CANDIDATE
NAME

CENTRE
NUMBER

CANDIDATE
NUMBER

COMPUTING **9691/32**

Paper 3 **October/November 2013**

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.

[Turn over

1 **(a)** Convert the following infix expressions into reverse Polish notation:

(i) `(x - y) / 5`

....

.... [1]

(ii) `2 / (4 * a + 1)`

....

.... [2]

(b) What is the value of this reverse Polish expression:

`a b + c d - /`

for `a = 7`, `b = 5`, `c = 8` and `d = 2` ?

Show your working.

....

.... [2]

(c) A binary tree can be used to represent an expression or a statement.
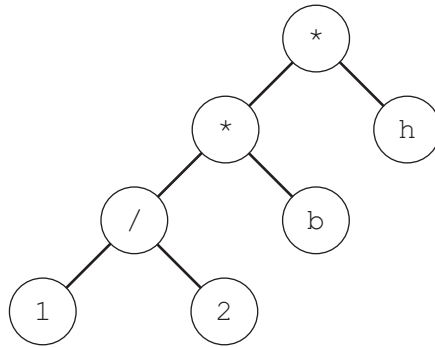
The diagram shows the binary tree for the infix expression:

                    1 / 2 * b * h

(i) Explain how the infix form for this expression is produced using a tree traversal.

....

.... [1]

(ii) What is the reverse Polish notation for this expression?

....

.... [1]

(iii) Explain how the reverse Polish notation is produced using a tree traversal.

....

.... [1]

                                                                [Turn over

2 Customers order products from a website.

- An order contains one or more products.
- Over time, a customer places many orders.
- A product will appear on many customer orders.
- Each product is sourced from a single supplier and a number of suppliers are used.
- A supplier can supply more than one product.

At present the company stores and manages all the data using flat files.

(a) Describe **three** advantages that a relational database would have over the use of flat files.

1 ....

....

2 ....

....

3 ....

.... [3]

(b) (i) What is the relationship between product and supplier?

.... [1]

(ii) What is the relationship between product and order?

.... [1]

(c) A database solution is to be developed.
Two of the tables are PRODUCT and ORDER.

(i) Draw an entity-relationship (E-R) diagram showing a database design which can be produced so that the product and order data are fully normalised.

[2]

(ii) Explain how the relationships are implemented.

....

....

....

.... [2]

(d) The following table design is suggested for PRODUCT.

PRODUCT(<u>ProductID</u>, ProductDescription, RetailPrice, SupplierID,
                                  SupplierName, SupplierTelNumber)

This is poorly designed.

(i) Is this table in First Norm Form (1NF)?
Explain.

....

.... [1]

(ii) Is this table in Second Normal form (2NF)?
Explain.

....

.... [1]

(iii) The table is not in Third Normal Form (3NF).
Explain.

....

.... [1]

(iv) Using only the attributes given in the PRODUCT table above, produce a new design
which is fully normalised.

The table descriptions should be expressed as:

TableName(<u>Attribute1</u>, Attribute2, Attribute3, ...)

....

....

....

.... [2]

 [Turn over

(e) Explain why all tables in the final design should be fully normalised.

....

....

....

.... [2]

(f) The table to store the order data has the following design:

ORDER(<u>OrderNo</u>, OrderDate, OrderTime, IsPaid, OrderAmountPaid,
                                        PaymentMethod, CustomerID)

- IsPaid has data type Boolean
- PaymentMethod has data type Char with possible values: C - credit card,
  D - debit card, A - account customer

Write a Data Manipulation Language (DML) query to report orders which were placed
on the 15 January 2013 and paid for using a debit card. Show the customer ID and
order number only.
Use the keywords SELECT, FROM, WHERE.

....

....

....

....

....

.... [3]

3 (a) Describe what is meant by a register.

....

....

.... [2]

(b) (i) Convert the denary number 60 into hexadecimal.

.... [1]

(ii) Convert the hexadecimal number 10F into denary.

.... [1]

(iii) Why do computer scientists often write binary numbers in hexadecimal?

....

.... [1]

(c) The diagram shows a program loaded into main memory starting at memory address
30 Hex.

Main memory
(contents shown in
Address   Hex.)

Address	Main memory (contents shown in Hex.)
30	2150
31	A351
32	A552
33	FFFF
58	003C
59	103C
5A	010B

(i) How many bytes are used to store each program instruction?

.... [1]

(ii) Describe the steps in the fetch stage of the fetch-execute cycle.
Refer to the instruction at address 30 to illustrate your answer.

....

....

....

....

....

....

....

....

.... [5]

(d) The following table shows some of a processor's instruction set in assembly language.

Instruction		Explanation
Op Code	Operand	
LIX	`<address>`	Load the contents of the address to the Index register (`IX`)
LDX	`<address>`	Indexed addressing. Form the address as `<address>` + the contents of `IX`. Copy the contents of this address to `ACC`
STO	`<address>`	Store the contents of `ACC` at the given address
ADD	`<address>`	Add the contents of the given address to the `ACC`
INC	`<register>`	Add 1 to the contents of the register (`ACC` or `IX`)
JMP	`<address>`	Jump to the given address

The following program is to be executed.
Shown are:

- the first six instructions of this program
- the memory locations which will be accessed by this program.

Main memory

Address	contents
100	LIX 200
101	LDX 200
102	ADD 204
103	STO 204
104	INC IX
105	JMP 101
200	1
201	13
202	14
203	22
204	0

Complete the trace table below for **three** iterations of the loop.

Show each change to the contents of the registers and memory location 204.

ACC	IX	Main memory address 204
		0

[4]

4 Object-oriented programming is one programming paradigm.

  (a) Explain the difference between a class and an object.

  ....

  ....

  ....

  .... [3]

 [Turn over

(b) The following scenario is to be implemented with object-oriented programming.

A software company stores data for all employees (EMPLOYEE). The company employs admin staff (ADMIN) and project staff (PROJECTSTAFF). Project staff are either programmers (PROGRAMMER) or technical authors (TECHAUTHOR).

Data stored will include:

- employee ID for employees
- specialist programming language for programmers
- software specialism for technical authors
- full time or part time indicator
- department for admin staff
- salary grade
- the project team that project staff are assigned to

Complete the class diagram showing the classes and properties only for the data given above.

```
          EMPLOYEE
   EmployeeID: INTEGER



```
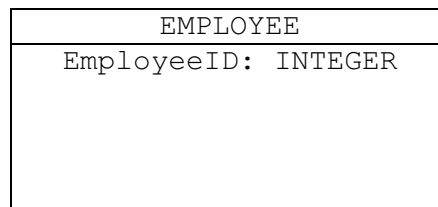
[8]

(c) Explain what is meant by encapsulation.

....

....

....

.... [2]

5 Customer names are stored in the array `Customer`.

An algorithm is to be designed to perform a serial search of the array for a requested customer name.

The algorithm will use the variables shown in the table.

(a) Study the table and the algorithm and fill in the gaps.

Identifier	Data Type	Description
Customer	ARRAY[100] OF STRING	Array of customer names
Index	INTEGER	Used to index the array elements
IsFound	....	....
SearchName	STRING	The requested customer name

```
//Serial search algorithm

INPUT    ..................................................................................

IsFound ← FALSE

Index ← 1


REPEAT

    IF  ..................................................... = SearchName

        THEN

            IsFound ← TRUE

            OUTPUT "Found at position " Index

        ELSE

            ..................................................................................

    ENDIF

UNTIL (IsFound = TRUE) OR  .................................................


IF  ..................................................................................

    THEN

        OUTPUT "Customer name was NOT FOUND"

ENDIF                                                                    [7]
```

(b) How many comparisons on average will be needed to find a requested customer from the Customer array?

.... [1]

(c) A binary search may be an alternative algorithm to a serial search.

(i) What condition is put on the `Customer` array for a binary search to be used?

.... [1]

The following recursive function is for the binary search algorithm.

```
FUNCTION BinarySearch(ThisArray, FindValue, Low, High) : INTEGER
    IF High < Low
        THEN
            RETURN -1 // not found
        ELSE
            Middle ← INT((High + Low) / 2)
            IF ThisArray[Middle] > FindValue
                THEN
                    BinarySearch(ThisArray, FindValue, Low,
                                                    Middle - 1)
                ELSE
                    IF (ThisArray[Middle] < FindValue)
                        THEN
                            BinarySearch(ThisArray, FindValue,
                                                Middle + 1, High)
                        ELSE
                            RETURN Middle // found
                    ENDIF
            ENDIF
    ENDIF
ENDFUNCTION
```

(ii) How can you recognise that the function is recursive?

.... [1]

(iii) A binary search is carried out on the data in the Surname array shown.

Surname

1	Ban
2	Chae
3	Dang
4	Hwang
5	Jeong
6	Jin
7	Jo
8	Ju
9	Ma
10	So
11	Song

Complete the trace table below for the following function call:

BinarySearch(Surname, "Hwang", 1, 11)

Low	High	Middle	RETURN
1	11	6	
1	5	3	
4	5	4	4

[4]

6 **(a)** The integers -126 and -5 are to be added.

Write the binary for -126 and -5 using two's complement. Show the addition in binary including any carry bits.

-126 | | | | | | | | |

-5 | | | | | | | | | +

| | | | | | | | |

Comment on the answer.

....

.... [4]

(b) Real numbers are to be stored using floating point representation with:

- 8 bits for the mantissa, followed by,
- 4 bits for the exponent
- two's-complement is used for both the mantissa and exponent

(i) Consider the binary pattern:

| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 1 | 1 |

What number is this in denary? Show your working.

....

....

....

....

.... [3]

(ii) Explain how you can recognise that the above number is normalised.

....

.... [1]

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(iii) The representation used 8 bits for the mantissa and 4 bits for the exponent. This is to be redesigned. The number of bits used for the mantissa and the exponent is changed, but the total number of bits remains 12.

What implications does this have for the range and precision of numbers that can be represented?

....

....

....

.... [2]

7 The encryption of data is widely used in computing.

(a) One application is online banking.

State **two** other applications where encryption is used.
Describe the reason for encrypting the data for each application.

Application 1 ....

Reason ....

....

Application 2 ....

Reason ....

.... [4]

(b) Explain the terms plain text and cipher text.

Plain text ....

....

Cipher text ....

.... [2]

(c) Symmetric encryption uses a single key.

Explain how a message is encrypted and decrypted using symmetric encryption.

....

....

....

....

....

.... [3]

(d) Authorisation and authentication are processes designed to protect the computer system and data.

Give **one** technique used for each.

Authorisation ....

....

Authentication ....

.... [2]

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