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**COMPUTING**

**9691/31**

Paper 3

**May/June 2014**

**2 hours**

Candidates answer on the Question Paper.

No additional materials are required.

No calculators allowed.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

No marks will be awarded for using brand names for software packages or hardware.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **16** printed pages.



1 The syntax of a high-level programming language is defined using Backus-Naur Form (BNF). Five of the rules are shown below.

- 1. <LeftBr> ::= [
- 2. <RightBr> ::= ]
- 3. <Digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
- 4. <Integer> ::= <Digit> | <Digit><Integer> | <Integer><Digit>
- 5. <ArraySubscript> ::= <LeftBr><Integer><RightBr>

(a) A rule may be recursive.

Explain what is meant by this and identify the rule above which is recursive.

.....

.....

Rule number ..... [2]

(b) (i) Use the above rules to explain why [8] is a valid <ArraySubscript>.

.....

.....

.....

..... [3]

(ii) Use the above rules to explain why [3917] is an invalid <ArraySubscript>.

.....

..... [1]

(c) The given rules permit an array subscript to start with a zero, i.e. [037] is valid.

The programming language however, does not allow an array subscript to start with a zero digit. The rules therefore need to be amended.

Complete the revised list of rules.

<LeftBr> ::= [  
 <RightBr> ::= ]

.....

.....

.....

.....

.....

..... [4]

2 A company hires vehicles to customers. A database is to be created to record data for all hire transactions.

The company has a number of depots in different towns. Each town has one depot only. A number of vehicles are available for hire. Each vehicle is based at one of the depots. Every vehicle starts and ends a hire from its base depot.

Depot data consist of:

- Depot town name
- Depot address

Vehicle data consist of:

- A unique registration number
- A vehicle type code. Vehicles are coded as SC – Small Car, LC – Large Car or V – Van.
- Vehicle mileage

Customer data consist of:

- Unique Customer ID
- Customer address

Data for each hire transaction consist of:

- Customer ID
- Vehicle registration number
- Date the booking was made
- Start date of the hire
- Return date
- Driving licence check. A check is carried out to confirm that customers have a valid driving licence and this is recorded. This check is done when the customer shows their driving licence when they collect the vehicle.
- Hire charge

(a) At first, the company used a single table named `DepotVehicle`. A sample of the table's data is shown below.

| DepotTown | RegistrationNo | VehicleType |
|-----------|----------------|-------------|
| Dhaka     | 0987           | SC          |
|           | 0988           | SC          |
|           | 0991           | V           |
|           | 0945           | V           |
| Kumba     | 1431           | SC          |
|           | 1476           | LC          |

Explain why the table is not in normal form.

.....

.....

..... [2]

The final design uses these four entities:

- Depot
- Vehicle
- Customer
- Hire.

(b) Consider the relationship between Depot and Vehicle.

(i) Draw the **entity-relationship (E-R)** diagram.

[1]

(ii) Complete the description for the Vehicle and Depot tables using the notation:

TableName (Attribute1, Attribute2, ...)

where the underlined attribute indicates the primary key.

Vehicle( ..... )

Depot( ..... ) [4]

(c) The Customer and Hire tables (with the primary keys not shown) are as follows:

```
Customer(CustomerID, CustomerAddress)
Hire(CustomerID, DateBooked, RegistrationNo,
      StartDate, ReturnDate, LicenceChecked, HireCharge)
```

Consider the relationship between Customer and Hire.

(i) Draw the **E-R** diagram.

[1]

(ii) Explain how this relationship between Customer and Hire is modelled using the given attributes.

.....

.....

..... [2]

(d) The following Data Manipulation Language (DML) query is run:

```
SELECT RegistrationNo
FROM Hire
WHERE (StartDate < Now() ) AND (ReturnDate > Now() );
```

Note: `Now()` is a function which returns the current date and time.

Describe what useful information is produced by the query.

.....  
 .....  
 ..... [2]

(e) A query is needed to list the depot and registration number for all small car vehicles.

Write the query in Data Manipulation Language (DML).

.....  
 .....  
 ..... [3]

(f) On 05/04/2014, customer 085 booked a vehicle hire. This hire will start on 13/04/2014. When the customer arrives, the receptionist will check their driving licence. If the licence is valid, the value of the licence check attribute, of the correct `Hire` record, must be updated.

Complete the Data Manipulation Language (DML) command to make the change.

```
UPDATE Hire
SET .....
WHERE CustomerID = '085' AND ..... ; [2]
```

3 A football club runs four teams for boys and girls and stores the following data:

- players
- team names
- the upper age limit for each team
- the gender of each team.

The following facts are stored in a knowledge base to be used by a logic program.

Age is stored rather than date of birth to simplify the programming.

```

team(juniorFemale).
team(juniorMale).
team(femaleU16).
team(maleU16).
ageLimit(juniorFemale, 11).
ageLimit(juniorMale, 11).
ageLimit(femaleU16, 15).
ageLimit(maleU16, 15).
teamGender(juniorFemale, f).
teamGender(juniorMale, m).
teamGender(femaleU16, f).
teamGender(maleU16, m).
player(bill, m, 16).
player(moira, f, 13).
player(imram, f, 14).
player(jajid, f, 15).
player(wasim1, m, 14).
player(wasim2, m, 10).
player(sarah, f, 11).
player(paul, m, 13).
player(neville, m, 12).
player(lewis, m, 14).
player(sajid, f, 15).

```

(a) Show the data displayed when the following queries are executed.

(i) `ageLimit(maleU16, X)`

..... [1]

(ii) `player(neville, m, Age)`

..... [1]

(iii) `player(Who, f, _)`

.....  
 .....  
 .....  
 ..... [1]

(iv) `ageLimit(juniorMale, X)` and `X=15`

..... [1]

(b) The club is about to start a new senior female team. This team's identifier in the knowledge base will be `seniorFemale`. The team will have no upper age limit for players.

Two females already want to be registered:

- Azhar, aged 24
- Asmar, aged 31

Write **four** new facts needed for the knowledge base:

.....

.....

.....

..... [4]

(c) The following rule is added to the knowledge base:

```
eligiblePlayer(PlayerX, TeamY) if player(PlayerX, GenderX, AgeX) and
    teamGender(TeamY, GenderY) and GenderX=GenderY.
```

(i) Describe what this rule is designed to do.

.....

..... [1]

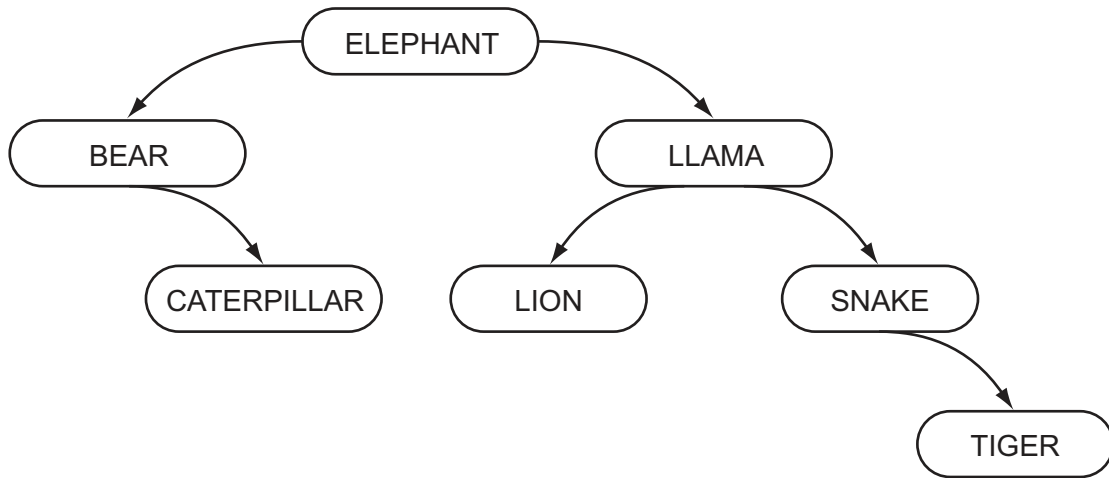
(ii) Identify what needs to be added to the above rule to check if a player is eligible to play for a team.

.....

..... [3]

4 A binary tree is maintained for a list of animals.

The tree currently has seven animals as shown below:



(a) (i) Draw a line around the left subtree. [1]

(ii) State the number of leaf nodes in the current tree.

..... [1]

The binary tree is implemented in a high-level language with the following data structures:

| Variable | Data type                  | Description                                 |
|----------|----------------------------|---|
| RootPtr  |                            | The array subscript of the root of the tree |
| Data     |                            | An array of animal names                    |
| RightPtr | ARRAY[1 : 2000] OF INTEGER | Array of right pointer values               |
| LeftPtr  | ARRAY[1 : 2000] OF INTEGER | Array of left pointer values                |

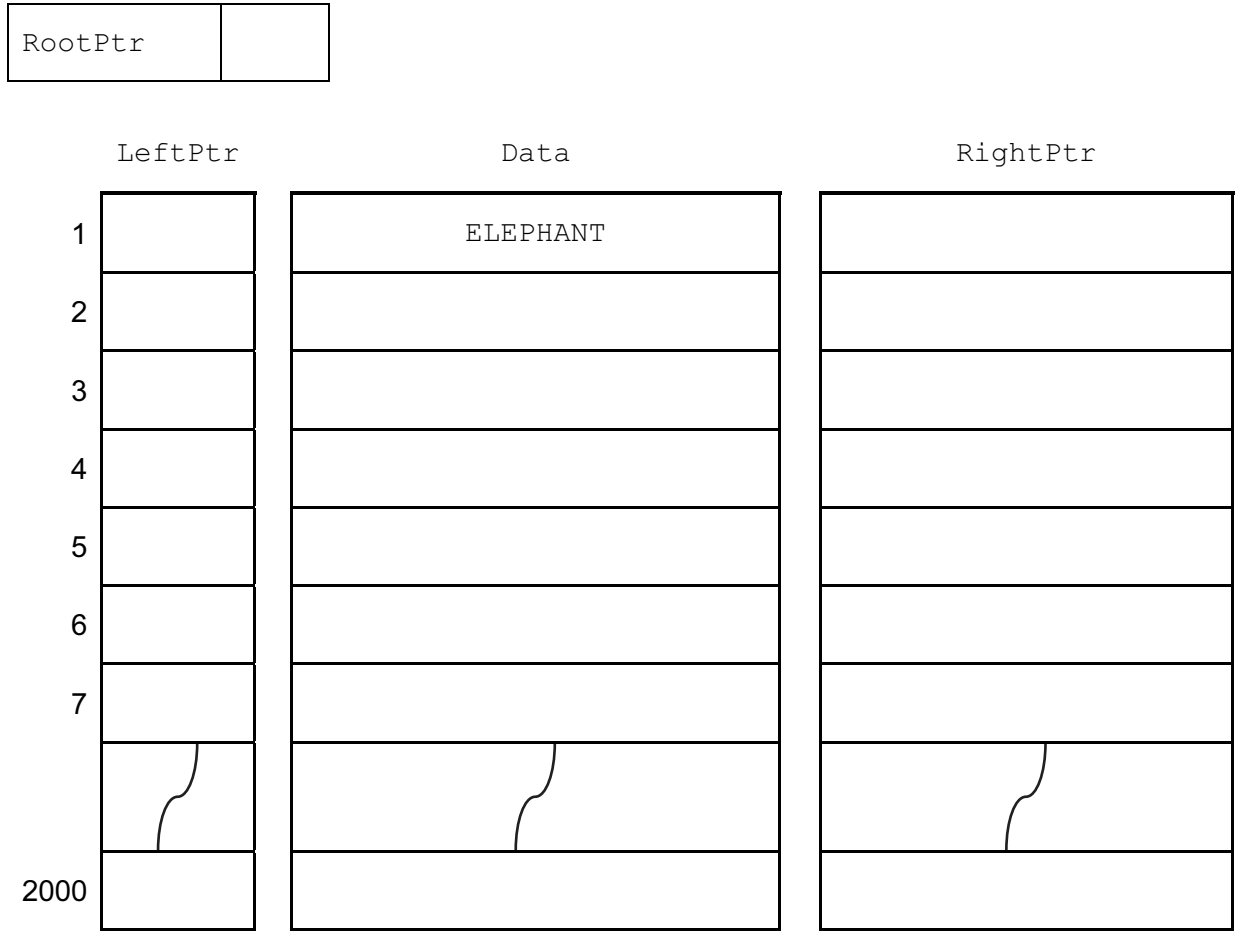
(b) Complete the **two** table entries above. [3]



(c) The animals joined the tree in the order:

ELEPHANT, LLAMA, SNAKE, BEAR, LION, CATERPILLAR, TIGER.

The diagram below is to show the contents of the arrays and the root pointer variable. Complete the diagram.



[4]

(d) (i) How many comparisons will be made to locate LION in the current tree?

.....

[1]

(ii) An algorithm is designed in pseudocode. It will search the binary tree for a particular animal.

The algorithm uses the variables below:

| Variable     | Data type | Description   |
|--------------|-----------|---|
| SearchAnimal | STRING    | Animal to search for                                  |
| Current      | INTEGER   | The array subscript for the item currently considered |
| IsFound      | BOOLEAN   | Flag set to TRUE when SearchAnimal is found           |

Complete the algorithm below:

```

//binary tree search

INPUT .....

IsFound ← FALSE

Current ← RootPtr

REPEAT

  IF .....

    THEN

      //found

      OUTPUT 'Found'

      IsFound ← TRUE

    ELSE

      IF SearchAnimal > Data[Current]

        THEN

          // move right

          .....

        ELSE

          Current ← LeftPtr[Current]

        ENDIF

      ENDIF

    UNTIL ..... OR Current = 0

  IF .....

    THEN

      OUTPUT SearchAnimal ' not found'

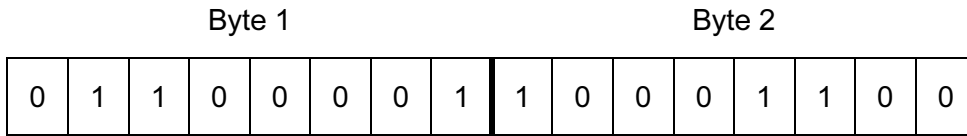
    ENDIF

```

[5]

5 (a) A computer system stores integers in 8-bit two's complement form.

Give the denary number represented by Byte 1 and Byte 2.



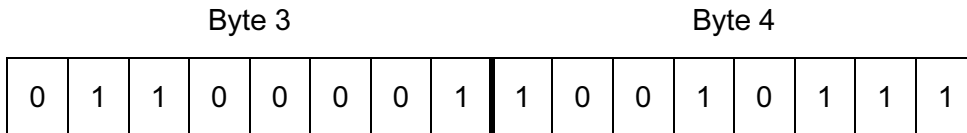
Byte 1 .....

Byte 2 .....

[2]

(b) Two bytes together are used to represent a Binary Coded Decimal (BCD) number.

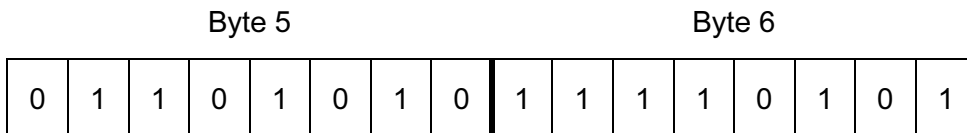
State the denary number represented by Byte 3 and Byte 4.



Denary: .....

[2]

(c) Byte 5 and Byte 6 together represent a 16-bit colour code used in a drawing program.



The drawing program displays a colour code as a hexadecimal number.

State the hexadecimal number for this code. ....

[2]

(d) Many computer systems need to store and process real numbers.

A computer uses two bytes to store a real number. The first (Byte 7) stores the mantissa and the second (Byte 8), the exponent. Both mantissa and exponent use two's complement.

(i) What denary number is represented by Byte 7 and Byte 8?

|        |   |   |   |   |   |   |   |        |   |   |   |   |   |   |   |   |
|--------|---|---|---|---|---|---|---|--------|---|---|---|---|---|---|---|---|
| Byte 7 |   |   |   |   |   |   |   | Byte 8 |   |   |   |   |   |   |   |   |
| 0      | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0      | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

Show your working.

.....

.....

.....

.....

..... [3]

(ii) Without any working out, how can you recognise that this 16-bit pattern (Byte 7 and Byte 8) is a positive number?

..... [1]

(e) (i) Without any working out, how can you recognise that this 16-bit pattern (Byte 7 and Byte 8) is normalised?

.....

..... [1]

(ii) Both of the representations shown below are not normalised.

Write in the empty rows the binary for the normalised form for the same value.

|          |   |   |   |   |   |   |   |          |   |   |   |   |   |   |   |   |
|----------|---|---|---|---|---|---|---|----------|---|---|---|---|---|---|---|---|
| Mantissa |   |   |   |   |   |   |   | Exponent |   |   |   |   |   |   |   |   |
| 0        | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
|          |   |   |   |   |   |   |   |          |   |   |   |   |   |   |   |   |

|          |   |   |   |   |   |   |   |          |   |   |   |   |   |   |   |
|----------|---|---|---|---|---|---|---|----------|---|---|---|---|---|---|---|
| Mantissa |   |   |   |   |   |   |   | Exponent |   |   |   |   |   |   |   |
| 1        | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0        | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
|          |   |   |   |   |   |   |   |          |   |   |   |   |   |   |   |

[3]

- (f) A change is made to use the two bytes as a 12-bit mantissa with a 4-bit exponent. Describe the effect of this change on the values that can be represented, compared with the old use of the two bytes.

.....

.....

..... [2]

6 A business has a customer services section. The business is considering a new Local Area Network (LAN) for this section.

(a) Describe what is meant by a **Local Area Network**.

.....  
.....  
..... [2]

The following are some comments made by the Chief Executive to the IT Manager.

(b) *“I am concerned that only the staff in the Customer Services team should have access to the LAN.”*

(i) State what authentication technique will be used for this.

..... [1]

(ii) Identify what hardware will be in place to restrict the access to the LAN.

..... [1]

(c) *“I understand if the network is to be a wired network, there is a choice about the type of cabling used.”*

Name and describe **two** types of cabling. Suggest a benefit for each cable type. The benefits should be different.

Cable type 1 .....

Description .....

Benefit .....

Cable type 2 .....

Description .....

Benefit .....

..... [6]

(d) *“Many customer enquiries will be dealt with over the World Wide Web; so each computer in the LAN needs access to the Internet”.*

Name the additional hardware needed to provide access to the Internet.

..... [1]

- (e) *“With the Internet connection, I am concerned that we will get unauthorised access to our LAN.”*

Name the hardware and/or software needed to prevent unauthorised access.

..... [1]

- (f) *“Customer Services staff must be able to get access to a centralised store of customer data. Our business deals with thousands of customers. They produce millions of transactions.”*

Explain what hardware and software will be needed to enable this.

Hardware .....

.....

Software .....

.....

.....

..... [3]

7 (a) Describe what is meant by a **computer simulation**.

.....  
.....  
..... [2]

(b) There are many programs that perform simulation. Weather forecasting is an example of one.

Data about the atmosphere need to be captured at a number of locations. One example is the capture of temperature data. This is performed with a temperature sensor.

Name **two** other sensors that can be used to collect weather data.

1 .....  
2 ..... [2]

(c) A flight simulator can be used to train pilots. This is another example of a computer simulation.

Weather forecasting and a flight simulator are different in a number of ways.

Describe **one** key difference between them.

.....  
.....  
.....  
..... [1]

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