Student Number:

THE UNIVERSITY OF MELBOURNE
SCHOOL OF COMPUTING AND INFORMATION SYSTEMS

COMP90038: Algorithms and Complexity
Sample Exam Questions (Weeks 1-5)

Note: this test should be used as a tool to help you evaluate your progress in the subject.

Instructions to students:

- There are three parts to the test:

  Part A – 5 $\times$ 1 mark multiple choice questions.

  Part B – 10 marks for short answer questions.

- Please write your answers to the multiple choice questions in the labelled boxes on page 2.
- Please write your answer to each of the short answer / algorithm questions in the ruled boxes below (or next to) the question. If necessary, use the reverse side of any page to prepare a draft answer. Then, copy your draft answer into the appropriate boxes.

Part A: multiple choice questions **[5 × 1 = 5 marks]**

Pick the best answer to each question. Write your answer in the boxes below.

1b 2d 3b 4b 5b

Question	1.	2.	3.	4.	5.
Answer					

1. Choose the correct statement

   (a) $n(n+1)/2 \in \Theta(n^3)$
   (b) $100n + 5 \notin \Omega(n^2)$
   (c) $5n^2 + 2n + 16 \in O(n)$
   (d) $0.01n \in O(\log n)$

2. The worst case running time when performing selection sort on a list of n integers is

   (a) $O(\log n)$
   (b) $O(n \log n)$
   (c) $\Theta(n)$
   (d) $\Theta(n^2)$

3. A sorting algorithm is considered stable if it

   (a) changes the relative order of equal elements in its input
   (b) preserves the relative order of any two equal elements in its input
   (c) performs its operations mostly in the same memory used by its input elements
   (d) has worst case efficiency $O(n \log n)$

4. The number of character comparisons made by the brute-force algorithm in searching for the pattern `TAB` in the text `NOBODY_NOTICED` is

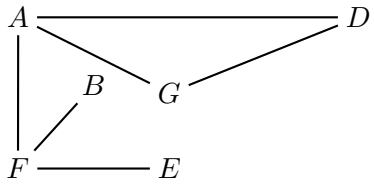
   (a) 12
   (b) 13
   (c) 14
   (d) 15

5. Given an adjacency-list representation of a directed graph, what is the time complexity to compute the out-degree of every vertex?

   (a) $O(|V| \times |E|)$
   (b) $\Theta(|V| + |E|)$
   (c) $\Theta(|E|)$
   (d) $\Omega(|E|)$

Part B: short answer questions **[10 marks]**

1. Consider the following graph:



(a) Starting at node A, traverse the graph by depth-first search, resolving ties by taking nodes in alphabetical order. Use the notation introduced in the Levitin text to illustrate the traversal stack as the search progresses. [2 marks]

		G3,1			B5,3	E6,4	
	D2	D2	D2,2	F4	F4	F4	F4,5
A1	A1	A1	A1	A1	A1	A1	A1,6

(b) Starting at node A, write down the sequence of the nodes visited in the graph when using breadth-first search, resolving ties by taking nodes in alphabetical order. [1 mark]

A I D F G I B E

(c) Is the graph acyclic (yes or no) ? [1mark]

2. Consider the pseudo-code below:

function MYSTERY($A[0..n-1], k$)
  //Input: an array of n integers and an integer k (where $k < n$)
  //Output: ?
  for $i \leftarrow 0$ to $n-1$ **do**
    $value \leftarrow 0$
    for $j \leftarrow 0$ to $n-1$ **do**
      if $i \neq j$ and $A[i] < A[j]$ **then**
        $value \leftarrow value + 1$
    if $value = k-1$ **then**
      return i
  return -1

(a) What does the algorithm compute? [2 marks]

No

Returns the index of the first item on the array that has exactly k-1 items greater than it in the array

(b) In Big-O terms, what is the overall time complexity of the algorithm on the previous page ? [1 mark]

O(n2)

3. Solve the recurrence equations – using telescoping/substitution – and give the asymptotic time complexity of the algorithm. [3 marks]

$C(n) = 3C(n-1)$ for $n > 1, \quad C(1) = 4$

C(n)=3C(n-1) n>1 C(1) = 4
Telescoping / repeated substitution results in
C(n) = 3^i C(n-i) Note: steps omitted from sample solution
Let i = n-1
C(n) = 3^(n-1) C (1) C(n) = 4/3 . 3^n
Thus O(3^n)