans for the system made up of several modules in the form of classes and must choose a suitable programming paradigm.
   a. Describe **THREE** similarities and/or differences between the OOP paradigm and the Imperative programming paradigm. Moreover, state which paradigm is more suited for Emily's system. (4)

   b. Name any other **ONE** programming paradigm which Emily might choose. (1)

   Emily decides to use Java as the programming language with which to develop the booking system. The following is a snippet of code belonging to the system.

```java
public abstract class Person {
protected int age;
protected String name;

Person (int inAge, String inName) {
        this.age = inAge;
        this.name = inName;
}

public String getName() {
    return this.name;
}
}

public class Teacher {
    private int yearlySalary;
        Teacher () { }
}
}
```

   c. Distinguish between the public, private and protected access modifiers. (3)
   d. Briefly describe why it is usually not recommendable to set attributes as public and then suggest an appropriate access modifier for attributes. (2)
   e. Briefly describe the concept of inheritance within the Object-Oriented programming paradigm and state an advantage of using inheritance. (2)
   f. Write down a line of code showing how the declaration of the Teacher class should be modified such that it inherits the Person class. (1)
   g. Rewrite the Teacher class to overload the Teacher() method such that it is possible to instantiate the class in the following way:
      `Teacher t1 = new Teacher("Thomas", 35, 20000);` (5)

h. If the Teacher class inherits the Person class, and another class called Student is introduced, show how you would relate the three classes using a UML class diagram. Note: no need to introduce other attributes or methods apart from those in the code provided above. (2)

(Total: 20 marks)

3. James is studying language translators, specifically the compilation process. However, in class he was frequently distracted by social media notifications.
   a. Explain **FOUR** reasons why it is necessary to perform both syntax analysis and semantic analysis when compiling source code. (4)
   b. Describe **FOUR** roles of the symbol table in the compilation process. (4)
   c. Outline a reason why it is not acceptable to have a statement in a formal language for which there are two parse trees. Moreover, outline how this problem can be solved. (2)
   d. Describe **ONE** similarity and **THREE** differences in the way compilers and interpreters translate a formal language. (4)

   James developed the following method using Java:

   ```java
   public int aMethod (int y) {
       String name = "Toby";
       for (int i = 0; i < 9; i++) {
           y = 3;
       }
       return name;
   }
   ```

   e. The code is not compiling. Identify and briefly describe how to fix a syntax error in James' method. (2)
   f. Identify and briefly describe **ONE** optimisation which James can carry out on the code above (given that the syntax error identified previously is fixed). (2)
   g. Briefly describe how programs written in Java on a Windows computer can be run on another computer running a Linux Operating System (e.g. Ubuntu). (2)

   (Total: 20 marks)

4. a. Describe **FOUR** main tasks that are performed by an Operating System. (4)
   b. Briefly describe the **THREE** states of a process. (6)
   c. One of the principle scheduling algorithms used by the OS is called "Round Robin". Briefly explain the concept behind this algorithm. (4)
   d. Suppose that a computer has a 16-bit address bus (64k of memory can be addressed) but only 32k of memory is installed.
      i. From the above statement, identify the logical virtual address space and the physical memory. (2)
      ii. How is the virtual address space divided? Name **FOUR** important considerations that determine whether these divisions are large or small. (4)

   (Total: 20 marks)

   Please turn the page.

5. a. Write an algorithm, using pseudocode or a flowchart, which describes how the bubble sort works. (5)
   b. Briefly explain the difference between a static data structure and a dynamic data structure. (2)
   c. Describe how the process of adding a node at the end of a linear linked list varies from the process of adding a node at the end of a double-linked list. (4)
   d. Convert the infix expression 4+(9-5)*4 to RPN using a stack. Make sure to show all your working by labelling each push and pop operation performed. (3)
   e. Use a stack to show how a processor would evaluate the RPN statement obtained previously. (2)
   f. Given an array of numbers {48, 12, 4, 44, 31}, describe how a quick sort algorithm would sort the array in ascending order. (4)

(Total: 20 marks)

6. A logic circuit needs to be designed with the following specifications:

   Inputs: A_3, A_2, A_1, A_0
   Outputs: X, Y, Z

   Output X should only be 1 when A_3 is 0 or when A_3 is 1 but A_2 and A_1 are 0. Otherwise, X should be 0.

   Output Y should only be 1 when A_3 is equal to 1 and either when A_2 is 1 or when both A_1 and A_0 are 1.

   Output Z should only be 1 only when A_3 and A_1 are 1 and A_2 and A_0 are 0. Otherwise, Z should be 0.

   a. Derive the truth table for the circuit described above. (9)
   b. Using Karnaugh maps techniques, or otherwise, minimise the truth table and derive the logic expression in terms of the inputs A_3, A_2, A_1, A_0. (6)
   c. Draw the logic circuit for the expressions derived in part b. (5)

(Total: 20 marks)

7. The owner of an English-Language school wants to connect all computers in the school on a network and approaches you to design this network.
   a. Through the use of appropriate diagrams, describe **FIVE** network topologies which can be implemented for the scenario described, highlighting the main advantages and disadvantages of each topology. (15)
   b. Which network topology is most-appropriate to set up the school's network? (1)
   c. Apart from the computers, identify **FOUR** other hardware or software items that are required to set up an efficient network. (4)

(Total: 20 marks)

8. a. Non-integer values such as -1.65 and 3.75 can be represented by a computer using either a fixed point or a floating point system.
   i. State **ONE** advantage of using a floating point system over a fixed point system and **ONE** advantage of using a fixed point system over a floating point system. (2)
   ii. The following is a floating point representation of a number, having an 8-bit mantissa and a 4-bit exponent (both in 2s complement).
   Mantissa: 10010010 and Exponent: 0100. What is the decimal equivalent of the number? (2)
   iii. Using the above format, determine the normalised floating point representation of the decimal value 5.625. (2)
   iv. What are the highest and lowest values that could be represented by this floating point system? Give your answers in binary. (4)
   b. With the aid of a proper diagram, explain the relationship between the CPU, Main Memory and I/O devices. Show the relevant buses together with their directions. (10)

(Total: 20 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**ADVANCED MATRICULATION LEVEL
2022 SESSION**

SUBJECT:	Computing Practical Tasks
PAPER NUMBER:	Task 1 + 2
DATE:	23rd November 2021
TIME:	2 hours 5 minutes

General Instructions:

- Answer **all** questions.

- This task should be completed within 2 hours 5 minutes. The first 5 minutes are reading and noting time.

- This paper has **THREE** questions with a total of 30 marks.

- Only the "BlueJ" programming environment shall be used throughout the practical task.

- Candidates are **not** allowed to make use of the Math class throughout the paper.

- The path where the project folder should be created and saved is to be set to the Computer Desktop or as otherwise instructed. It should be named to *Name Surname Id Card Number* (e.g. Joe Borg 123456M). All work must be saved in this project folder.

- Candidates are requested to include an inline comment with their name, surname and ID card number before starting each question.

- At the end of the exam, candidates are to print a copy with the help of the technician and save a copy of their project folder on the USB stick provided by MATSEC.

- Candidates are to sign **each** of their printouts.

- Before leaving, candidates are to sign the attendance sheet, write down the time at which they leave the examination room (Time Out) and the username, if any, on the attendance sheet.

- Marks will only be awarded if the above instructions are followed.

1. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

   The equation for the volume of a cone is given by: $V = \frac{\pi r^2 h}{3}$, where π can be approximated as 3.142, and r and h refer to the radius and height of the cone respectively.
   You are to design and implement a program using one class called 'Task1Question1' which performs the following:

   a) Allows the user to input a radius value and a height value. (3)
   b) Calculate the volume of the cone and output it. (3)
   c) Repeat parts a) and b) until the user inputs a value of -1 for radius. (3)

   (Total: 10 marks)

2. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

   You are to design and implement a program using one class called 'ClothesShop.'

   a) The class contains a method called 'inventory' which takes as a parameter the number of t-shirts. The number of t-shirts should be inputted by the user in the 'main' function. This method 'inventory' should be called from the 'main' function. (3)
   The method 'inventory' should perform the following:
   b) Prompts the user for the prices of **each** t-shirt, storing them into a data structure which is declared for the whole class (but initialised in the method). (3)
   c) Calculates and outputs the minimum and the maximum price of the t-shirts. (3)

   (Total: 10 marks)

3. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

   This question builds on **Question 2**. You are to overload the 'inventory' method such that it takes no parameters. This method should:

   a) Ask the user whether they want to change the price of a t-shirt. The user should type "yes" or "no" before program execution continues. In case of an incorrect input, the user is asked the same question again. (4)
   b) If "no", the method should not do anything else. (1)
   c) If "yes", the user will be asked for the index (you can assume a 0-based index) and for the new price. The price of the t-shirt should then be updated in the data structure. (2)
   d) If "yes", print out all the prices inside the t-shirt price data structure. (2)

   (Total: 10 marks)

Print all your work (3 questions) and save a copy of your work on the pen drive provided by MATSEC. All printouts shall be signed.

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**ADVANCED MATRICULATION LEVEL
2022 SESSION**

SUBJECT:	Computing Practical Tasks
PAPER NUMBER:	Task 3
DATE:	9th March 2022
TIME:	3 hours 5 minutes

General Instructions:

- Answer **ALL** questions.

- The paper consists of **ONE** question which carries a total of 40 marks.

- This task should be completed within 3 hours 5 minutes. The first 5 minutes are reading and noting time.

- Only the "BlueJ" programming environment shall be used throughout the practical task.

- Candidates are **not** allowed to make use of the `Math` class throughout the paper.

- The path where the project folder should be created and saved is to be set to the Computer Desktop or as otherwise instructed. It should be named to *Name Surname Id Card Number* (e.g. Joe Borg 123456M). All work must be saved in this project folder.

- Candidates are requested to include an inline comment with their name, surname and ID card number before starting each question.

- At the end of the exam, candidates are to print a copy with the help of the technician and save a copy of their project folder on the USB stick provided by MATSEC.

- Candidates are to sign each of their printouts.

- Before leaving, candidates are to sign the attendance sheet, write down the time at which they leave the examination room (Time Out) and the username, if any, on the attendance sheet.

- Marks will only be awarded if the above instructions are followed.

Joseph owns a second-hand car dealership in which he sells both private cars and commercial vehicles (vans). Each vehicle has an identification number, a make, a model, and a price. Joseph's lead software developer has identified a parent class called `Vehicle` and another two classes called `Car` and `Van`, which inherit from the parent class.

a. Write code for the `Vehicle` class, which must include the following:

Attributes

- Unique Identification Number
- Make
- Model
- Price

Methods

- Constructor.
- Getters and setters for all attributes.
- A method called `returnInfo()` which returns a `String` with all information on the vehicle.

(11 marks)

b. Write code for the two classes `Car` and `Van`, which properly inherit from the `Vehicle` class. In the class `Van`, add a String variable called `fourWheelDrive` and in the class `Car`, add a String variable called `fuelType`. Add also the respective setters and getters for these variables. In both classes, write a constructor which initialises each object with their respective variables.

(6 marks)

c. Joseph has learned that commercial vehicles (`Vans`) have an 18% tax rate (VAT). Override the appropriate setter such that 18% are added to the van price.

(3 marks)

d. Write a test class called Main which displays the following main menu:

```
1. Enter New Car
2. Enter New Van
3. Display Vehicles
4. Edit Car Make
5. Set and View Van Price
6. Exit
```

When the user presses (1) or (2), a new instance of car or van is created, and the user inputs the value for the identification number, make, model, price and the additional variable specified in part b). The vehicles should be stored in an appropriate data structure. When the user presses (3), all the inputted vehicles are displayed. If no vehicle is found, the program should output "Vehicle Not Found". Option (4) presents the user with a prompt to enter a Car ID, and if found accepts the new car make. Similarly, option (5) allows the user to enter a Van ID, and if found, prompts the user to enter a price without VAT. This option then displays the van price with the VAT. The program exits when the user enters (6).

(20 marks)