Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX _____

Semester II Examinations, 2005/2006

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)	Dr. Jim Duggan
	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 digit in the number 85617 when sorted numerically using

   (a) quick sort

   (b) bubble sort

   (c) selection sort

   (20 marks)

2. (a) Using exactly 6 nodes/vertices, draw an example of

      (i) a cyclic connected graph

      (ii) an acyclic disconnected graph

      (iii) a ternary tree

      (9 marks)

   (b) Draw the graphs corresponding to the following sets:

      (i) $V = \{v_1, v_2, v_3\}, \quad E = \{(v_3, v_3), (v_1, v_2), (v_2, v_2)\}$

      (ii) $V = \{a, b, c, d, e\}, \quad E = \{(d, e), (a, e), (d, b), (c, b)\}$

      (iii) $V = \{1, 2\}, \quad E = \{(1, 1), (1, 2), (2, 2)\}$

      State which (if any) of these graphs are trees. (11 marks)

3. A truck, with weight capacity 7 kilotonnes, must pick up a number of pallets from a depot, with the objective of maximizing the total value. There are five pallets available, with weights (in kilotonnes) of 2, 5, 1, 1, 3 and corresponding values (in kiloeuro) of 11, 24, 7, 8, 20 respectively. Using *dynamic programming*, calculate which pallets should be chosen. You must show your calculations in detail by writing the table of values calculated by the algorithm.

   (20 marks)

4. Let A and B be two large positive integers, each with n digits. By writing $A = A_1 10^{n/2} + A_2$ and $B = B_1 10^{n/2} + B_2$, describe how to develop two different algorithms to calculate the product AB. Calculate the computational complexity (in "Big Oh" notation) of each algorithm, and explain any assumptions or approximations made. (20 marks)

5. (a) Write (in pseudocode) a *recursive* algorithm to calculate x^n (where n is a positive Natural number) in $\mathbf{O}(\log n)$ time. (14 marks)

   (b) Using the operations defined on the *list* abstract data type (ADT), write a pseudocode fragment to swap two elements of the list. (6 marks)

6. (a) Given the (entity) set $A = \{p, q, r\}$, write down

      (i) the power set $P(A)$

      (ii) a relation R_1 on $A \otimes A$ with $\#(R_1) = 3$

      (iii) a relation R_2 on $A \otimes P(A)$ with $\#(R_2) = 2$

      (11 marks)

   (b) Explain, with an example in each case, three operations one can perform on the *queue* ADT. (9 marks)

7. (a) Give four advantages of using Databases over File-based systems (8 marks)

   (b) Give an example of

   (i) a unary relationship

   (ii) a ternary relationship

   Explain (using an Entity Relationship Diagram) how to decompose a ternary relation into binary relations. (12 marks)

8. (a) Describe the components of an Expert System. (6 marks)

   (b) We have an Expert System with the following rules:

   - $S(x,y) \Rightarrow P(x,y)$
   - $S(x,y) \wedge P(y,z) \Rightarrow P(x,z)$
   - $S(x,y) \wedge S(x,z) \Rightarrow \neg P(y,z)$

   and the facts S(Yves,Jaime), S(Petra,Rob), S(Yves,Aoife), S(Petra,Yves). In this notation, S(x,y) means "x supervises y" and P(x,y) means "x is paid more than y". Use forward chaining to determine the set of all people that are

   (i) paid less that Yves

   (ii) paid more than Jaime

   (14 marks)