Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

COMPUTING **CPT4**
Unit 4 Processing and Programming Techniques

Thursday 5 June 2008 1.30 pm to 3.00 pm

You will need no other materials.
You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. **Answers written in margins or on blank pages will not be marked.**
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 65.
- The marks for questions are shown in brackets.
- The use of brand names in your answers will **not** gain credit.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 The binary pattern 1001 1000 0100 can be interpreted in a number of different ways.

1 (a) Convert the binary pattern to hexadecimal.

.....

(1 mark)

1 (b) What is the decimal value if this binary pattern represents BCD?

.....

(1 mark)

1 (c) The above binary pattern represents a normalised two's complement floating point number with an **eight** bit mantissa followed by a **four** bit exponent.

1 (c) (i) State its value in **denary**.

.....

.....

.....

(3 marks)

1 (c) (ii) Give **one** reason for storing floating point numbers in normalised form.

.....

.....

(1 mark)

1 (c) (iii) How does the above binary pattern indicate that the floating point number is normalised?

.....

(1 mark)

1 (c) (iv) What is the largest positive denary number that can be stored using this representation?

.....

.....

(2 marks)

9

2 A queue may be implemented by using either an array or a linked list.

2 (a) Give a disadvantage of

2 (a) (i) an array implementation.

.....

(1 mark)

2 (a) (ii) a linked list implementation.

.....

(1 mark)

2 (b) As items are added and removed in the array implementation the queue will gradually move along the array. How can the program deal with the situation when the end of the array is reached?

.....

.....

(1 mark)

2 (c) A queue is implemented with the following operations:

`AddItem` – add an item to the queue
`RemoveItem` – remove an item from the queue
`FrontItem` – obtain the item at the front of the queue
`IsQueueEmpty` – return true if the queue is empty, otherwise return false.

What additional operation is required if the queue is implemented using an array?

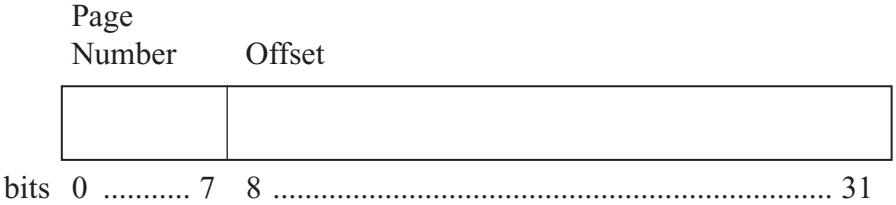
.....

(1 mark)

4

Turn over for the next question

3 An operating system implementing virtual memory for memory management uses 32-bit addresses that contain the following:



The page number is used to access the page table.

3 (a) Give **two** items of information that might be stored in a page table.

1 .....

2 .....

(2 marks)

3 (b) Describe how a memory address is calculated using the virtual memory address and the page table.

.....

.....

.....

.....

(3 marks)

3 (c) State where the page table is likely to be stored in the computer system and explain why this location is chosen.

.....

.....

.....

.....

(2 marks)

7

4 The following represents part of the internal memory of an 8-bit computer system.

Address	Contents
00010000	00000000
00010001	00010101
00010010	11110000
00010011	01010100
00010100	00000000
00010101	00001111
00010110	11111111
00010111	00000011
00011000	00110000

4 (a) The instruction op-code LD causes data to be loaded into the accumulator. What will the accumulator contain after the operation LD 00010001 has been executed if the instruction uses

4 (a) (i) immediate addressing

.....

(1 mark)

4 (a) (ii) direct addressing

.....

(1 mark)

4 (a) (iii) indirect addressing?

.....

(1 mark)

4 (b) (i) Explain what is meant by indexed addressing.

.....

.....

.....

.....

(4 marks)

4 (b) (ii) Give a situation where indexed addressing might be used.

.....

.....

(1 mark)

Turn over ▶

8

5 A binary tree has the following functions defined

`RootValue(T)`	Returns the contents of the root node of the tree T
`LeftChild(T)`	Returns the left child of the root node of the tree T
`RightChild(T)`	Returns the right child of the root node of the tree T

A recursively-defined procedure P with a tree as a parameter is defined below.

```
Procedure P(T)
  If RightChild(T) Exists
    Then P(RightChild(T))
  Output RootValue(T)
  If LeftChild(T) Exists
    Then P(LeftChild(T))
EndProc
```

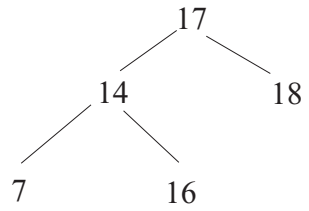
5 (a) What is meant by a recursively-defined procedure?

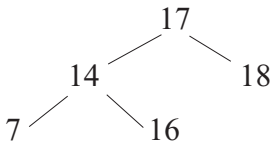
.....

.....

(1 mark)

5 (b) (i) Complete the table opposite by dry running the procedure call P(T) for the tree T given below



Procedure Call	T
P_1	

(7 marks)

Output

5 (b) (ii) What does the procedure P describe?

.....

(2 marks)

Turn over ▶

6 For an object-oriented program to store and retrieve details of the boats moored in a marina, a **Boat** class is needed. Two subclasses have been identified: **MotorBoat** and **Yacht**, which have inheritance relationships with class **Boat**.

6 (a) Draw an inheritance diagram for these classes.

(2 marks)

6 (b) The **Boat** class has data fields **Name, Length, Colour**.

The class definition for **Boat** is

```
Boat = Class
         Public
           Procedure   SetBoatDetails
           Function    GetName
           Function    GetLength
           Function    GetColour
         Private
           Name : String
           Length : Real
           Colour : String
       End
```

While preserving the private status of the Colour field, what modification would you make to this class definition in order to allow the colour of the boat to be changed?

.....

.....

(2 marks)

6 (c) The **Yacht** class has the following additional private data fields:

- **Masts** that represent the number of masts.
- **Engine** that represents whether the yacht has an engine or not.

Write the class definition for **Yacht**.

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

10

Turn over for the next question

7 A computer system has the following assembly code instructions that you are to use in this question:

Label	Opcode	Operand (s)	Description
	AND	#nn	Logical AND the accumulator with hexadecimal value nn
	OR	#nn	Logical OR the accumulator with hexadecimal value nn
	LD	nnnn	Load contents of hexadecimal address nnnn into the accumulator
	LD	label	Load contents of labelled memory into the accumulator
	ST	nnnn	Store contents of the accumulator into hexadecimal address nnnn
	ST	label	Store contents of the accumulator into labelled memory
	ADD	#nn	Add the hexadecimal value nn to the accumulator
	ADD	nnnn	Add the contents of hexadecimal address nnnn to the accumulator
	MUL	#nn	Multiply the accumulator by the hexadecimal value nn
	MUL	nnnn	Multiply the accumulator by the contents of the hexadecimal address nnnn
	CMP	#nn	Compare the accumulator with hexadecimal value nn
	CMP	label	Compare the accumulator with the contents of the labelled memory
	JP	label	Jump unconditionally to the label
	JE	label	Jump to the label if the result of a compare shows the accumulator to be equal to the operand
	JNE	label	Jump to the label if the result of a compare shows the accumulator not to be equal to the operand
	JG	label	Jump to the label if the result of a compare shows the accumulator to be greater than the operand
	JGE	label	Jump to the label if the result of a compare shows the accumulator to be greater than or equal to the operand
	JL	label	Jump to the label if the result of a compare shows the accumulator to be less than the operand
	JLE	label	Jump to the label if the result of a compare shows the accumulator to be less than or equal to the operand

7 (a) (i) Give **two** reasons why some software is still developed in an assembly language.

1 .....

.....

2 .....

.....

(2 marks)

7 (a) (ii) Give **one** reason why the majority of software is no longer developed using assembly language.

.....

(1 mark)

7 (b) A printer driver needs to wait until it is possible to send a character to the printer. It does this by checking the status register for the printer. The algorithm to do this is as follows:

```
Repeat
  Check printer status
Until printer is ready to receive data
```

The status register for the printer is a memory location labelled pstatus.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
pstatus																

Bit 3 indicates whether or not the printer is ready to receive data.
0 = printer not ready
1 = printer ready
Write the necessary asssembly code instructions to implement the above algorithm.

Label	Opcode	Operand(s)	Comment

(6 marks)

Turn over for the next question

9

8 A logic program is used to represent, as a set of facts and rules, details of towns, regions and countries in the British Isles. The set of facts are shown below in clauses labelled 1 to 15.

```
 1.  country (england)
 2.  country (wales)
 3.  country (scotland)
 4.  region (lancashire, england)
 5.  region (surrey, england)
 6.  region (pembrokeshire, wales)
 7.  region (stirling, scotland)
 8.  region (falkirk, scotland)
 9.  town (wigan, lancashire)
10.  town (dorking, surrey)
11.  town (reigate, surrey)
12.  town (haverfordwest, pembrokeshire)
13.  town (callander, stirling)
14.  town (grangemouth, falkirk)
15.  town (bonnybridge, falkirk)
```

Clause	Meaning
1	There is a country named england.
4	There is a region named lancashire and it is located in england.
9	There is a town called wigan and it is located in lancashire.

8 (a) There is a town called `norwich` that is located in the region called `norfolk`. `norfolk` is located in `england`. Write the extra facts required to represent this town.

.....

.....

.....

(2 marks)

8 (b) The clause `region (Name, scotland)` would return the result `stirling, falkirk`. Write the result returned by the clause:

```
town (Name, surrey)
```

.....

(2 marks)

8 (c) Complete a rule that could be used to determine whether two towns are in the same country.

`in_same_country (Town1,Town2)` .....

.....

.....

(4 marks)

END OF QUESTIONS

8