COMP20003 Algorithms and Data Structures
Spring 2017 **Name:** ____________________
Midterm **Student ID** ____________________
8/9/2017
Time Limit: 30 Minutes
Reading Time: 5 Minutes

This paper has three questions. Answer all questions on the test paper on the printed side only. You may use the facing page for your own notes if you wish, but it will not be marked unless you clearly indicate this as your wish.

There are extra blank pages at the end of the paper.

Marks are shown out of 10, and this paper counts for 10% of your final grade. You are permitted to use pencil.

This exam contains 9 pages (including this cover page) and 8 questions.

Please do not open this test until instructed to do so.

Grade Table (for teacher use only)

Question	Points	Score
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	3	
Total:	10	

Computational Complexity (2 marks)

1. (1 point) Given the following functions $f(n)$ and $g(n)$, is f in $O(g(n))$? If true, prove it, e.x. specify a constant c and point n_0, if false, briefly specify why.

   (a) (1/3 points) $f(n) = n(n-1)/2$, $g(n) = n^2$.

   (b) (1/3 points) $f(n) = 3n + log_2 n$, $g(n) = log_2 n$.

   (c) (1/3 points) $f(n) = 2^{n+100}$, $g(n) = 2^n$.

2. (1 point) Write down a) how many operations are executed for each code segment, and b) express it in terms of Big-Θ complexity:

```
for( i = 0; i < n; i++ )
   for( j = 0; j < n; j++ )
      for( k = 0; k < n; k++ ) {
         q = i + j*k;
         printf("%d\n",q);
      }
```

```
for( i = 0; i < n; i++ )
   for( j = 0; j < n; j++ )
      acum += A[i][j];
k=0;
while( k < n ) {
   acum -= k;
   k++;
}
```

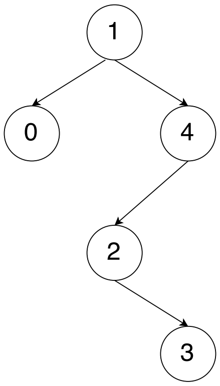
Searching and Sorting (5 marks)

Briefly and clearly answer each of the following questions.

3. (1 point) (a) (1/2 points) You are given a **sorted** dataset of n items. If you want to build an app that supports lookup operations, is it better to store it in an array or a binary search tree? Justify your answer.

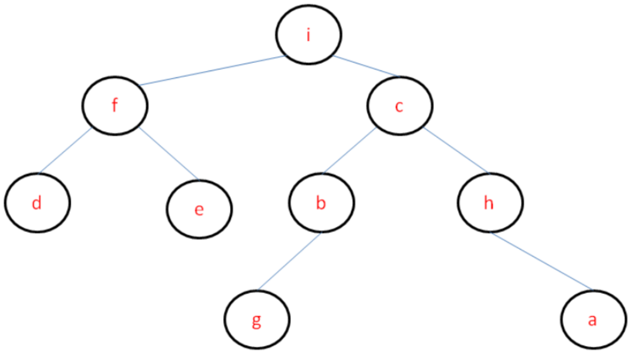
   (b) (1/2 points) Given an **unsorted** array of n integers whose value range from 0 to 1, is it possible to sort the array in order $O(n)$? Justify your answer.

4. (1 point) Given the tree below:



Show step by step the rotations needed to get a balanced tree

5. (1 point) Given the tree below:



Which traversal is needed to copy the tree? Justify your answer by showing the sequence of nodes visited.

6. (1 point) In the year 2050, COMP20003 Robo-lecturer's brain stores in a hash-table all m student faces in order to greet them when they come to class. Its internal hash-table size is n. Internally it has a perfect hash function that maps a student to a unique position in the table. Under which conditions the Robo-lecturer is guaranteed to find faces in O(1)? Justify your answer in terms of the size of n and m.

7. (1 point) Given the sequence of integers $\{4, 8, 2, 1, 10, 5\}$, sort them in ascending order using quicksort, by selecting the **leftmost** element as pivot. For each iteration, show **only** which is the selected pivot and the result of each partition.

C Code (3 marks)

8. (3 points) On the next page, you are given a partially written C program. Fill the Gaps.

```
#include<stdlib.h>
#include<stdio.h>

typedef struct node{
   int key;
   struct node* next;
} node_t;

typedef node_t* node_ptr;

void main()
{
   node_ptr p = NULL;
   node_ptr listhead = NULL;

/**
* ADD CODE HERE:
* Create a listhead with key = 1,2,3,...,10
*/
```

```

/**
* ADD CODE HERE
* delete all keys from memory
*/
```

```

}
```