General Certificate of Education
June 2004
Advanced Level Examination

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

COMPUTING CPT4
Unit 4 Processing and Programming Techniques

Tuesday 22 June 2004 Morning Session

No additional materials are required.
You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 65.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

CPT4

Answer **all** questions in the spaces provided.

1 A logic programming language is used to represent, as a set of facts and rules, details of cities of the world. The sets of facts and rules are shown below in clauses labelled 1 to 17.

1. capital (paris).
2. capital (london).
3. capital (lima).
4. capital (caracas).
5. capital (tunis).
6. city_in (paris, france).
7. city_in (lima, peru).
8. city_in (toulouse, france).
9. city_in (maracaibo, venezuela).
10. continent (france, europe).
11. continent (peru, south_america).
12. continent (uk, europe).
13. visited (paris).
14. visited (lima).
15. visited (maracaibo).
16. capital_of (City, Country) IF capital (City) AND city_in (City, Country).
17. city_in_europe (City) IF city_in (City, Country) AND continent (Country, europe).

Clause	Meaning
1	paris is a capital
6	paris is in france
10	france is in the continent of europe
13	I visited paris
16	City is the capital of Country if City is a capital and it is in Country
17	City is a city in europe if City is in Country and Country is in europe

(a) Write the extra clauses needed to express the following facts:

(i) london is in the uk ....

(1 mark)

(ii) I visited strasbourg ....

(1 mark)

(b) The clause city_in (City, france) would return the result: paris, toulouse.
Write the result returned by the clause:

continent (Country, europe)...

(2 marks)

(c) Complete the rule to list countries that I have visited.

countries_visited (Country) IF ....

....
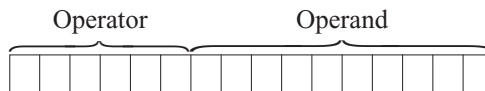
(3 marks)

2   A processor with an instruction format of 16 bits and a word length of 16 bits is being used.

(a)   Integers are stored in 2's complement form. What is the possible range of integers that can be stored in a 16-bit word?

....

....
(2 marks)

(b)   The instruction format uses 6 bits for the operator and 10 bits for the operand.

Operator						Operand									

If direct addressing is used, what is the highest address possible?

....

....
(1 mark)

(c)   The main registers involved in the fetch-execute cycle are the Program Counter (PC), the Current Instruction Register (CIR), Memory Address Register (MAR) and the Memory Data Register (MDR). List the **steps** of the fetch-execute cycle, including how the above registers are used.

....

....

....

....

....

....
(6 marks)

9

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

3 For an object-oriented program to store and calculate payroll details for an organisation, an Employee class is needed. A subclass has been identified: **HourlyPaidEmployee**, which has an inheritance relationship with class **Employee**.

   (a) Draw an inheritance diagram for these classes.

(2 marks)

   (b) What is polymorphism?

   ....

   ....
(1 mark)

   (c) The **Employee** class has data fields *Name, National Insurance Number, Annual Pay, Gross Pay To Date*.

   The class definition for **Employee** is

```
TEmployee = Class
               Public
                 Procedure   AddNewEmployee
                 Procedure   AmendEmployeeDetails
                 Procedure   PrintPaySlip
                 Procedure   CalculatePay
               Private
                 Name  :  String
                 NationalInsuranceNumber  :  String
                 Annual Pay  :  Currency
                 GrossPayToDate  :  Currency
             End
```

Monthly pay for an employee object of **TEmployee** class definition is calculated differently from the monthly pay for an employee object of **THourlyPaidEmployee** class definition.

In the case of an employee object of class definition

- **THourlyPaidEmployee**: monthly pay is calculated by multiplying number of hours worked in month by hourly pay rate.

- **TEmployee**: monthly pay is calculated by dividing the annual pay by 12.

An hourly paid employee object needs one additional operation, which collects the number of hours worked in a month.

Write the class definition **THourlyPaidEmployee**:

....

....

....

....

....

....

....

....

(6 marks)

9

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

4 (a) A system stores integers in **16 bits**. Using binary representation, show the steps of subtracting 6 from 18, using two's complement.

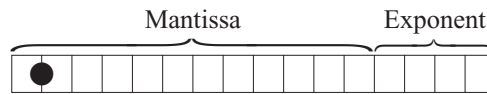...

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....

(4 marks)

(b) The system stores floating point numbers in *normalised form* using 2's complement with a 12-bit mantissa and a 4-bit exponent as follows.

Mantissa   Exponent

(i) A floating point number is stored in main memory at symbolic address Num1. Complete the table below, showing the contents of the memory location using binary notation and the value in decimal.

Symbolic Address	Hexadecimal Representation	Binary Representation	Decimal Value
Num1	A802		

(4 marks)

(ii) Why should floating point numbers be stored in normalised form?

....

....

(1 mark)

9

5 (a) The ASCII code for "A" is denary 65 and for "a" is denary 97. Using a logical OR operation, write the necessary assembly language instructions to convert an uppercase letter stored in main memory location with address 3C5 into lower case and store the result in 3CB.

Opcode	Operand(s)	Comment

(4 marks)

(b) What would be the result if the letter in 3C5 was in lower case before your code is executed?

....

....

(1 mark)

6 (a) What is relocatable code?

....

....

(1 mark)

(b) Explain base register addressing and its role in a multi-programming operating system.

....

....

....

....

....

(5 marks)

Turn over ▶

7 On a single processor machine the scheduler program for a particular multi-programming, multi-user operating system that supports both *interactive* and *batch processing* maintains a list of currently active jobs and a list of inactive jobs.
The inactive list consists solely of batch jobs, whereas the active list contains a mixture of interactive and batch. New batch jobs are added to the inactive list.
The scheduler transfers batch jobs from the inactive list to the active list when appropriate.
A job on the active list may be running, runnable or suspended.
If it is running it will be at the front of the list.
When a job is completed it is removed from the active list.

(a) Give **two** ways in which interactive and batch processing differ.

1 ....

....

2 ....

....
(2 marks)

(b) State **three** items of control that could be specified by job control language statements for each batch job.

1 ....

2 ....

3 ....
(3 marks)

(c) Describe **two** distinct situations that would lead to a job in the active list being suspended.

1 ....

....

2 ....

....
(2 marks)

(d) Name an appropriate data structure for storing the list of active jobs.

....
(1 mark)

(e) Give **two** factors that could cause a job to be moved from the inactive list to the active list.

1 ....

2 ....
(2 marks)

8   A recursively-defined procedure X with three integer parameters is defined below.
x DIV *y* calculates how many times *y* divides exactly into *x*. For example 7 DIV 3 = 2.

```
Procedure X (E,L,H)
  If L > H
    Then Print 'False'
    Else M←(L+H)DIV 2
      If E = List[M]
        Then Print 'True'
        Else
          If E < List[M]
            Then X (E,L,M−1)
            Else X (E,M+1,H)
          Endif
      Endif
  Endif
EndProc
```

(a)   What is meant by recursively-defined?

....
(1 mark)

(b)   (i)   Using the table below, dry-run the procedure call X (6502, 1, 11) applied to the
integer array *List* containing the following elements:

Index	List
1	1234
2	1789
3	3125
4	4789
5	5006
6	5789
7	6502
8	7411
9	8407
10	8971
11	9053

E	L	H	M	List[M]	Printed Output

(7 marks)

(ii)   What process does procedure X describe?

....
(2 marks)

END OF QUESTIONS

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