Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX ______

Semester II Examinations, 2002/2003

Exam Code(s)	0MS1, 1MF1
Exam(s)	MS1 M.Sc.Degree
	MF1 M.Sc.Degree(Software Design & Development)
Module Code(s)	CT518
Module(s)	Algorithms And 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 4 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) In the Travelling Salesman problem, the Salesman must visit each city exactly once while minimizing the total distance travelled. Consider the following table of distances (kilometres) between 7 Indian cities:

	Bangalore	Calcutta	Delhi	Hyderabad	Jaipur	Madras	Thiruvan-anthapuram
Bangalore	0	1881	2061	562	1985	331	753
Calcutta	1881	0	1461	1516	1462	1676	2384
Delhi	2061	1461	0	1499	258	2095	2814
Hyderabad	562	1516	1499	0	1443	688	1315
Jaipur	1985	1462	258	1443	0	2019	2697
Madras	331	1676	2095	688	2019	0	708
Thiruvan-anthapuram	753	2384	2814	1315	2697	708	0

(i) If the Salesman starts at Hyderabad, and uses the Greedy Strategy to determine his optimum route, describe the path he would take (i.e. write down the sequence of cities, and the total distance).

(ii) If he were to use a Brute Force strategy (again starting from Hyderabad), how many different routes must be considered? Estimate (in "Big Oh" notation) the complexity of both approaches (Brute Force and Greedy).

(b) Explain by giving an example each of the following:

(i) De Morgan's Law

(ii) Associativity property of $\vee$

(iii) Distribution Law of $\vee$ over $\wedge$

(iv) Commutativity of $\wedge$

5. (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.