

Semester II Examinations, 2007/2008

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 _____

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Internal Examiner(s) Prof. 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 word “murcia” when sorted alphabetically using

- (a) bubble sort
- (b) selection sort
- (c) merge sort

(20 marks)

2. (a) Suppose $f(n) = \mathbf{O}(g(n))$. Use the definition of “Big Oh” notation to write down in the simplest possible form, in terms of $g(n)$, the complexity of

- (i) $3f(n)$
- (ii) $f(n)/2$
- (iii) $3f(n) - 2g(n)$
- (iv) $(f(n))^5$ (8 marks)

(b) Suppose three algorithms A1 (complexity $\mathbf{O}(\log_2(n))$), A2 (complexity $\mathbf{O}(n^2)$), and A3 (complexity $\mathbf{O}(2^n)$) are written to solve the same problem. All three algorithms take 10 seconds to run on an input of $n = 100$. If we triple the input to $n = 300$, state the amount of time (approx.) it will take each algorithm to run. (12 marks)

3. (a) Calculate $f(6)$ where f is the recursive function defined by the following pseudocode.

```
f(i)
IF (i<2) THEN
f ← i
ELSE
    IF ((i<5) AND (i>1)) THEN f ← f(i-1) - f(i-2)
    ELSE f ← f(i-1) + f(i-3) (5 marks)
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(b) How many times was the function f called in the calculation of $f(6)$? (5 marks)

(c) Suppose we change the last line of pseudocode from $\text{ELSE } f \leftarrow f(i-1) + f(i-3)$ to $\text{ELSE } f \leftarrow f(i-1) + 3$
Answer again parts (a) and (b) for this new algorithm. (10 marks)

4. A container truck has maximum capacity 16 kilo tonnes. 5 loads are available to fill the truck, each of a certain weight and value. The weights are $w[i] = 5, 7, 4, 8, 2$ (in kilo tonnes) and the corresponding values are $v[i] = 9, 12, 7, 16, 5$ (in kilo euro). Only one of each load is available. Using *Dynamic Programming* determine which loads should be chosen to maximize the value and explain the procedure used.

(20 marks)

5. (a) Suppose in a certain country the only coins used are in units of 10, 6, and 1 cents. We want to make up a certain amount n using the minimum number of coins. We happen to have in our pocket exactly two 1-cent coins, but we have a large number (assume ∞ if you want) of the 10-cent and 6-cent coins. (As an example: if $n=22$, the solution is to use a 10 and two 6's (three coins) rather than two 10's and two 1's (four coins).) If we were to use a *greedy* strategy, calculate the solution it would obtain for

- (i) $n=18$
- (ii) $n=19$
- (iii) $n=20$
- (iv) $n=33$

For each of these cases state also the optimum answer, and whether or not it equals that obtained by the greedy strategy. (12 marks)

- (b) Suppose we use a greedy strategy that looks two steps ahead instead of just one: Calculate the new answers obtained by this method in all four cases. Does it improve the answer in any of them? (8 marks)

6. (a) Explain how the Abstract Data Type (ADT) *ordered list* may be implemented using

- (i) an array
- (ii) a linked list

(11 marks)

- (b) Which implementation is more efficient in terms of

- (i) speed of insertion of a new item?
- (ii) speed of deletion of an item?
- (iii) total (memory) storage space used?

Explain your answer in each case.

(9 marks)

7. (a) Given the (entity) set $A = \{8, 3, -2\}$, write down

- (i) the power set $P(A)$
- (ii) a relation R_1 on $A \otimes A$ with $\#(R_1) = 4$
- (iii) a relation R_2 on $P(A) \otimes A$ with $\#(R_2) = 3$

(11 marks)

- (b) Draw an Entity-Relationship (ER) diagram to represent

- (i) a Unary Relationship
- (ii) a one-to-many Binary Relationship
- (iii) a Ternary Relationship

(9 marks)

8. Explain what an Association Rule is in Data Mining. Define the *support* and *confidence* of an Association Rule and explain how they can be used to determine its validity. (20 marks)