Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX _____

Semester II Examinations, 2006/2007

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)	Dr. John A. Keane
Internal Examiner(s)	Prof. G. Lyons
	Dr. M. Mc Gettrick
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 word "gdansk" when sorted alphabetically using

   (a) quick sort

   (b) insertion sort

   (c) merge sort

   (20 marks)

2. (a) Use the definition of "Big Oh" notation to prove that if $f(n) = \mathbf{O}(g(n))$ then $f(n) + g(n) = \mathbf{O}(g(n))$. (8 marks)

   (b) Suppose two algorithms A1 (of complexity $\mathbf{O}(n^3)$) and A2 (of complexity $\mathbf{O}(n)$) are run in parallel on a computer. On an input of size $n = 1,000,000$, A1 finishes in 10 seconds, while A2 takes 100 seconds. Estimate the approximate size of the input n for which both algorithms will take the same amount of time. (12 marks)

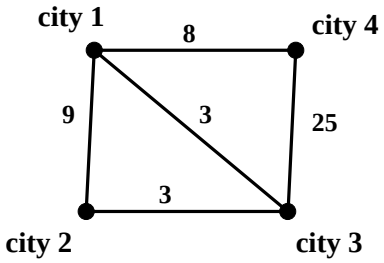
3. Describe a *Divide and Conquer* algorithm which allows us to multiply two n- digit numbers in

   (a) $\mathbf{O}(n^2)$

   (b) $\mathbf{O}(n^{\log_2 3})$

   State any approximations you make along the way. (20 marks)

4. (a) The diagram below shows a road network between four cities, with the length of each road marked. Let D_{ij} be the length of the shortest route from city i to city j (e.g. D_{12} = length of shortest route from city 1 to city 2 = 6 (travelling via city 3)) **Using the Dynamic Programming method**, calculate the matrix D (Hint: start by writing down the matrix A where A_{ij} is the length of the edge between i and j, $A_{ij} = \infty$ if there is no edge between i and j, and $A_{ii} = \infty$). For full marks you must both obtain the correct answer **and** illustrate your method.



   (15 marks)

   (b) In the general case, if n is the number of cities, estimate the complexity (in "Big Oh" notation) of your algorithm from part (a) (**Hint:** In calculating the matrices, how many distinct numbers must one calculate?) (5 marks)

5. (a) Write down the pseudocode for the *binary search* algorithm, where we are searching for an object X in an ordered list L of n items. (12 marks)

   (b) State the difference between LIFO (Last In First Out) and FIFO (First In First Out) Abstract Data Types (ADT). Give an example of a FIFO ADT, explaining three operations on it.

   (8 marks)

6. Explain (with an example in each case) the distinction between

   (a) A multivalued and a single valued attribute

   (b) A binary and a ternary relationship

   (c) A one-to-many and a one-to-one relationship

   (d) The degree and the cardinality of a relationship

   (e) A field and a record

   (20 marks)

7. (a) Explain your understanding of the difference between the terms "data" and "information".

   (6 marks)

   (b) Explain, with an example in each case, how to

   (i) decompose a many-to-many binary relationship into two one-to-many relationships

   (ii) write a ternary relationship as three binary relationships

   (14 marks)

8. In different countries, records are kept on the car colors that are most popular. For countries C_1 to C_4 the most popular colors 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}

   Beginning with large 1-itemsets, list all large itemsets (that are above a threshold of 70%). Write down any Association Rules that arise from these large itemsets, and calculate associated support and confidence values to determine if the Rules are valid at our threshold level.

   (20 marks)