

Name

IBDP Computer Science - SL

Year 12

October, 2023

Instructions

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name 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.
- Calculators must not be used in this paper.

The time available is the entire session.

If you complete the paper before the session ends, you may hand in your paper. After that, you have the option to read a book.

You may not use any technology during the entire session, even after handing in your paper.

There are 65 marks available in this paper.

1

By making direct reference to the technologies used, explain how a virtual private network (VPN) allows a travelling salesperson to connect securely to their company's network.

[4]

2

Construct a truth table for the following Boolean expression.

$(A \text{ AND } B) \text{ NOR } C$

[3]

3

A school uses a local area network (LAN) which connects several computers and a printer to a server and allows access to the internet.

(a) Define the term *server*. [1]

(b) Identify the different clients in this network. [1]

(c) (i) Identify **one** external threat to the security of the school's computer system. [1]

(ii) State **one** way to protect the computer system from the threat identified in part (c)(i). [1]

4

A sub-program `all_even()` accepts a positive integer `N` and outputs `true` if all digits of `N` are even, otherwise it outputs `false`. For example, `all_even(246)` outputs `true` and `all_even(256)` outputs `false`.

The following algorithm is constructed for the sub-program `all_even(N)`.

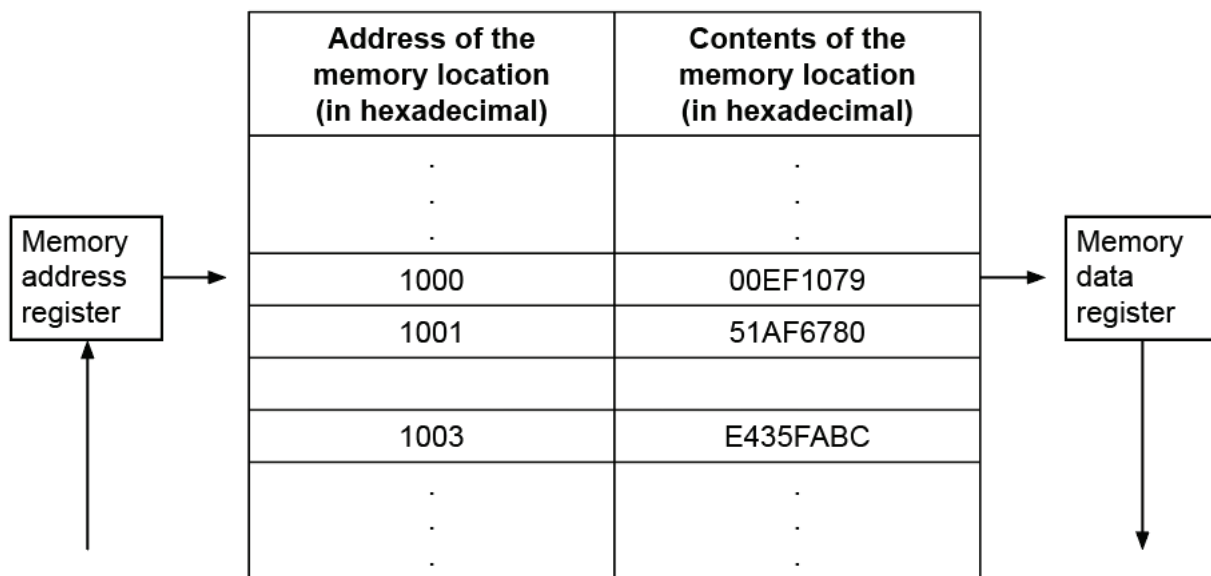
```
EVEN = true
loop while (N > 0) and (EVEN = true)
    if (N mod 10) mod 2 = 1 then
        EVEN = false
    end if
end loop
output EVEN
```

(a) Explain why this algorithm does not obtain the correct result. [2]

(b) Outline what should be changed in the algorithm to obtain the correct result.

[3]

- 5 The following diagram shows the structure of the random access memory (RAM).



(a) Calculate the number of bits in each memory location.

[1]

(b) Calculate the number of bytes in each address.

[1]

(c) Outline the function of the:

(i) memory address register

[2]

(ii) memory data register. [2]

(d) (i) Identify **two** functions of the operating system. [2]

(ii) State where the operating system is held when the computer is turned off. [1]

The machine instruction cycle refers to the retrieval of an instruction from the RAM, and subsequently decoding, executing and storing the result.

(e) (i) Construct a diagram to illustrate the structure of a central processing unit (CPU), clearly showing the flow of data within the CPU. [4]

(ii) Identify the part of the CPU which performs decoding. [1]

(iii) Identify the part of the CPU which executes the instruction. [1]

7

Trace the following algorithmic fragment for $N = 6$. Show all working in a trace table.

```
SUM = 0
loop COUNT from 1 to (N div 2)
  if N mod COUNT = 0 then
    SUM = SUM + COUNT
  end if
end loop
if SUM = N then
  output "perfect"
else
  output "not perfect"
end if
```

[4]

8

A large company with locations in different cities has taken an OOP approach in creating an administration program that manages all aspects of its business. These aspects include:

- the sale of all of the different products that the company manages
- the salaries for managers, office staff and sales personnel.

- (a) By making use of an example from the above scenario, distinguish between a class and an instantiation of a class.

[3]

The different modules in the program each open up a graphical user interface (GUI). Each GUI has a similar design, but contains differences specific to each module.

- (b) By giving **two** examples, explain how the principles of inheritance can be incorporated into the design of this administration program.

[4]

- (c) Describe how the use of libraries can facilitate the development of programs like this company's administration program.

[3]

The company employs several sales personnel to sell its products to different retailers. Each branch of the company keeps track of its own sales with a suite of programs that include the two classes `SalesPerson` and `Sales`.

```
class SalesPerson // each object contains details of one salesperson
{
    private String id;
    private Sales[] salesHistory; // details of the different sales
    private int count = 0;        // number of sales made

    //constructor for a new salesperson
    public SalesPerson(String id)
    {
        // code missing
    }

    // constructor for a salesperson transferred (together with
    // their sales details) from another branch

    public SalesPerson(String id, Sales[] s, int c)
    {
        // code missing
    }

    public int getCount(){return count;}
    public String getId() {return id;}

    public void setSalesHistory(Sales s)
    {
        salesHistory[count] = s;
        count = count + 1;
    }

    public double calcTotalSales() // calculates total sales for the
                                   // salesperson
    {
        // code missing
    }

    public Sales largestSale() // calculates the sale with the largest
                               // value
    {
        // code missing
    }
}
```

9

Each instance variable is initialized when a `SalesPerson` object is instantiated.

- (a) Complete the constructor `public SalesPerson(String id)`, from the `SalesPerson` class.

[2]

- (b) Explain why accessor methods are necessary for the `SalesPerson` class.

[3]

```
class Sales // each object contains details of one sale
{
    private String itemId; // id of the item
    private double value; // the price of one item
    private int quantity; // the number of the items sold

    // constructor missing

    public double getValue() {return value;}
    public int getQuantity() {return quantity;}
}
```

- (c) (i) Construct unified modelling language (UML) diagrams to clearly show the relationship between the `SalesPerson` and `Sales` classes.

Note: There is no need to include mutator or accessor methods or a constructor.

[4]

- (ii) Outline a negative effect that a future change in the design of the `Sales` object might have on this suite of programs.

[2]

The company employs several sales personnel. The different `salesPerson` objects are held in the array `salesPeople`.

The `Main` class contains various methods that operate on the `SalesPerson` and `Sales` classes. The array `salesPeople` is declared globally. The `Main` class contains the following code:

```
SalesPerson[] salesPeople = new SalesPerson[6];
salesPeople[0] = new SalesPerson("100");
salesPeople[1] = new SalesPerson("101");
salesPeople[2] = new SalesPerson("102");
salesPeople[0].setSalesHistory(new Sales("A100",300.00,10));
salesPeople[0].setSalesHistory(new Sales("A200",1000.00,2));
salesPeople[1].setSalesHistory(new Sales("A300",2550.40,10));
System.out.println(salesPeople[2].getId());
System.out.println(salesPeople[0].getCount());
System.out.println(salesPeople[1].getSalesHistory(0).getValue());
System.out.println(salesPeople[0].calcTotalSales());
```

- (d) State the output after running this code.

[4]

- (e) Construct the method `calcTotalSales()`, in the `SalesPerson` class that calculates the **total value** of the sales for a specific `SalesPerson` object.

[5]