

OLLSCOIL NA hÉIREANN GAILLIMH  
NATIONAL UNIVERSITY OF IRELAND GALWAY

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SUMMER EXAMINATIONS 2001

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M.Sc. in Software Design and Development

**ALGORITHMS AND LOGICAL METHODS (CT518)**

Professor D. Bell  
Professor G. Lyons  
Dr. M. Mc Gettrick

Time allowed: *two* hours.  
Attempt *four* questions.

1. (a) Using each of the following methods, write down (step by step) the position of each letter in the word "italy" when sorted (in alphabetical order) using
  - (i) bubble sort
  - (ii) merge sort
 (b) State precisely what is meant by saying an algorithm has complexity  $O(f(n))$ . State the complexity of the algorithms in part (a) and hence calculate the number of comparisons each makes to sort 16 items.
  
2. (a) Write the pseudocode for an algorithm which calculates  $x^n$ , given as input  $x$  and  $n$  where  $n$  is a positive integer, using
  - (i) Iteration
  - (ii) Recursion
 (b) Write the pseudocode for a recursive algorithm which checks whether or not a word is a palindrome (a palindrome is a word which reads the same written in either direction, e.g. "deed", "abba").
  
3. (a) We have 64 identical coins, one of which is known to be defective. It is also known that the defective coin is heavier than all the others. Explain how, using a weighing scales, one might use a divide and conquer strategy to find the defective coin. Compare this solution to the one proposed by a brute force approach.
 (b) Consider the following knapsack problem: We have a bag with weight capacity 6 kilograms. There are five items with weights  $w(i) = [1, 4, 2, 2, 3]$  (kilograms) and values  $v(i) = [2, 6, 3, 4, 7]$ . There is only one of each item, and we wish to maximize the total value obtained by putting items in the bag without exceeding its capacity. Use Dynamic Programming to find which items we should pick.

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4. (a) Draw the binary tree that results from inserting into an initially empty tree the following words in the order given:

**white, blue, brown, green, red, yellow**

If we had 57 data items to insert into a **ternary tree**, what is the minimum possible depth of the tree?

- (b) Distinguish between each of the following terms.
- (i) Propositional Calculus
  - (ii) Predicate Calculus
  - (iii) FOPC (First Order Predicate Calculus)
5. (a) Use truth tables to determine whether each of the following well formed formulae (wff) are tautologies, contradictions, or neither.
- (i)  $\neg(A \vee B) \leftrightarrow \neg A \wedge \neg B$
  - (ii)  $A \vee (B \wedge C) \leftrightarrow (A \vee B) \wedge (A \vee C)$
  - (iii)  $\neg(A \wedge B) \rightarrow (A \vee \neg B)$

- (b) Given the predicates

$E(x)$  : "x is an Eagle"

$M(x)$  : "x is a Mouse"

$A(x,y)$  : "x Attacks y"

write statements in First Order Predicate Calculus to express each of the following.

- (i) All Eagles Attack Mice.
- (ii) Some Eagles Attack all Mice.
- (iii) Only Eagles Attack Mice.