UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3128211673

COMPUTING **9691/32**

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 **16** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

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

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

.....

.....

.....

..... [2]

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

.....

.....

.....

..... [3]

For Examiner's Use

(b) A company offers training courses to its employees.

- Each employee is given a unique `EmployeeID`
- Each course has a unique `CourseCode`
- Over a period of time an employee will enrol on many courses
- Each course will be attended by many employees
- An employee never enrols on a particular course more than once.

A table description can be expressed as:

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

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

(i) Add **two** attributes to each of the `Employee` and `Course` tables.

`Employee(EmployeeID,` ..... , ...)

`Course(` ..... , ...) [3]

(ii) A third table, `CourseEnrolment`, will record which employee enrolled on which courses.

State **two** essential attributes for this table. Show the primary key.
You should **not** create a `CourseEnrolmentID` for the table.

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

(c) Storing data in flat files has been replaced by storing data in relational database tables.

Explain how the use of a relational database reduces **data redundancy**.

.....

.....

.....

..... [2]

For Examiner's Use

2 **(a)** A binary pattern can be interpreted in a number of different ways.

Consider the binary pattern **1001 1010**

(i) What denary number is this if it represents a sign and magnitude integer?

.....

[1]

(ii) What denary number is this if it represents a two's complement integer?

.....

[1]

(iii) Describe **one** advantage of using two's complement representation rather than sign and magnitude.

.....

.....

[1]

(b) A computer system stores real numbers using a 12-bit floating point representation. The first 8 bits are the mantissa and the final 4 bits the exponent. Both the mantissa and the exponent use two's complement representation.

Consider the binary pattern:

1	0	0	0	1	0	0	0	0	1	1	1

(i) What is the mantissa in denary?

.....

[1]

(ii) What is the exponent in denary?

.....

[1]

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

.....

.....

.....

.....

[2]

For Examiner's Use

(iv) Show the binary pattern for the largest and smallest positive numbers which can be represented with this 12-bit floating point representation.

Largest positive number in binary:

Smallest positive number in binary:

[4]

3 **(a)** The sequence of operations below show - in register transfer notation - the fetch stage of the fetch-execute cycle.

```
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) Describe what is happening at step 4.

.....

..... [1]

(ii) Explain how the data bus is used at step 3.

.....

..... [1]

(iii) Explain how the address bus is used at step 3.

.....

..... [1]

(b) A programmer writing low-level code has the choice of using either machine code or assembly language.

(i) Describe **two** advantages of using assembly language.

1 .....

.....

2 .....

..... [2]

(ii) Describe **three** specific tasks done by the assembler software.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(c) A low-level language contains instructions for **direct addressing** and **relative addressing**.

Explain these terms. You may wish to illustrate your answers with a diagram.

(i) Direct addressing .....

.....

.....

.....

.....

..... [2]

(ii) Relative addressing .....

.....

.....

.....

.....

..... [2]

For Examiner's Use

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

(a) A source code program is compiled for the first time.

State **two** outputs that could be produced by the compiler.

1 .....

.....

2 .....

..... [2]

(b) Describe **two** benefits of using a compiler (rather than an interpreter).

1 .....

.....

2 .....

..... [2]

(c) Explain what is meant by code optimisation.

.....

.....

.....

.....

.....

..... [3]

(d) Explain why the following system software may be required to produce the final executable file.

(i) Linker .....

..... [1]

(ii) Loader .....

..... [1]

For Examiner's Use

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

.....

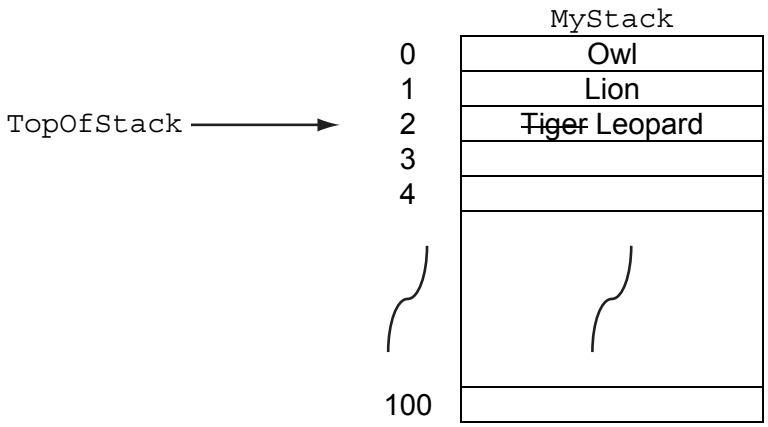
..... [1]

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

Variable	Data Type	Description
`MyStack`	`ARRAY[100]: STRING`	Stores the string data values
`TopOfStack`	`INTEGER`	Stores the index position of the `MyStack` array for the current 'top of stack' position. `TopOfStack` has value -1 when the stack is empty.

The diagram below shows the state of the array and `TopOfStack` after the following:

- three values have been pushed on to the stack (Owl, Lion and Tiger)
- a value is popped from the stack
- then the value Leopard is pushed on to the stack.



Popping a single value is to be implemented with the procedure `PopFromStack`.

For Examiner's Use

```
PROCEDURE PopFromStack

    IF .....
       THEN
          OUTPUT "Stack is already EMPTY"
       ELSE
          OUTPUT MyStack [ ..... ] "is popped"
          TopOfStack ← .....
    ENDIF
ENDPROCEDURE
```

Complete the pseudocode by filling in the **three** answer spaces. [3]

(c) (i) State when a stack would be required in the operation of a computer system.

..... [1]

(ii) Explain how the stack is used.

.....

.....

.....

..... [2]

For Examiner's Use

6 **(a)** Multiprogramming is the ability to have more than one program loaded in the main memory at the same time.
The operating system for a computer which supports multiprogramming must contain a program module for management of the main memory.

Describe **two** strategies for memory management.

1 .....

.....

.....

.....

2 .....

.....

.....

..... [4]

(b) In a multiprogramming computer system, describe **two** possible strategies for scheduling the use of the processor.

1 .....

.....

.....

.....

2 .....

.....

.....

..... [4]

For Examiner's Use

(c) (i) Describe what is meant by an interrupt.

.....

.....

.....

..... [2]

(ii) State **two** different sources of an interrupt and give a reason for each interrupt.

Source 1 .....

Reason .....

.....

Source 2 .....

Reason .....

..... [4]

For Examiner's Use

7 **(a)** Name and describe **two** different media used for the transmission of data across a local area network.

Medium 1 .....

Description .....

.....

Medium 2 .....

Description .....

..... [4]

For Examiner's Use

(b) A library has a central computer at its Head Office. There are libraries in three towns: Town A, Town B and Town C. Each has a single computer connected to the Head Office computer over a Wide Area Network (WAN) using a star topology.

(i) Explain what is meant by a WAN.

.....

.....

.....

..... [2]

(ii) Draw a labelled diagram showing this star network.

[3]

(iii) Describe **two** benefits of a star network.

1 .....

.....

2 .....

..... [2]

For Examiner's Use

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

```
CharacterCount(ThisChar: CHAR, ThisString: STRING) RETURNS INTEGER
```

returns an integer value for the number of times the character `ThisChar` occurs within `ThisString`.
`CHAR` is a data type for a single character.

For Example:

`CharacterCount('J', "James Joyce")` will return the integer 2

An error is returned if the function is not properly called.

(i) Explain what is meant by the term function identifier.

.....

..... [1]

(ii) State the function identifier for the function given above.

..... [1]

(iii) Explain what is meant by the term parameter.

.....

..... [1]

(iv) State the parameter identifiers for the function given above.

.....

..... [2]

(b) What is returned from the following function calls?

For Examiner's Use

(i) `CharacterCount('A', "Adams Apple")`

..... [1]

(ii) `CharacterCount('a', "Amber Arif")`

..... [1]

(iii) `CharacterCount("s", "Mississippi")`

..... [1]

For Examiner's Use

9 A declarative programming language is to be used to represent the knowledge base shown below:

```
1.  continent(asia).
2.  continent(north_america).
3.  continent(australasia).
4.  country(india, asia).
5.  country(china, asia).
6.  country(usa, north_america).
7.  country(australia, australasia).
8.  state(queensland, australia).
9.  state(tasmania, australia).
10. state(texas, usa).
11. state(alaska, usa).
```

These clauses have the following meaning:

Clause	Explanation
1	There is a continent named asia
4	The country india is in asia
9	There is a state in australia named tasmania

(a) More facts are to be included.
There is a country in the continent of South America called Peru.

Write the extra facts to record this.

.....

..... [2]

(b) Using variable `ThisState`, the clause:

```
state(ThisState, usa)
```
would return the result: `ThisState = texas, alaska`

Write the result returned by the clause:

```
country(ThisCountry, asia)
```

`ThisCountry =` ..... [1]

(c) Complete the rule below to determine if two countries are in the same continent.

```
in_same_continent(Country1, Country2)
```

`IF` ..... [3]