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Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
 January 2006
 Advanced Level Examination



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

Tuesday 24 January 2006 9.00 am to 10.30 am

You will need no other materials.
 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.
- Answer the 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.
- 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. Quality of Written Communication will be assessed in these answers.

For Examiner's Use			
Number	Mark	Number	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 0111 0100 can represent different numbers.

(a) State its hexadecimal representation.

.....
(1 mark)

(b) State its value in denary if it represents BCD.

.....
(1 mark)

(c) State its value in denary if it represents an unsigned fixed point number with four bits after the binary point.

.....
(2 marks)

(d) State its value in denary if it represents a two's complement fixed point number with four bits after the binary point.

.....
.....
(2 marks)

(e) (i) State its value in denary if it represents a normalised two's complement floating point number with an eight bit mantissa followed by a four bit exponent.

.....
.....
.....
(3 marks)

(ii) Give a reason for storing floating point numbers in normalised form.

.....
.....
(1 mark)

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

(a) Give a disadvantage of:

(i) an array implementation;

.....
(1 mark)

(ii) a linked list implementation.

.....
(1 mark)

(b) Under what circumstances would it be more appropriate to use:

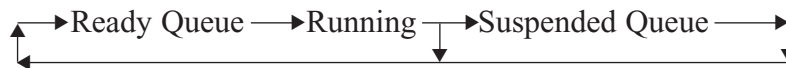
(i) an array;

.....
(1 mark)

(ii) a linked list.

.....
(1 mark)

3 A program that is being executed under the control of a multiprogramming operating system is known as a process. A process will go through the following cycle:



(a) Give **three** reasons for a process to leave the running state.

- 1
- 2
- 3
(3 marks)

(b) Give **three** characteristics that may be taken into account by the operating system when selecting the next process to be taken from the ready queue.

- 1
- 2
- 3
(3 marks)

4

6

4 A 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.

```

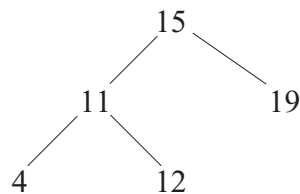
Procedure P (T)
  If LeftChild(T) exists
    then P(LeftChild(T))
  Output RootValue(T)
  If RightChild(T) exists
    then P(RightChild(T))
EndProc
  
```

(a) What is meant by recursively-defined?

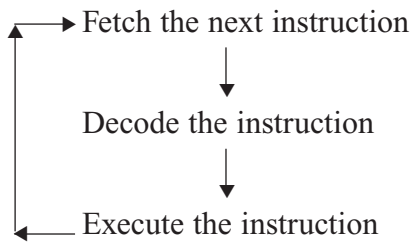
.....

(1 mark)

(b) (i) Complete **Table 1** by dry running the procedure call P(T) for the tree T given below.



5 The fetch execute cycle may be described as:



(a) Name **four** registers that are used in the Fetch Decode part of the cycle.

- 1
- 2
- 3
- 4

(4 marks)

(b) (i) What additional steps would be required if the computer system had an interrupt mechanism?

-
-

(2 marks)

(ii) Where would they be placed in the above cycle?

-

(1 mark)

(c) (i) Describe the vectored interrupt mechanism.

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

(3 marks)

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

.....
.....

(1 mark)

11

Turn over for the next question

- 6 For an object-oriented program to store and retrieve details of a company's vehicles, a **Vehicle** class is needed. Two subclasses have been identified: **Car** and **Van**, which have inheritance relationships with class **Vehicle**.
- (a) Draw an inheritance diagram for these classes.

(2 marks)

- (b) The **Vehicle** class has data fields **RegistrationNumber**, **Make**, **Colour**.

The class definition for **Vehicle** is

```
Vehicle = Class
    Public
        Procedure SetVehicleDetails
        Function GetRegistrationNumber
        Function GetMake
        Function GetColour
    Private
        RegistrationNumber : String
        Make : String
        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 vehicle to be changed?

.....
.....

(2 marks)

(c) The Van class has additional private data fields:

- Capacity that represents the weight that can be carried in kilograms;
- TailLift that represents whether the van has a tail lift or not.

Write the class definition for **Van**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(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.

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
ST	nnnn	Store contents of the accumulator into hexadecimal address nnnn
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

- (a) (i) Given that the ASCII code for '0' is the binary value 00110000, write an AND instruction to convert any numeric ASCII code stored in the accumulator to its 8-bit binary integer equivalent.

.....
(1 mark)

- (ii) The accumulator contains an 8-bit integer in the range 0 to 9. Write an OR instruction to convert it into its equivalent ASCII code.

.....
(1 mark)

- (b) The memory locations 01A3 and 01A4 contain the ASCII characters '2' and '6' representing the denary value 26 as follows.

Address	Hexadecimal Representation	ASCII Character
01A3	32	'2'
01A4	36	'6'

Write the necessary assembly code instructions to convert the characters '2', '6' into a binary number representing the denary value 26 and store the result in location 01A6. You may use location 01A5 as a work area.

Opcode	Operand(s)	Comment

(5 marks)

Turn over for the next question

8 A logic program is used to represent, as a set of facts and rules, details of the computers owned by a school. The set of facts are shown below in clauses labelled 1 to 15.

1. computer (laa, laptop)
2. computer (lab, laptop)
3. computer (daa, desktop)
4. computer (dab, desktop)
5. computer (dac, desktop)
6. in_department (laa, mathematics)
7. in_department (daa, mathematics)
8. in_department (lab, ict)
9. in_department (dab, ict)
10. in_department (dac, library)
11. make (daa, brandx)
12. make (dab, brandx)
13. make (laa, brandx)
14. make (lab, brandy)
15. make (dac, brandz)

Clause	Meaning
1	The school owns a computer named laa and it is a laptop
6	The computer named laa is in the mathematics department
11	The computer named daa is made by brandx

(a) The school has obtained a brandz desktop computer to be placed in the library. Write the extra facts required to represent this computer.

.....

 (3 marks)

(b) The goal make (Name, brandx) would return the result daa, dab, laa. Write the result returned by the goal:

in_department (Name, mathematics).
 (2 marks)

(c) Complete a rule that could be used to list the laptops in departments.

department_laptop (Computer, Department)

 (3 marks)

END OF QUESTIONS