
# OLLSCOIL NA hÉIREANN MÁ NUAD

# THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

## AUTUMN 2014 EXAMINATION

# CS210

# Algorithms & Data Structures 1

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Time allowed: 2 hours

Answer all three questions

**All questions** carry equal marks

**[25 marks]**

**1** (a) Select a sorting algorithm of your choice and state its big O complexity. Explain in detail why the algorithm has this complexity. [6 marks]

(b) Describe an algorithm for inserting a new item into a sorted array. Complete the Java method below where `array` is an array of `int`s and key is the value to be inserted. [6 marks]

```
public void insertSorted (int key, int array){

     …fill this in…
}
```

(c) Explain the bubble sort algorithm using examples and diagrams as appropriate. Provide a Java implementation of the algorithm. [7 marks]

(d) Describe how the binary search algorithm works. Show step by step how it would search for the number 21 in the following array, keeping track of the values of the upper and lower bounds. [6 marks]

```
[15  21  24  26  58  59  65  69  74  78  92]
```

**[25 marks]**

**2** (a) Show how the contents of a queue, priority queue (higher numbers have higher priority) and stack would update given the following operations. [6 marks]

```
insert(3)
insert(5)
  peek()
 remove()
insert(9)
insert(1)
 remove()
  peek()
insert(4)
 remove()
```

(b) Design an algorithm that uses a `Stack` object to reverse a `String`. You can assume that a `Stack` class is available with `push()` and `pop()` methods. Provide a Java implementation of your algorithm and explain how it works. [6 marks]

(c) Explain the concept of a linked list in your own words, using [6 marks]

examples and diagrams as appropriate. In your answer you should describe the concepts of singly-linked, doubly-linked, single ended and double ended.

(d) Describe the merge sort algorithm in detail, explaining how it uses a divide and conquer approach to achieve $O(n \log n)$ performance. Show how it would sort the numbers below. [7 marks]

6 5 3 1 8 7 2 4

**[25 marks]**

**3** (a) Write a Java method that takes in the current time in hours and minutes and outputs the angle in degrees between the hour and minute hands on a watch displaying the current time (e.g. at midnight the angle is 0 degrees). [8 marks]

(b) By definition, the first two numbers in the Fibonacci sequence are 0 and 1, and each subsequent number is the sum of the previous two. Write a Java method that takes in an `int` and outputs that number of the Fibonacci sequence (e.g. given an input of 5 the program should output 3, which is the fifth Fibonacci number). [8 marks]

(c) Write a Java method that takes in an `int` and outputs whether or not the number is a palindrome, using the mathematical operations modulus and division (e.g. 13431 is a palindrome because it reads the same forwards as backwards). [9 marks]