

QUEEN MARY, UNIVERSITY OF LONDON

DCS128 ALGORITHMS AND DATA STRUCTURES

Class Test Monday 21st February 2005 10.35-11.55

Please fill in your Examination Number here:

Student Number here:

All answers to this test should be written on the test sheet, but you may use spare paper for rough working. Answer as many of the questions as you can.

- 1) Explain in the space below what a **loop invariant** is, and explain how this concept can be used to prove the correctness of some algorithms.

- 2) a) Write a Java static method `replace` which takes as its argument an array of integers and two integers and destructively replaces all occurrences of the first integer by the second in the array. For example, if the array is:

5	7	9	3	7	4	1	2	8	7	3
---	---	---	---	---	---	---	---	---	---	---

and the integers are 3 and 6, it will change the array to:

5	7	9	6	7	4	1	2	8	7	6
---	---	---	---	---	---	---	---	---	---	---

- b) Write in the space below a static method which performs the same operation as in part a), but does it constructively.

- c) Write in the space below a Java static method `delete` which takes as its argument an array of integers and an integer, and returns an array consisting of all the integers in the original array in the same order, except that there are no occurrences of the integer given as an argument. For example, if the array argument was the one from question 2 a), and the integer argument was 7, the array returned would be:

5	9	3	4	1	2	8	3
---	---	---	---	---	---	---	---

- 3) The operation of searching for a particular item in an array is described as $O(N)$ when the items in the array are not ordered, but can be done using an algorithm which is described as $O(\log N)$ when the items are ordered.

In the space below, explain what is meant by these descriptions, outline the algorithm which is described as $O(\log N)$, and argue informally why this algorithm is $O(\log N)$ rather than $O(N)$.

- 4) a) Describe briefly the difference between a **mutable** and an **immutable** object.
- b) Explain briefly what is meant by **aliasing** and why this may be a problem with mutable but not immutable objects.
- c) Explain briefly what is meant by **tail recursion**.
- d) Suppose we have a method with the following header in class `Thing` :
- ```
public Thing doSomething(int n)
```
- and for certain values of `n` when this method is called the statement `return this` is executed. Explain briefly what executing this statement causes to happen.

- 5) Describe **three** different data structures that may be used to implement the abstract data type “set of integers”. For each of them, give its advantages and disadvantages.