UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTING **9691/31**

Paper 3 **October/November 2012**

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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 **15** printed pages and **1** blank page.

For Examiner's Use

1 **(a)** In database design:

(i) Describe what is meant by a **foreign key**.

.....

.....

.....

..... [2]

(ii) Explain how keys are used to implement a one-to-many relationship between the two entities X and Y shown below:

.....

.....

.....

.....

..... [3]

For Examiner's Use

(b) A company has a number of products for sale and receives orders from customers.

- Customers are given a CustomerID and other customer data are recorded
- Each product has a ProductID and other product data are recorded
- Over a period of time a customer will place many orders, and each product can appear on many customer orders
- You should assume:
  - all orders are for one product only,
  - on any given day a customer will place at most one order.

A table description can be expressed as:

`TableName(Attribute1, Attribute2, Attribute3, ...)`

The primary key is indicated by underlining one or more attributes.

(i) Describe the given data model by adding **two** attributes to the `Customer` table and **two** attributes to the `Product` table.

`Customer(CustomerID,` ..... `,` ..... `)`

`Product(ProductID,` ..... `,` ..... `)` [2]

(ii) Give the attributes for the `Order` table, showing the primary key.
You should **not** create an OrderID for this table.

`Order(` ..... `,` ..... `,` ..... `,` ..... `)` [2]

(c) In database design, unnecessary data duplication should be avoided.

Explain, using an example, what is meant by data duplication.

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.....

.....

..... [2]

For Examiner's Use

2 **(a)** Binary representation is used for many different data values.

Consider the binary pattern **1001 0100**

What is its value if it represents:

(i) an 8-bit two's complement integer?

..... [1]

(ii) a binary coded decimal (BCD) number?

..... [1]

(b) A computer system stores real numbers in floating point format with 12 bits. The first 8 bits are the mantissa and the final 4 bits the exponent. Both the mantissa and the exponent use two's complement format.

Consider the binary pattern **0100 1010 0111**

(i) What is the exponent in denary?

..... [1]

(ii) What real number is being represented? (Show your working.)

..... [2]

For Examiner's Use

(c) An attempt at representing 16 ½ gave the binary pattern:

0010 0001 0110

which correctly represents 16 ½ but is **not** in normalised form.

(i) What is the normalised form for 16 ½?

..... [2]

(ii) Explain why normalised form should be used for floating point representation.

.....

..... [1]

For Examiner's Use

3 Most modern computers are designed using Von Neumann architecture.

(a) Describe what is meant by Von Neumann architecture.

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..... [2]

(b) The sequence of operations below shows the fetch stage of the fetch-execute cycle in register transfer notation.

1. **MAR ← [PC]**
2. **PC ← [PC] + 1**
3. **MDR ← [[MAR]]**
4. **CIR ← [MDR]**

Note:
- **[register]** denotes the contents of the specified register
- Step 1 above is read as 'The contents of the Program Counter are copied to the Memory Address Register'.

(i) Explain what is happening at step 2.

.....

..... [1]

(ii) Explain what is happening at step 3.

.....

..... [1]

(iii) Describe the **two** remaining steps needed to complete the fetch-execute cycle.

.....

.....

.....

..... [2]

For Examiner's Use

(c) A processor will allow the use of a variety of modes of addressing.

Explain these terms, using an example in each case. You may wish to illustrate your answer with a diagram.

(i) Direct addressing .....

.....

.....

.....

.....

..... [2]

(ii) Indirect addressing .....

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.....

..... [2]

(iii) Indexed addressing .....

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..... [2]

For Examiner's Use

4 Two types of software which are used to translate high-level programs are a compiler and an interpreter.

(a) Explain how an interpreter executes a high-level language program.

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..... [3]

(b) State **two** advantages of using a compiler rather than an interpreter.

1 .....

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2 .....

..... [2]

(c) Describe what happens during the lexical analysis stage of translation.

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.....

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..... [3]

(d) Explain what is meant by code optimisation.

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..... [2]

For Examiner's Use

5 **(a)** Describe the operation of a stack data structure.

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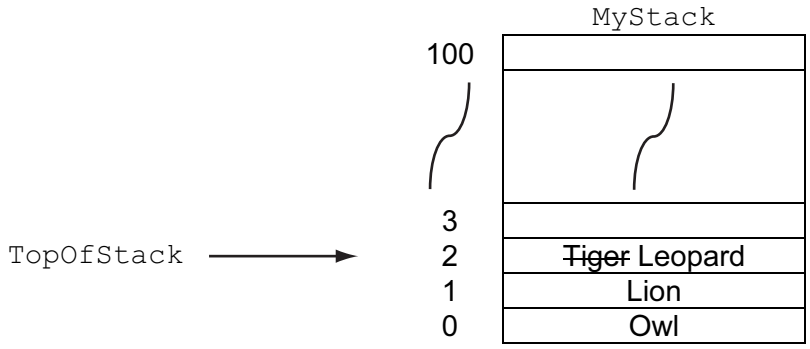
..... [1]

(b) A stack is to be implemented to store data using the following variables.

Identifier	Data Type	Description
`MyStack`	`ARRAY[100]: STRING`	Stores the data values
`TopOfStack`	`INTEGER`	Stores the index position of the item currently at the top of `MyStack`
`NewItem`	`STRING`	Stores a data value to be added to `MyStack`

The diagram shows the state of `MyStack` and `TopOfStack` after three values were inserted (Owl, Lion and Tiger), a value was deleted, then the value Leopard inserted.



Inserting and deleting a single item to/from the stack are to be implemented with two procedures `PushToStack` and `PopFromStack` respectively.

Shown below is the incomplete pseudocode for the `PushToStack` procedure. Using the variables given above, fill in the missing code.

```
PROCEDURE PushToStack

    IF .....
       THEN
          OUTPUT "Stack is already FULL"
       ELSE
          INPUT NewItem
          TopOfStack ← .....
          .....
    ENDIF

ENDPROCEDURE
```

[4]

(c) Describe an application in the operation of a computer system where a stack data structure would be required.

For Examiner's Use

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.....

..... [3]

6 The operating system for a computer which supports multiprogramming will have several programs loaded into main memory at any one time. Segmentation is used to manage main memory.

(a) (i) Describe how main memory is managed when a program terminates.

.....

.....

.....

..... [2]

(ii) Describe how the operating system will decide where in main memory to load a new program.

.....

.....

.....

..... [2]

For Examiner's Use

(b) A processor is capable of receiving and handling interrupts. Each interrupt has a priority.

(i) Describe what is meant by an interrupt.

.....

..... [2]

(ii) State **two** possible sources of an interrupt. Give a reason for each.

Source 1 .....

Reason .....

.....

Source 2 .....

Reason .....

..... [4]

(iii) Describe the sequence of steps the processor would carry out after receiving an interrupt.

.....

.....

.....

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..... [5]

For Examiner's Use

7 **(a)** Describe **two** different media used for the transmission of data across a wide area network.

1 .....

.....

2 .....

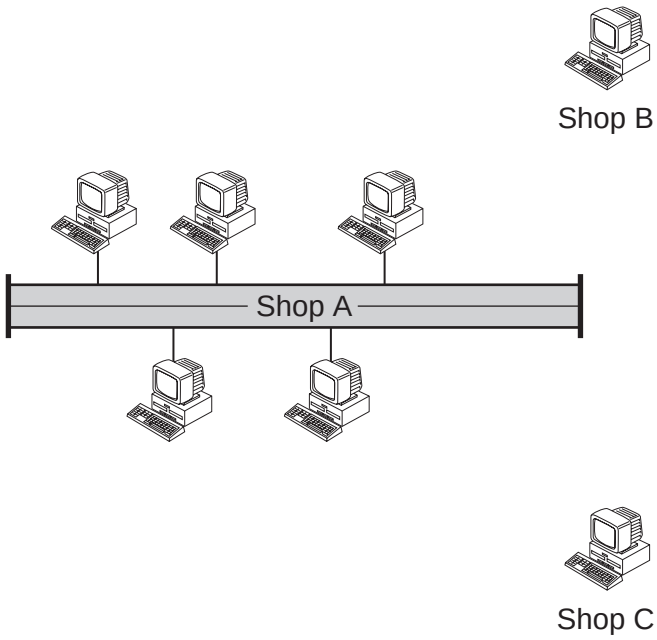
..... [4]

(b) A company has three retail shops – Shop A, Shop B and Shop C – located in different towns.

- Shop A has a Local Area Network (LAN) consisting of five computers.
  - A file server on this network (ServerX) contains all the administration and order processing data for all three shops.
  - A second file server (ServerY) authenticates all logons.
- Shop B and Shop C each have a single computer which connect to the network of Shop A.

The shops are connected over a Wide Area Network (WAN) using a star topology.

Complete the diagram showing the additional hardware needed for this LAN and WAN.



[4]

(c) The LAN in Shop A is to be expanded to 40 computers. The computers are to be organised as two network segments.

What additional hardware is required? Explain its purpose.

Hardware .....

Explanation .....

..... [2]

(d) The management is considering setting up a company intranet.

(i) Describe **two** benefits to the company that an intranet could provide.

1 .....

.....

2 .....

..... [2]

(ii) Intranet content will be viewed with browser software available on all computers.

Name the type of file server used to make the intranet pages available.

..... [1]

For Examiner's Use

8 **(a)** A high-level programming language has the following built-in function `ChangeString` defined as follows:

```
ChangeString(ThisString1: String, ThisString2: String) RETURNS
String
```

will return the String value `ThisString2<Space>first character of ThisString1`

For Example:

`ChangeString("Ben", "Pollard")` will return `"Pollard B"`

If the function is not properly formed an error is generated.

(i) State the function identifier and parameters for the above function.

Function identifier .....

Parameters .....

..... [2]

What value is returned from the following function calls?

(ii) `ChangeString("Wesley", "Lyons")`

..... [1]

(iii) `ChangeString("923", "SMITH")`

..... [1]

(iv) `ChangeString("Zawinal")`

..... [1]

(b) Describe **two** similarities between a user-defined function and a procedure.

1 .....

.....

2 .....

..... [2]

For Examiner's Use

9 **(a)** Many high-level languages use a procedural paradigm.

Explain the term procedural programming language.

.....

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.....

..... [2]

(b) Some high-level languages use a declarative paradigm.
The clauses 1 to 12 show some of the facts to be implemented with a declarative programming language. Clause 13 is a rule which uses variable `X`.

```
1.  car(a1).
2.  car(a2).
3.  car(a3).
4.  part(motorA).
5.  part(motorB).
6.  part(gearbox1).
7.  part(gearbox2).
8.  supplier_part(motorA, dealerD).
9.  supplier_part(gearbox1, thirdpartyE).
10. combination(gearbox1, a1).
11. combination(motorA, a2).
12. combination(motorB, a2).
13. guaranteed_part(X) IF part(X) AND supplier_part(X, dealerD).
```

Note: `car(a1)` means `a1` is a car.
`supplier_part(motorA, dealerD)` means `motorA` is supplied by `dealerD`.

(i) Write a new clause for each of the following facts:

There is a car `'zx6'`.

14. .....

`'gearbox2'` is a part required for the `'a3'` car.

15. .....

The supplier for part `'motorB'` is `'dealerD'`.

16. ..... [3]

(ii) Explain the rule given by clause 13.

.....

..... [1]

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