UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9188780506

COMPUTING **9691/33**

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.

This document consists of **18** printed pages and **2** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

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

(i) `(p + q) / 2`

.....

..... [1]

(ii) `6 / (3 + 5 * p)`

.....

..... [2]

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

```
p q - r s - /
```

for `p = 8`, `q = 2`, `r = 5` and `s = 3` ?

Show your working.

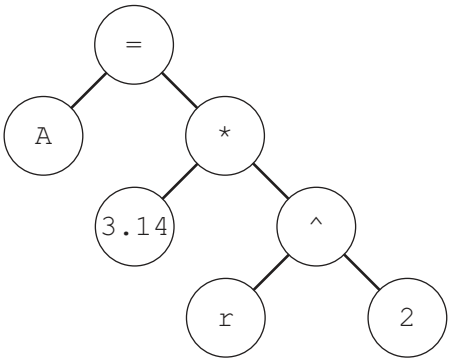
.....

.....

..... [2]

(c) A binary tree can be used to represent an expression or a statement.

For Examiner's Use



The diagram shows the binary tree for the infix statement:

```
A = 3.14 * r ^ 2
```

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

.....

..... [1]

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

.....

..... [1]

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

.....

..... [1]

For Examiner's Use

2 A car hire company in a large town hires out cars to customers.

- There are five depots.
- A number of cars are based at each depot.
- Each car registration number is unique.
- Each customer hire is for a single car only.
- Customers may return for future car hires.
- A customer's future hire may involve a different car.

At present the company records all car, customer and hire data in 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 car and customer?

..... [1]

(ii) What is the relationship between depot and car?

..... [1]

(c) A database solution is to be developed.
Two of the tables are `CAR` and `CUSTOMER`.

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

[2]

For Examiner's Use

(ii) Explain how the relationships are implemented.

.....

.....

.....

..... [2]

(d) The following table design is suggested for `CAR`.

```
CAR(CarRegistrationNo, CarMake, CarModel, HirePriceCode, DepotID,
                                        DepotAddress, DepotManager)
```

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 `CAR` table above, produce a new design which is fully normalised.

The table descriptions should be expressed as:

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

.....

.....

.....

..... [2]

For Examiner's Use

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

.....

.....

.....

..... [2]

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

```
HIRE(HireID, CarRegistrationNo, HireBookingDate, HireStartDate,
                                    NoOfDays, HireRate, CustomerID)
```

Write a Data Manipulation Language (DML) query to report all hire bookings made for car registration 456431 with customer C674. Display the customer ID and hire ID only. Use the keywords `SELECT`, `FROM`, `WHERE`.

.....

.....

.....

.....

.....

..... [3]

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

.....

.....

..... [2]

(b) **(i)** Convert the hexadecimal number 7F into denary.

..... [1]

(ii) Convert the denary number 291 into hexadecimal.

..... [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 40 Hex.

For Examiner's Use

Address	Main memory (Contents shown in Hex.)
40	7324
41	A351
42	A552
43	FFFF
⋮	⋮
68	003C
69	103C
6A	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.
Use the instruction at address 40 to illustrate your answer.

.....

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..... [5]

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

Instruction		Explanation
Op Code	Operand	
LDD	<address>	Direct addressing. Load the contents of the given address to ACC
LDI	<address>	Indirect addressing. At the given address is the address to be used. Load the contents of this second 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 seven instructions in this program
- the memory locations which will be accessed by this program.

Address	Main memory
130	LDI 160
131	ADD 153
132	STO 153
133	LDD 160
134	INC ACC
135	STO 160
136	JMP 130
150	13
151	23
152	11
153	0
160	150

Complete the trace table below for **two** iterations of the loop.
Show each change in the contents of the register and memory locations.

For Examiner's Use

Register	Memory location	
ACC	153	160
	0	150

[4]

4 In a particular country, to become a qualified driver you must:

- have a licence; there is a minimum age at which a person can be issued with a licence and it is different for cars and motorbikes
- pass a theory test; it is the same test for cars and motorbikes
- pass a driving test for that vehicle (car or motorbike)

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

1	`minimum_age(car, 18).`
2	`minimum_age(motorbike, 16).`
3	`age(yu, 16).`
4	`age(kong, 16).`
5	`age(ho, 15).`
6	`age(zhen, 21).`
7	`age(tain, 21).`
8	`age(shen, 21).`
9	`has_licence(yu).`
10	`has_licence(kong).`
11	`has_licence(ho).`
12	`has_licence(zhen).`
13	`has_licence(tain).`
14	`has_licence(shen).`
15	`able_to_drive(X, V) IF has_licence(X) AND minimum_age(V, L) AND age(X, A) AND A >= L.`
16	`passed_theory_test(kong).`
17	`passed_theory_test(yin).`
18	`passed_theory_test(zhen).`
19	`passed_theory_test(yu).`
20	`passed_driving_test(zhen, car).`
21	`passed_driving_test(yu, motorbike).`
22	`passed_driving_test(kong, car).`
23	`passed_driving_test(kong, motorbike).`
24	`passed_driving_test(shen, motorbike).`
25	`qualified_driver(X, V) IF able_to_drive(X, V) AND passed_theory_test(X) AND passed_driving_test(X, V).`

These clauses have the following meaning:

Clause	Explanation
1	The minimum age for a car licence is 18
8	Shen is aged 21
13	Tain has a licence
15	Person `X` is able to drive vehicle `V` if person `X` has a licence, and the age `A` of person `X` is greater than or equal to the minimum age `L` to drive vehicle `V`

For Examiner's Use

For Examiner's Use

(a) List the clause numbers for the rules in this knowledge base.

.....

[1]

(b) Show the output produced from theses clauses:

(i) `passed_driving_test(Who, car).`

.....

.....

.....

.....

[1]

(ii) `able_to_drive(ho, motorbike).`

.....

.....

.....

.....

[1]

(iii) `NOT(has_licence(shen)).`

.....

.....

[1]

(c) Write a clause to output:

(i) all qualified motorbike drivers.

.....

.....

[2]

(ii) all drivers who have passed the theory test but not a driving test.

.....

.....

[3]

(d) To produce the output from a clause, the inference engine uses a process called backtracking.

For Examiner's Use

Consider the clause:

```
able_to_drive(ho, motorbike).
```

List the order in which clauses are used to produce the output.
For each clause, describe the result that it returns.

.....

.....

.....

.....

.....

..... [3]

For Examiner's Use

5 Book titles are stored in the file `Book.txt`.
An algorithm is to be designed to perform a serial search of the file for a requested book.
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
`Book.txt`	`FILE`	Serial file of book titles
`NextBook`	`STRING`	Book title read from the file
`IsFound`	.....	.....
`SearchBook`	.....	The requested book

```
//Serial search algorithm
OPENFILE Book.txt FOR OUTPUT
INPUT .....
IsFound ← FALSE

REPEAT
    FILEREAD next book data value and assign to NextBook
    IF ..... = SearchBook
       THEN
           IsFound ← TRUE
           OUTPUT "FOUND"
    ENDIF
UNTIL (IsFound = TRUE) OR .....

IF .....
    THEN
       OUTPUT "Book title was NOT FOUND"
ENDIF
```

..... [8]

(b) There are 250 book titles in the file.

How many book titles on average will be read to find a requested book title?

.....

..... [1]

(c) The book titles in `Book.txt` are read to the array `BookTitle`.
A binary search may be an alternative algorithm to a serial search.

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

..... [1]

The following is a recursive function 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 following test data in the `BookTitle` array.

For Examiner's Use

	BookTitle
1	100 Great Artists
2	C++ Made Easy
3	Computing Glossary
4	Database Theory
5	Great Cricket Matches
6	History Of Television
7	Networking
8	Particle Physics
9	String Theory
10	Tortoise Care
11	Visiting China

The trace diagram shown below is for the function call:

```
BinarySearch(BookTitle, "Tortoise Care", 1, 11)
```

```
BinarySearch(BookTitle, "Tortoise Care", 1, 11)
  High < Low is FALSE
  Middle = 6
  BookTitle[6] > "Tortoise Care" is FALSE
  BookTitle[6] < "Tortoise Care" is TRUE
  BinarySearch(BookTitle, ......................)
    High < Low is FALSE
    ................
    BookTitle[9] > "Tortoise Care" is FALSE
    BookTitle[9] < "Tortoise Care" is TRUE
    ........................................
      High < Low is FALSE
      Middle = 10
      ....................................
      BookTitle[10] < "Tortoise Care" is FALSE
      RETURN 10
    ENDFUNCTION
    ............
  ENDFUNCTION
```

Fill in the gaps in the trace diagram. [5]

For Examiner's Use

6 **(a)** State where the computer's boot file would be stored.
Explain how the boot file is used to make the computer system ready for use.

.....

.....

.....

.....

.....

..... [3]

(b) **(i)** Explain what is meant by an interrupt.

.....

..... [1]

(ii) An example of an interrupt generated by a hardware device is the process in which a printer signals that it is out of paper.

Give **two** further examples of interrupts, one which is hardware generated, and one which is generated by an executing program.

Hardware generated .....

.....

Program generated .....

..... [2]

(c) In a multiprogramming environment several processes are concurrently loaded into main memory. Each process is in one of three states: RUNNING, READY, SUSPENDED.

Explain these **three** terms.

RUNNING .....

.....

READY .....

.....

SUSPENDED .....

..... [3]

For Examiner's Use

7 **(a)** Below are some terms and definitions for devices used for networking.

(i) Match up each device on the left with its definition. Draw a line connecting each description to the appropriate network device.

(ii) Complete the missing component name.

Router	Hardware or software to control unauthorised access to a private network
Bridge	Hardware used to convert analogue signals to digital signals (and vice versa)
Firewall	Hardware used to connect nodes in a circuit switching network
Switch	Circuit board which connects the computer to a network
Modem	Device to direct packets across a packet switched network
.....	Device used to connect two bus network segments to allow communication between all nodes

[6]

For Examiner's Use

(b) (i) Networks use a variety of different media for communication.

Name and describe **two** of these media.

Medium 1 .....

.....

.....

Medium 2 .....

.....

..... [4]

(ii) A new communication link is to be constructed in a network.

Name **one** factor that will be considered when deciding on the medium to be used.

..... [1]

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