Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
June 2003
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

COMPUTING CPT4
Unit 4 Processing and Programming Techniques

Monday 16 June 2003 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.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 Describe how the elements in a non-empty queue are reversed with the aid of a stack.

.....

.....

.....

.....

.....

(4 marks)

4

2 (a) Describe the vectored interrupt mechanism.

.....

.....

.....

.....

(3 marks)

(b) How does this mechanism make the use of interrupts more flexible?

.....

.....

.....

(1 mark)

4

3 One of the concepts of Object Oriented Programming is *containment*.

Class TForm1 inherits from class TForm.

A form, Form1, of class TForm1, contains 2 buttons, Button1 and Button2, of class TButton.

Write the class definition for TForm1.

.....

.....

.....

.....

(3 marks)

3

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4 (a) The number 0111 0010 1011 1101 is stored in twos complement notation in 16 bits with the most significant 10 bits representing the mantissa and the least significant 6 bits representing the exponent.

(i) Is this number positive or negative?.....

(ii) Estimate the magnitude of this number. Circle the correct answer below.

$>2^{32}$	Between 2^{16} and 2^{32}	Between 2^{2} and 2^{-2}	$<2^{-2}$

(2 marks)

(b) The number 0110 0001 0100 1000 is stored in the **same format**. Convert this number into denary.

(3 marks)

(c) (i) Give **one** advantage of fixed point over floating point representation.

.....

(ii) Under what circumstances would fixed point representation be used rather than floating point?

.....

(2 marks)

7

5 (a) A process is a program whose execution has started but not yet finished. Give **two** reasons why a process might not execute continuously in a multi-programming environment.

1 .....

2 .....

(2 marks)

(b) Distinguish between *processes* and *threads* in a multi-programming environment.

.....

.....

.....

(2 marks)

4

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6 The list **Days** contains the following representation of the days of the week.

[Sun, Mon, Tue, Wed, Thu, Fri, Sat]

The table below shows some functions which take a list as their single argument and return a result which is either an element of a list, another list, or a Boolean value.

Head(list) – returns the element at the head of **list** (e.g. Head(Days)→ Sun) if **list** is non-empty otherwise it reports an error.
Tail(list) – returns a new list containing all but the first element of the original list (e.g. Tail(Days)→ [Mon, Tue, Wed, Thu, Fri, Sat]) if **list** is non-empty otherwise it reports an error.
Empty(list) – returns True if **list** is the empty list or False otherwise. The empty list is denoted by [].

(a) What result is returned when the following function calls are made?

(i) Head (Tail(Days)) .....
(1 mark)

(ii) Tail ([(Head(Days)]) .....
(1 mark)

(iii) Empty(Tail(Tail(Tail(Days)))) .....
(1 mark)

(b) Explain why it is faster to access these elements if the above data is stored as a one dimensional array.

.....

.....
(2 marks)

7 In the context of memory management, explain the following terms:

(a) virtual memory;

.....

.....

.....
(3 marks)

(b) paging.

.....

.....

.....
(3 marks)

5

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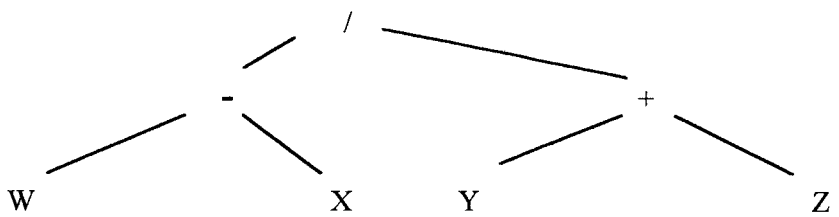
8 An algebraic expression is represented in a binary tree as follows.



(a) On the above diagram, circle and label the *root* of this tree, a *branch* and a *leaf node*.
(3 marks)

(b) In the spaces below, draw the *left sub-tree* and the *right sub-tree* of this tree.

left sub-tree | right sub-tree

(2 marks)

(c) What is the result if this tree is printed using in-order traversal?

.....

(3 marks)

8

TURN OVER FOR THE NEXT QUESTION

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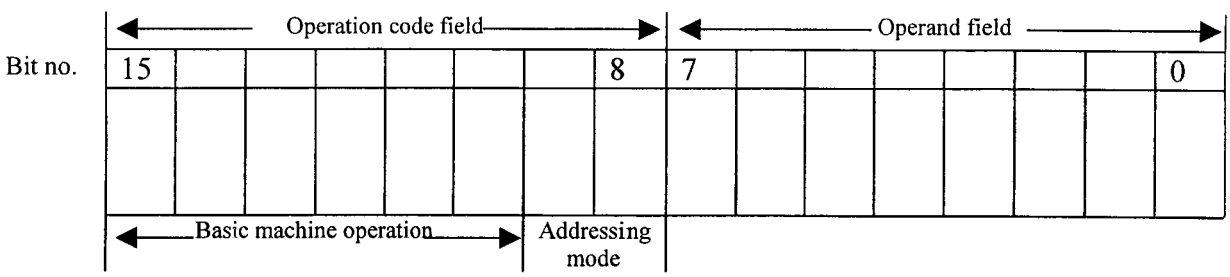
9 A computer design company has produced a design for an elementary computer. It is to be used to teach students about machine architecture, machine operations and the design of an *instruction set.*

The current instruction register has a length of 16 bits.
The accumulator has a length of 16 bits.
The size of each memory location is 16 bits.
The current instruction register is designed to hold one instruction at a time.
A machine instruction is 16 bits in length.
The most significant eight bits of a machine instruction denote the machine operation. The least significant bits denote an operand or the address of an operand.
Main memory stores both instructions and data.

The structure of a machine instruction is as follows.



(a) Define the term instruction set.

.....

.....

(1 mark)

(b) With 6 bits of the operation code reserved to denote basic machine operations, how many basic machine operations may be coded?

.....

(1 mark)

(c) With reference to the operand field of a machine instruction, describe the following addressing modes:

(i) Immediate: .....

.....

(1 mark)

(ii) Direct: .....

.....

(1 mark)

(iii) Indirect: .....

.....

.....

(2 marks)

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(d) The following machine operations have their operation codes expressed in hexadecimal.

Machine operation	Addressing Mode	Operation Code (hex)	Description
LDA	Immediate Direct Indirect	A1 A2 A3	Load accumulator
STA	Direct Indirect	B2 B3	Store accumulator
ADD	Immediate Direct Indirect	61 62 63	Add operand to contents of accumulator, storing result in accumulator

(i) Convert the operation code for the operation STA for indirect addressing from hexadecimal to binary.

.....

(1 mark)

(ii) It is required to add the hexadecimal number 6 to the contents of a main memory location whose address in hexadecimal is C1, with the result being stored in another memory location at hexadecimal address AB.

Complete the sequence of instructions, in hexadecimal, to perform this task on the machine above.

A1 06

.....

.....

(4 marks)

(e) For the given machine:

(i) What is the highest memory address that can be addressed by an instruction using direct addressing?

.....

(1 mark)

(ii) What is the highest address that can be addressed by an instruction using indirect addressing?

.....

(2 marks)

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10 A simple logic processing language is used to represent, as a set of facts and rules, the valid construction of sentences. The set of facts and rules are shown below in clauses labelled 1 to 13.

1. determiner (the).
2. adjective (big).
3. adjective (little).
4. verb (is).
5. verb (climbs).
6. noun (thomas).
7. noun (hill).
8. noun_phrase(X) IF noun(X).
9. noun_phrase(X,Y) IF determiner(X) AND noun(Y).
10. noun_phrase(X,Y,Z) IF determiner(X) AND adjective(Y) AND noun(Z).
11. sentence (A,B,C) IF noun_phrase(A) AND verb(B) AND noun_phrase(C)
12. sentence (A,B,C,D,E) IF noun_phrase(A) AND verb(B) AND noun_phrase(C,D,E).
13. sentence (A,B,C,D,E) IF noun_phrase(A,B,C) AND verb(D) AND noun_phrase(E).

Clause 1 has the meaning 'the is a determiner'.
Clause 9 has the meaning 'X followed by Y is a noun_phrase if X is a determiner and Y is a noun'.

(a) Using the given set of facts and rules (1–13) above, give one example of

(i) a fact: .....

(ii) a rule: .....

(2 marks)

(b) Using the given set of facts and rules (1–13) above, state whether or not the following sentences are valid.

(i) thomas climbs the little hill: .....

(ii) the little hill climbs thomas: .....

(2 marks)

(c) The sentence 'little thomas climbs the hill' is not valid according to the facts and rules (1–13) above. Write a further rule or set of rules which would make it valid.

.....

.....

.....

.....

(6 marks)

END OF QUESTIONS

10

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