

Semester II Examinations, 2004/2005

Exam Code(s)	1IF1
Exam(s)	IF1 B.Sc. (Information Technology)
Module Code(s)	CT102
Module(s)	Algorithms & Information Systems
Paper No.	1
Repeat Paper	Special Paper
External Examiner(s)	Professor P. Nixon
Internal Examiner(s)	Professor G. Lyons
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Instructions

Answer 5 questions.
All questions will be marked equally.

Duration	3hrs
No. of Answer Books	1

Requirements

Handout	_____
MCQ	_____
Statistical Tables	_____
Graph Paper	_____
Log Graph Paper	_____
Other Material	_____

No. of Pages	_____
Department(s)	_____

1. Using each of the following methods, write down (step by step) the position of each letter in the string “verona” when sorted alphabetically using
 - (a) quick sort
 - (b) merge sort
 - (c) selection sort

2. (a) “Big Oh” notation allows us to write equations such as $3n^2 - \log_2(n) = \mathbf{O}(n^2)$. Write each of the following functions in their simplest possible “Big Oh” notation:
 - (i) $7n! + 3^n - n^5$
 - (ii) $5n^3 \log_2(n)$
 - (iii) $(n^4 - 1)/(n^2 + 1)$
 - (iv) $(5 + 3n^4)(n + 2 \log_2(n))$
 (b) Explain the difference between the best case and worst case behaviour of the quicksort algorithm, in both cases stating the complexity in “Big Oh” notation. For a quicksort of a million items, how much slower would you expect the worst case behaviour to be compared to the best case behaviour?

3. (a) Calculate $f(5)$ where f is the recursive function defined by the following pseudocode.


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f(i)
IF (i<3) THEN
f ← i
ELSE
f ← f(i-1) + f(i-2) + f(i-3)
      
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 (b) How many times was the function f called in the calculation of $f(5)$?

 (c) Given two positive integers x, y with $y \geq x$, write an algorithm using either iteration or recursion to calculate how many times x goes into y and the integer remainder (i.e. find q and r where $y = qx + r$ and $r < x$).

4. (a) Draw an example of
 - (i) A cyclic disconnected graph
 - (ii) A ternary forest
 - (iii) A unary tree
 - (iv) A binary tree of depth 4
 (b) Describe any three operations associated with the **(ordered) list** Abstract Data Type (ADT). For this ADT, explain how it can be implemented using
 - (i) an array
 - (ii) a linked list
 and state an advantage of each implementation.

5. (a) Five (5) cities are connected by a road system, with distances in km given by the following matrix:

$$\begin{pmatrix} \infty & 31 & 77 & 21 & 143 \\ 31 & \infty & 191 & 52 & 110 \\ 77 & 191 & \infty & 99 & 82 \\ 21 & 52 & 99 & \infty & 44 \\ 143 & 110 & 82 & 44 & \infty \end{pmatrix}$$

(So, for example, city 2 is connected to city 4 by an arc/road/edge of length 52 km. An infinity (∞) in the matrix indicates the two cities are not (directly) connected.)

- (i) Draw the graph corresponding to the matrix.
 - (ii) Starting from city 4, calculate the route proposed by the *greedy* strategy which makes a tour of all the cities, visiting each exactly once and then returning to base. State the length of this tour.
- (b) State in “Big Oh” notation the complexity of the greedy approach to solving the travelling salesperson problem described in the previous section. If a greedy algorithm for such a problem with $n = 100$ cities takes 1.7 seconds to run, estimate the time it will take to run if we double the number of cities.

6. Explain each of the following terms:

- (a) Database.
- (b) The 3-schema architecture.
- (c) Logical and Physical Data Independence.
- (d) Entity-Relationship Diagrams.

7. Describe the components of an Expert System. Explain the difference between Bottom-Up (Forward Chaining) and Top-Down (Backward Chaining) Inference, giving an example of each.

8. In different countries, records are kept on the car colours that are most popular. For countries C_1 to C_4 the most popular colours are given below.

C_1 : {blue, red, black, brown}

C_2 : {red, yellow, brown}

C_3 : {black, white, red}

C_4 : {red, green, black, brown}

Calculate the support and the confidence of each of the following Association Rules, and state which are valid if we set our threshold at 70%.

- (a) {brown, red} \rightarrow {blue}
- (b) {green} \rightarrow {red}
- (c) {red} \rightarrow {black}