PAPER CODE NO.	EXAMINER : **Dr FP Coenen**	
COMP205	DEPARTMENT : Computer Science	Tel. No. **3698**

JANUARY 2000 EXAMINATIONS

Degree of Master at Mathematics in Mathematics: Year 2
Degree of Bachelor of Arts : Year 2
Degree of Bachelor of Engineering : Year 2
Degree of Bachelor of Science : Year 2

PROGRAMMING LANGUAGES

TIME ALLOWED : Two Hours

INSTRUCTIONS TO CANDIDATES

Candidates should attempt all three sections A, B and C.

Answer **ALL** 12 questions in Section A (3 marks each)
In Section B credit will be given for the best **FOUR** answers (6 marks each)
In Section C credit will be given for the best **TWO** answers (20 marks each)

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

SECTION A (COMPULSORY SECTION)

1) In what circumstances might it be better to use an array of structures rather that a linked list?

(3 marks)

2) Briefly differentiate between "access values" as found in the Ada group of imperative programming languages and C pointers.

(3 marks)

3) What did Dijkstra mean by the statement "goto statement considered harmful"?

(3 marks)

4) Given the following piece of code what would you expect the output to be:

```
#include <stdio.h>

void main(void)
{
typedef union data {
     int integer;
      char character;
       } DATA_T;
DATA_T input;

input.integer = 2;
printf("input.integer = %d\n",input.integer);

input.character = 'A';
printf("input.character = %c\n",input.character);
}
```

(3 marks)

5) What is an abstract data type as supported by some imperative languages?

(3 marks)

6) What are the principal advantages and disadvantage of dynamic binding with respect to Object Oriented Programming languages?

(3 marks)

7) In Object Oriented Programming what do we mean by inheritance?

(3 marks)

8) Using an example, explain how :: (cons) can be used to select the correct equation in a Hope function.

(3 marks)

9) Give an example of a Hope operation, which is evaluated lazily.

(3 marks)

10) Using the following Hope function, square, define a Hope function, quad, which raises its argument to the fourth power.

```
dec square : num -> num;
--- square x <= x * x;
```

(3 marks)

11) Explain what is meant by a Horn Clause in Logic Programming.

(3 marks)

12) Briefly describe the topology of a butterfly interconnection network employed in some parallel computers?

(3 marks)

SECTION B (ANSWER FOUR OUT OF SIX)

1) What would you expect the output to be given the following C program?

```
#include <stdio.h>

void main(void)
{
int n, *nptr;

n = 2;
nptr = &n;
printf("%d\n",n);
printf("%d\n",&n);
printf("%d\n",nptr);
printf("%d\n",&nptr);
printf("%d\n\n",*nptr);
*nptr = *nptr+4;
printf("%d\n",n);
}
```

(6 marks)

2) When implementing program error handling mechanisms what are the distinguishing features that differentiate "signal statements" from "exception handlers". Illustrate your answer with an appropriate code fragment of exceptions handler code.

(6 marks)

3) Given the following objects;

Object	Attributes	Operations
square	length	Calculation of Area
rectangle	length width	Calculation of Area
Cube	length	Calculation of Volume
Cuboid	length width height	Calculation of Volume

and using C++ (or any similar language that you a familiar with) organise the objects into a class hierarchy.

(6 marks)

4)

(i) Write a Hope function to return a list of the squares of all numbers up to and including n.

(3 marks)

(ii) The following Hope function reverses the elements of a list of numbers.

```
dec reverse : list num -> list num ;
--- reverse nil  <=  nil ;
--- reverse ( h :: t ) <=  reverse( t )  <>  [h] ;
```

Show how HOPE will evaluate the following expression by specifying the arguments and the result for each function call (i.e. sequence of reductions)

```
reverse [ 4 , 2 ]
```

(3 marks)

5)

(i) Determine whether the pattern (a :: (b :: c) , h :: nil) matches the following expressions. If an expression does match the pattern then give the values that are assigned to the variables in the pattern as a result of the match.

(a) ([(2,3), (4,5)] , [1])
(b) ([1,2,3] , [7,2,4])

(3 marks)

(ii) The following Hope function (isone) returns true, if the number of elements in a list is one. The function isone calls the function length to determine the number of elements in a list. Using pattern matching redefine the function isone without the function length.

```
dec isone : list  num  ->  truval;
--- isone ( alsit ) <= length (isone) = 1 ;
```

(3 marks)

6) Consider the following Prolog program consisting of the single clause:

likes(bob,[jazz,logic_programming,wimbledon]).

What would be the answer to the following queries?

(i) likes(bob,X).
(ii) likes(bob,[X]).
(iii) likes(X,Y).
(iv) likes(bob,[X,logic_programming,Y]).
(v) likes(bob,[X,logic_programming | Y]).
(vi) likes(bob,[X | Y]).

(6 marks)

SECTION C (ANSWER 2 OUT OF 4)

1)

(a) Suggest an appropriate data structure that can be used to store "tables" of information of the form shown below.

(4 marks)

2	4	6	8	10
4	6	8	10	12
6	8	10	12	14
8	10	12	14	16
10	12	14	16	18

(b) Illustrate how you would use the data structure suggested in (a) to declare and initialise a data item to store the above table.

(6 marks)

(c) Describe an appropriate algorithm to search through the above table and count the number of occurrences of a given element.

(10 marks)

2)

(a) Using C, define a "tree" structure (type name = tree_t) comprising the following fields:

Type	Name
int	value

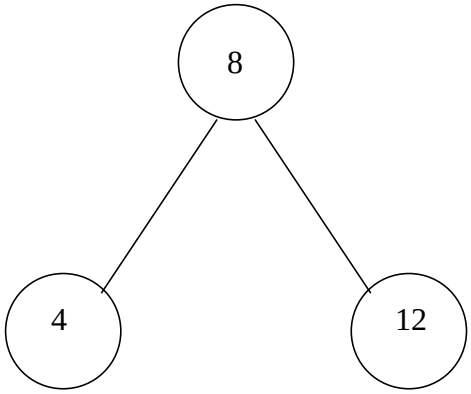
tree_t	leftBranch
tree_t	rightBranch

(8 marks).

(b) Define a function (called createTreeStruct) that will dynamically create a structure of the form defined in part (a) given a specific value for the value field and assuming the other two fields take the value NULL, and return a pointer to it.

(8 marks)

(c) Suggest a sequence of calls to the createTreeStruct function defined in (b) and pointer re-assignments that will result in a tree of the form given below.



(4 marks)

3)

(a) Write a Hope function that will return the number of occurrences of a term given as its first argument in a list given as its second argument. For example,

occ (2, [3, 2, 5, 2, 4, 2])

should return 3.

(5 marks)

(b) Using the function defined in (a) write a Hope function, occ1, that will return the number of occurrences of the first element in a list. For example:

occ1 ([3, 2, 5, 3, 2, 3, 3])

should return 4.

(5 marks)

(c) Using the function defined in (a) write a Hope function, occ2, that takes two lists as arguments and will return a list of the number of occurrences of each element of the first list in the second. For example,

occ2 ([4, 5, 2], [5, 2, 5, 4, 2, 3, 5])

should return [1, 3, 2].

(7 marks)

(d) List three features of a functional language such as Hope.

(3 marks)

4)

(a) Briefly define:

(i) The Hypercubic Interconnection Network for processors employed in some parallel computers.

(4 marks)

(ii) the theoretical Parallel Random Access Machine (P-RAM).

(4 marks)

(b) Outline how the addition of n numbers can be achieved in O(log n) parallel time on a P-RAM using n/(log n) processors.

(8 marks)

c) Why is this an optimal parallel algorithm?

(4 marks)