Ollscoil na hÉireann, Gaillimh *GX* ______

National University of Ireland, Galway

Semester II Examinations, 2002/2003

Exam Code(s)	1MS1, 1SD1
Exam(s)	MS1 M.Sc.Degree
	SD1 H.Dip.(Software Design And Development)
Module Code(s)	CT853
Module(s)	Algorithmics & Logical Methods
Paper No.	1
Repeat Paper	______ Special Paper ______
External Examiner(s)	Professor D. Bell
Internal Examiner(s)	Professor G. Lyons
	Dr. M. Mc Gettrick

Instructions Answer 3 questions.
All questions will be marked equally.

Duration	2hrs
No. of Answer Books	1

Requirements

Handout ______

MCQ ______

Statistical Tables ______

Graph Paper ______

Log Graph Paper ______

Other Material ______

No. of Pages ______

Department(s) ______

1. (a) Using each of the following methods, write down (step by step) the position of each letter in the word "korea" when sorted alphabetically using

   (i) selection sort

   (ii) merge sort

   (b) State (in "Big Oh" notation) the complexities of the algorithms in part (a). On a supercomputer, it takes 2 seconds to perform a merge sort on one billion ($1,000,000,000 = 10^9$) items. Estimate how long (in seconds) it would take using merge sort on the same computer to sort 10 billion items ($10,000,000,000 = 10^{10}$).

2. (a) Explain the Divide and Conquer approach to algorithm design. Give an example (using pseudocode) of a Divide and Conquer algorithm to calculate x^n, where n is a positive integer.

   (b) In cryptography we often need to multiply two large integers. Using a Divide and Conquer strategy, the *Karatsuba* algorithm gives us an efficient way to do this. Describe the algorithm, explain why it is more efficient than "standard" multiplication, and give (in "Big Oh" notation) its complexity.

3. A container truck has total (weight) capacity 5 KiloTonnes. In a port, there are four loads it can can collect, each with a different weight and value:

Load:	A	B	C	D
Weight(Kilotonnes):	2	1	4	3
Value(Millions of Euro):	5	3	7	6

The objective is to decide which loads to take to maximize the Value, while not surpassing the 5 KiloTonne limit.

   (a) Using a Greedy approach to this problem, what solution is obtained if the Greedy approach is based on

   (i) maximizing value?

   (ii) minimizing weight?

   (iii) maximizing the (value/weight) ratio?

   (b) Describe (by composing a table of intermediate values) how Dynamic Programming can be used to solve this problem, and state the solution obtained.

4. (a) Use truth tables to determine whether each of the following well formed formulae (wff) are tautologies, contradictions, or neither.

   (i) $A \vee [(\neg B \wedge \neg A) \vee B]$

   (ii) $(A \wedge \neg A) \rightarrow (B \wedge \neg B)$

   (iii) $[A \vee (B \rightarrow C)] \wedge (\neg C \vee B)$

   (b) Given the predicates

   H(x) : "x is a hard language" (Universe $U \equiv$ set of all languages, $x \in U$)

   I(y) : "y is an Irish person " (Universe $V \equiv$ set of all people, $y \in V$)

   S(p,q) : "p Speaks (language) q" ($p \in V, q \in U$)

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

   (i) Joe speaks Japanese.

   (ii) Irish French speakers (i.e. Irish people who speak French) do not speak Korean or other hard languages.

   (iii) Easy languages are spoken by everybody.

   (iv) No Irish person speaks all the hard languages.